The Alaska Power Authority

SUSITNA HYDROELECTRIC PROJECT

A Detailed Plan of Study

September 1979

INTERNATIONAL ENGINEERING COMPANY, INC.
A MORRISON-KNUDSEN COMPANY

CONSULTING
ENGINEERS

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9052-902

10 September 1979

Mr. Eric P. Yould
Executive Director
Alaska Power Authority
333 West 4th Avenue, Suite 31
Anchorage, Alaska 99501

Dear Mr. Yould:

International Engineering Company, Inc. has prepared the accompanying Plan of Study for the Susitna Hydroelectric Project in accordance with the Service Contract of 22 June 1979 and the Alaska Power Authority's Request for Proposal.

IECO's proposed Plan of Study combines the activities required to formulate a rational plan for developing the hydroelectric potential of the Upper Susitna River Basin; verifying and documenting the feasibility of such a plan; and preparing the application for Federal Energy Regulatory Commission license.

The proposed Plan of Study provides for substantial utilization of Alaskan expertise - institutions, agencies and enterprises.

The time schedules set forth have been very carefully developed to realistically provide for accomplishing the Plan of Study work and to prepare for subsequent phases of the project - the objective being to realize benefits as soon as practicable.

Estimated costs have been objectively developed by IECO and supporting subcontractors. These costs, and the various work plans upon which they are based, may be adjusted through joint review with the Alaska Power Authority preparatory to commencing work.

The key staff indicated in the proposed Plan of Study has been reserved for this work. You will hear from a group of these people, and have an opportunity to question them, during the oral presentation on September 27th.

The issues...technical, environmental and social...involved in providing timely and economical energy to Alaska's developing Railbelt are complex and challenging. They must and will be understood and an appropriate program implemented, a program sensitive to the concerns of all Alaskans.

We offer our enthusiastic support and our professional capabilities to this end.

Yours truly,

R. B. Christensen

R. B. Christensen

RBC/sjw

Encl: Plan of Study (5)

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Section 1 - Program Objectives

The Plan of Study presented herein, leading to a Federal Energy Regulatory Commission (FERC) license application for the Susitna Hydroelectric Project, has been prepared in response to a request from the Alaska Power Authority (APA), dated June 22, 1979.

To accomplish the objectives of the Plan of Study, International Engineering Company, Inc. (IECO) has put together the following team of engineering and environmental specialists--firms experienced in comprehensive planning of major energy development programs:

- Prime Consultant - IECO
- Associated Consultants
  - Environmental: EDAW, Inc., and Dames and Moore
  - Hydrological Modeling: Hydrocomp

Other organizations and individuals that have been selected by the Study Team to participate in the project studies in the areas of their particular expertise are:

- Supporting Subcontractors
  - Cook Inlet Region, Inc./Holmes and Narver, Inc. (CIRI/H&N)
  - University of Alaska Geophysical Institute
  - University of Alaska Museum
  - University of Alaska Institute of Social and Economic Research
  - Shannon and Wilson, Inc.
- Special Consultants

The long-range goal of the APA is to develop and implement a plan for generation of electric power to meet the future energy requirements of the State of Alaska at the lowest economic cost and with minimal adverse environmental impact. Hydroelectric development of the Upper Susitna basin is among the potential sources for meeting the energy needs of the Railbelt Region.

The objective of the Plan of Study is to provide information in sufficient detail for the State to determine whether to proceed with implementation of the Susitna Hydroelectric Project and, if so, to prepare an Application for License for submittal to the FERC. The IECO team will achieve this objective by, first, determining the most advantageous plan for satisfying the electric energy needs of the market area (Plan Formulation); second, verifying the technical, economic, and financial feasibility and the environmental acceptability of the Susitna Hydroelectric Project (Definitive Project Studies); and third, preparing an FERC license application.

In this three-step program, the Plan Formulation Stage will determine whether or not development of the power potential of the Susitna basin fits into the optimum plan for meeting the electric energy requirements of the people of Alaska. If it does, the program will proceed to the Definitive Project Studies Stage, in which more detailed consideration will be given to project layout; project costs and cash flow requirements; physical, economic, and financial risks; environmental and social impacts; and mitigation measures. The Definitive Project Studies will determine the feasibility of the Susitna Hydroelectric Project. If the project is found to be feasible, the program will proceed to the third stage, preparation of an FERC license application for construction of the recommended project.

During the studies the level of detail will be limited to that necessary to accomplish the program objectives. Therefore, full use will be made of available data concerning the area's future energy requirements and of previous studies of hydroelectric development of the Susitna basin, other alternative sources of electric power (such as coal- or gas-fired thermal plants or non-Susitna hydro developments), and the environmental and social impacts associated with various alternative developments.

Section 2 - Study Approach

The Susitna Hydroelectric Project, which will, if implemented, develop the power potential of the Upper Susitna basin, has been studied prevously. The U.S. Bureau of Reclamation investigated it several years ago, and the U.S. Corps of Engineers recently studied it in considerable detail. In addition, a number of other groups have also investigated this reach of the Susitna River and recommended development of its power potential. However, a comprehensive study tying the energy needs of the Railbelt Region to a systematic development of potential energy resources has never been performed.

This kind of comprehensive overall system study should now be made. It should take into account the many varied factors involved and identify the future role which the power potential of the proposed Susitna project should serve. Environmental impacts and public interests, as brought out by citizens' involvement during the planning process, would be an important input for the formulation of an optimum plan for meeting the future energy needs of the region.

A comprehensive system study should treat Susitna as one of several potential sources of energy. In parallel with Susitna hydroelectric development, and in a balanced and equitable manner, energy from coal, gas, small diversified hydro developments, and more exotic energy sources, including wind, tidal, solar and geothermal sources, should be considered. Evaluation of the relative merits of such alternatives should be based on reliability, demonstrated economics, and full consideration of their environmental and social impacts.

A preliminary design of the Susitna Hydroelectric Project should be completed only after the need for the development of the power potential has been demonstrated, and the optimum plan for staging the construction of the recommended project has been identified. Once the technical and economic feasibility of the project has been demonstrated conclusively, the APA can proceed with an application for licensing by the FERC.

The approach used in developing the Plan of Study presented herein follows the above sequence. The three stages, broadly outlined below, are referred to in the detailed descriptions of activities (Part A, Section 5):

- Stage 1 - Plan Formulation
- Stage 2 - Definitive Project Studies
- Stage 3 - FERC License Application

In effect, the end of each of the above stages will become an important milestone and decision point. At the completion of either the Plan Formulation or the Definitive Project Studies, the APA could determine that the Susitna Hydroelectric Project lacks economic or environmental justification and terminate the program. The IECO team must and will conduct the studies described without any preconceived conclusions regarding the outcome so that the results will be totally objective. If the Susitna Hydroelectric Project proves to be the optimum energy development, and expansion of the energy needs of the Railbelt Region occurs at an early date, then added importance is placed on carrying out the needed engineering and environmental studies through a Plan of Study scheduled in the most expeditious and timely manner.

The above constraints create some difficulty in determining the activities and the timing and particularly in estimating the cost of the Plan of Study to suit the requirements specified in the Request for Proposal. Consequently, certain hypotheses were made so that a realistic and straightforward Plan of Study, taking the project up to Stage 3, FERC License Application, could be formulated. Should any of these hypotheses prove to be unfounded, the Plan of Study will be adjusted accordingly. The hypotheses are:

- The power-generation potential of the Susitna Hydroelectric Project will prove to be the first-priority energy resource for development in order to meet the energy demand of the Railbelt Region.

- Optimum development of the Upper Susitna basin will consist of two projects--Watana and Devil Canyon--as recommended by the Corps of Engineers.

- Watana Dam will be the first project to be constructed.

- The Plan of Study should proceed as rapidly as is consistent with full achievement of the study objectives and the FERC license application should be submitted at the earliest possible date.

- The Plan Formulation Stage will indicate that an FERC license for the Susitna Hydroelectric Project should be sought for the complete development of the Upper Susitna basin, including a staged development of both the Watana and Devil Canyon sites.

To satisfy the above, certain geotechnical investigations and environmental studies, which have seasonal constraints or are long-term programs of study, must be started as early as possible, based on reasonable assumptions as to the outcome of the Plan Formulation Stage.

Again, it is emphasized that the above hypotheses are presented for the purpose of estimating an overall program and should not be taken as indicating any preconceived conclusions or opinions. Indeed, the IECO team's approach to the study must and will be flexible enough to respond to new information as it becomes available and to any change in direction that may develop from the planning process.

The depth of detail into which the proposed studies will be carried will be sufficient to ensure that valid decisions will be made and that the objectives of the program can be achieved. The design work performed for the Definitive Project Studies will be preliminary design, in sufficient detail to obtain reasonable construction cost estimates, to determine the feasibility of the project, and to satisfy the requirements of the FERC staff. However, because of seismic considerations and the magnitude of the structures, detailed stability analyses will have to be made for Watana and Devil Canyon Dams. The results of these analyses will be submitted to the FERC as supplemental data.

The remainder of this section outlines the details of the study approach proposed by IECO. Summary flow diagrams illustrating the interrelationships among the four assignment areas are shown on Exhibit A-2-1.

2.1 PUBLIC PARTICIPATION AND INFORMATION

Construction of the Susitna Hydroelectric Project will obviously influence the activities and plans of the people residing in the area to be served, as well as those in areas proximate to the construction activities. Since the lives of these people will be affected by the project, both during and after construction, it is essential that they be informed of the plans as they are developed. The basic purpose of all information dissemination must be to provide accurate and timely information on the project that will prepare the citizenry for effective participation in the planning process. The release of all information must be judicious, but not premature. The information must be factual and complete. During the planning process many alternatives are considered that are later found to be neither technically nor economically feasible. All such studies must be made a matter of record and available to those interested, but they should not necessarily be published. Care must be exercised to avoid premature publication of information that might lead to either unwarranted speculation or adverse economic reactions.

To disseminate information, extensive use should be made of the news media. Another method would be an APA Newsletter, issued periodically (perhaps quarterly), describing progress on the project.

A. Public Participation Program

Public participation entails bringing together the people affected by any given proposal, examining its merits and drawbacks and seeking a common ground for reaching mutually acceptable solutions. Working with the APA, the IECO team will develop a program to establish a Citizens' Advisory Panel (CAP) to serve as a vehicle for public participation. Membership of the CAP will be composed of representatives from government, business, industry, public service groups, and interested volunteers. The CAP will represent a cross section of interest and geographic locations. The function of the CAP will be to plan and schedule public meetings and workshops during which the economic, social, environmental, and political aspects of a particular proposal will be analyzed. To be effecive the CAP must foster a spirit of collaboration and community involvement whereby the public's concerns can be integrated into the decision-making process.

The Public Participation Program will be divided into a series of subtasks, as described below:

- Formulate Goals and Objectives of Public Participation - This is a critical first step. Often, the public is asked to attend or participate in project-related meetings with no clearcut purpose in mind. As a result, the benefits to the project program are minimal, and the public becomes confused. The IECO team will meet with the APA staff early in the project and define the specific goals and objectives of the participation program.

- Identify "Publics" - The APA and IECO will jointly analyze, identify, and characterize all factions of the public to be involved, including local, State, and Federal agencies; special groups, clubs, and committees; and various elements of the general public, including recreationists, commercial fishing industry, community economic development leaders, etc.

- Identify and Evaluate Alternative Participation Techniques - The IECO team will identify and evaluate the pros and cons of alternative participation techniques, including public meetings, public workshops, attitude surveys, etc. Those methods felt to be most valuable to the Susitna program will be outlined in detail and recommended to the APA.

- Design Participation Program - A flow chart will be prepared matching the project work plan and schedule. This chart will indicate key activities in the Public Participation Program, their relationship to project decision points, and the methods to be utilized during each phase of the project.

- Conduct Program/Evaluate and Adjust as Necessary - The CAP participation program will involve sessions with regulatory agency representatives and the general public at key points in the project schedule. Topics to be addressed in these sessions will include but not be limited to:

  - Identification of agency and public concerns and issues.
  - Identification of information sources/points of contact.
  - Participation in assessment of energy needs.
  - Participation in evaluation of energy alternatives.
  - Identification of project impacts--social, environmental, economic.
  - Identification of environmental mitigation/compensation measures.
  - Participation in community socioeconomic impact mitigation.
  - Identification of recreational needs.
  - Participation in recreational development.
  - Participation in resource management planning.
  - Participation in transmission line and road alignment decisions.

The IECO team anticipates that workshop sessions will be utilized to address many of the above topics, with participants actively contributing their thoughts and ideas. IECO team representatives will be present at all sessions to introduce topics, summarize work progress to date, facilitate discussion, distribute workshop materials, and record results.

B. Public Agency Coordination

Public agencies involved in Railbelt resource development, as well as local and State governmental entities, will have numerous plans and programs that will require extensive coordination with the Susitna plan. This coordination will be accomplished to some degree by the Public Participation Program outlined above, since the agencies will be a part of the participating public. However, the plans and involvement of the agencies will be so varied, and sometimes complex, that a coordination effort over and above the Public Participation Program will be essential.

To accomplish this, the APA and the IECO team will, early in the project, identify all agencies concerned and then keep each one advised of the Susitna project progress. For those agencies that have technical, legal, economic, or environmental concerns, an early meeting with their respective staffs will be arranged to work out a mutually satisfactory scheme for maintaining a coordination effort.

2.2. SUPPORTING OPERATIONS

Essential to the success of the project will be professional implementation of the many activities that will be performed in Alaska. Equally important will be proper coordination of the activities to ensure that information is gathered and disseminated in acccordance with the needs of the project. IECO is in a unique position because it already has a fully staffed office well established in Anchorage. This office will serve as the focal point for coordination of the activities performed in Alaska and as a base for project field personnel. Some of the support that will be furnished in Anchorage and the operations that will be directed by the Anchorage office are described below.

A. Coordination with the Client

Continuing communication with the APA will be essential during the study to keep the APA informed of the progress of the work and to keep IECO abreast of matters affecting the scheduling or scope of the study. IECO's District Manager and Vice President, R. W. Retherford, will serve as Deputy Project Manager. He will meet with APA representatives on a regularly scheduled basis. He will also be available at any time to discuss project matters.

B. Public Participation and Information Staff Support

Richard Burg of IECO's Anchorage office will be responsible for staff support for public participation and information. He will also be responsible for coordinating the Public Participation Program and answering inquiries. He will also assist in preparing and disseminating information (including a proposed quarterly newsletter) to the news media and the public and in setting up and publicizing meetings and workshops in Anchorage, Fairbanks, and the Susitna area. In addition, he will coordinate meetings between various agencies, the APA, and IECO and ensure that comments and recommendations from the agencies are referred to the appropriate individuals for action.

C. Coordination of Support Operations

A single focal point for coordination of all Alaska support services is essential to efficient operations in Alaska. Subcontractors for the services listed below will be subject to scheduling and coordination by IECO's Deputy District Manager, R. S. Samuelson, and his Anchorage staff.

- Field Camps and Logistics - This service comprises planning and establishing the field camp, furnishing housing and subsistence, and providing logistics support.

- Permit Applications and Real Estate - This service comprises preparing and processing applications, identifying landowners, and preparing maps and land descriptions.

- Surveying and Mapping - This work will be done by subcontractors' personnel under the direction of IECO's Photogrammetric and Survey Chief, Mr. P. Clauzon. IECO's Anchorage staff will provide support as required.

- Support of Other Field Activities - Other groups, including the University of Alaska and the U.S. Geological Survey, will be involved in various phases of the study. IECO's Anchorage staff will assist in coordinating the specialized services provided by these groups.

D. Office Support Services

During prosecution of the project, use of facilities and personnel in IECO's Anchorage office will expedite various project activities. Office support that will be provided includes:

- Offices, furnishings, and supplies.

- Support by technical personnel (engineers, draftspersons, technicians).

- Clerical assistance, including use of the IBM OS-6 word processor. A computer terminal capable of communicating with IECO's San Francisco computer and others. Other desk computers, as required.

- Telex, telephone, and telecopier equipment.

E. Operations To Be Directed by the Anchorage Office

Specific operations that will be directed by the Anchorage office are described below.

1. Preparation and Processing of Permit Applications - Required permit applications will be prepared as soon as authorization to proceed is issued in order to allow early establishment of camp facilities and mobilization of field investigation personnel. Preparation of the permit applications will be subcontracted to the joint venture of Cook Inlet Region, Inc./Holmes and Narver (CIRI/H&N). Permits required for entry and use of public or Native lands will be obtained in accordance with applicable stipulations.

The IECO team expects at this time that title to most of the land in the dam and reservoir area will be conveyed to Cook Inlet Region, Inc., and village corporations before the study work commences. Even though most of the land in the proximity of the damsites is owned by Natives, it will be necessary to cross Bureau of Land Management (BLM) lands to gain access to project sites and to conduct many of the studies, particularly environmental investigations, on BLM lands. The stipulations of Temporary Use Permit AK-017-9025 will be followed for all activities on BLM lands.

Permits for entry and use of Native lands will be obtained from Cook Inlet Region, Inc., and village corporations. An agreement between the Native owners and the APA is presently being processed. This agreement should also be complete by the time the study work commences.

Permits from the State of Alaska for activities on State lands or relating to the sanitary aspects of the camps (water supply, sewage disposal, etc.) will be obtained early in the project.

There are few, if any, private landowners in the dam and reservoir areas. Private lands will, however, be entered during reconnaissance of the transmission line route. The private lands to be entered will be determined and the appropriate landowners identified so that rights-of-entry can be obtained for study work.

2. Landownership Status Determination, Boundary Descriptions, and Determination of Land Acquisition Costs - Ownership and other interests in the project areas, adjoining areas, and associated transmission line corridors will be identified to obtain information needed for power project planning, for land acquisition analysis, and for obtaining rights-of-entry to conduct field studies. After the landownership status has been determined, descriptions and maps will be prepared, and the costs of required land and rights-of-way will be estimated. The acquisition costs will be used in developing the overall cost of the project.

Cook Inlet Region, Inc., to which this work will be subcontracted, is well experienced in this kind of activity and has already collected a substantial portion of the information required.

Ownership information will be gathered from various sources, and lands will be classified by the following general ownership categories: private land, State land, Federal land, and Native land. Other factors affecting land status, such as third-party rights, State or Federal agency designations, or limited interest rights will be indicated.

The maps will be prepared covering the land that will be affected by the dams, reservoirs, and appurtenant facilities, as well as the transmission line and access road corridors. Each private landowner will be identified, and the amount and market value of the land to be acquired by either easement or purchase will be estimated. The amount of public land required will be broken down by agency landholder, and the cost of right-of-way permits will be estimated. Evidence of title will be secured as needed. All third-party rights will be identified, and the effect of such rights on acquisition costs will be determined.

3. Surveying and Mapping - Most of the maps presently available for the project areas are inadequate for the proposed study. CIRI/H&N,

under a subcontract to IECO, will be responsible for performing required photogrammetric mapping for the project. Early delivery of finished maps for the reservoir areas and the Watana damsite is particularly important. Until these maps are ready, in the fall of the first year, Plan Formulation data will of necessity be based on existing maps. This data will of course be verified when the new maps become available.

CIRI/H&N will also furnish surveying support, including obtaining river cross sections and staking out the locations of various geotechnical field investigations.

2.3 ENVIRONMENTAL STUDIES PROGRAM

The main objectives of the Environmental Studies Program are to:

- Perform an environmental evaluation of alternative energy plans, including a comparison of the Susitna Hydroelectric Project energy plan with non-Susitna energy plans.

- Perform environmental planning and make impact assessments for the Susitna Hydroelectric Project.

- Prepare the required environmental documents (Exhibits R, S, V, and W) for an FERC license application.

Based on a review of previous environmental documents on a Susitna project and on the personal knowledge of members of the Environmental Study Group, the major environmental issues surrounding a Susitna project appear to be 1) the desire for a more thorough evaluation of alternative energy plans; 2) the effects of changes in seasonal streamflow in the Susitna River on anadromous and resident fisheries, particularly in overwintering areas; 3) the effects of reservoir impoundments on large mammals, particularly moose and the Nelchina Caribou herd; 4) the visual impact of transmission lines, particularly along the Anchorage-Fairbanks corridor, in the vicinity of Mount McKinley National Park; 5) the secondary environmental effects in the vicinity of the Susitna project sites caused by improved access to the area; 6) the concern for public safety, because of the geologic conditions in the project area, particularly seismic hazards and permafrost; 7) the loss of a white-water portion of the Upper Susitna River and the effects on recreational uses of the river; and 8) potential socioeconomic and cultural effects caused by construction activities.

A. Scheduling

Preparations for field work at the Watana and Devil Canyon damsites will begin immediately upon award of contract. All but two environmental studies tasks will be completed by June 1982, at which time the FERC license application will be submitted. The two exceptions are the anadromous fisheries studies and the cultural/archaeological studies. An interim report on anadromous fisheries will be prepared for inclusion in the FERC license application, and these studies will continue as programmed. Upon their completion the results will be submitted to the FERC as a supplement to the initial application package. Final studies for the cultural/archaeological work are scheduled for completion before the award of any construction contracts.

B. Environmental Assessment of Alternative Energy Plans

An assessment of the relative environmental impacts of various alternative energy plans, including the Susitna Hydroelectric Project plan and non-Susitna plans, will be conducted as part of the Stage 1, Plan Formulation, process. Once the best apparent alternative to the Susitna Hydroelectric Project has been selected, environmental costs associated with its environmental impacts and required mitigation measures will be developed for optimization and economic comparison studies.

C. Environmental Planning

Close coordination of the work of the Environmental Studies Group, the Preliminary Design Group, and the Plan Synthesis Group will be maintained throughout the study period. Such coordination is essential to environmental planning in that it will enable the Environmental Studies Group to advise the other two study groups early in the project of the major environmental constraints and opportunities. Methods for avoiding or minimizing potential environmental impacts can then be incorporated in the initial design concepts. Coordination between the Preliminary Design Group and the Environmental Studies Group will also enable the environmental studies to be refined or altered, as required, on the basis of any changes in project design, construction, or operation.

The environmental studies will provide input for the following aspects of the project:

- Location of structures.
- Operational procedures (particularly regarding reservoir releases).
- Location of access roads and transmission lines.
- Location and treatment of construction staging areas.
- Location and treatment of spoil areas.
- Location of sensitive areas that should be avoided if possible.
- Construction scheduling.
- Environmental restoration programs.

In addition, the Environmental Studies Group will provide input to the Public Participation Program, by providing information for distribution to governmental agencies and the general public to keep these groups informed of the status of proposed and ongoing environmental studies and by providing assessments of the options available for impact mitigation.

D. Impact Assessment Procedure

The first step in assessing the potential environmental impacts of the Susitna Hydroelectric Project will be the development of a detailed description of the existing conditions. In-depth knowledge of the environmental setting of the project area is essential to establishing a baseline against which potential environmental changes can be measured. Maximum use will be made of existing data, with primary data gathering efforts being conducted to fill in data gaps as required.

The field work performed under the Environmental Studies Program will emphasize climatological/meteorological monitoring, fish and wildlife studies, vegetation and terrestial habitat mapping, and cultural/archaeological surveys. Water quality sampling, which will be essential to the assessment of impacts on fisheries, will, for the most part, be conducted under the sampling program of the Hydrological Studies Group. Grab samples for water quality analysis will be taken as part of the anadromous and resident fisheries studies to supplement the data provided by the Hydrological Studies Group. Similarly, environmental data gathering efforts will be coordinated with climatological and hydrological data gathering efforts. The locations of many of the hydrologic sampling sites have been coordinated with the locations of the meteorological sampling sites. All hydrologic and water quality data collected will be entered into the data management module of the Susitna Modeling System. This data management system is described in Subsection 2.4, "Hydrological Studies Program".

Assessment of project impacts will begin early in the study period, before all the baseline data have been gathered. These preliminary impact assessments will be based on existing knowledge of the environmental and initial project design, construction, and operation plans. An early assessment of potential impacts is essential if environmental considerations are to be incorporated in the project design. The impact assessment will be continually refined and updated as more baseline data become available.

A distinction will be made between impacts that are temporary (generally related to the period of construction) and those that are long-term or permanent. In addition, both positive and negative impacts will be assessed.

The magnitude of impacts will be quantified wherever possible; where this is not possible, a professional judgment concerning the magnitude of an impact will be made to assist in the evaluation of overall impacts.

Mitigation measures incorporated in the project design or that will be carried out as part of the construction and restoration procedure will be described. Potential adverse impacts that cannot be mitigated will be identified as unavoidable adverse impacts. Similarly, irreversible commitments of resources, such as land, construction materials, and capital funds, will be identified and quantified.

E. Preparation of Environmental Documents for FERC License Application

The Environmental Studies Program will culminate in the preparation of four distinct but closely related products, which will be part of the FERC Application for License:

- Exhibit W - Environmental Report
- Exhibit R - Recreation Plan
- Exhibit S - Fish and Wildlife Resource Protection Plan
- Exhibit V - Natural, Scenic and Historic Resource Protection Plan.

Most of the effort of the Environmental Studies Program will be expended in the preparation of Exhibit W. Exhibits R, S, and V will be assembled primarily from data developed as part of Exhibit W tasks.

All environmental studies will be designed to provide the documentation and analyses required to prepare an accurate, complete FERC Application for License. No studies will be undertaken unless they have a high likelihood of resulting in data that will improve the ability of the Environmental Study Group to quantify impacts and design more effective mitigation measures.

All environmental documents will rely heavily on maps, charts, and photographs to improve understanding and readability. Quantitative techniques will be used wherever possible to describe environmental changes. Both positive and negative impacts will be fully addressed to provide the basis for a well-informed decision regarding the environmental acceptability of the Susitna Hydroelectric Project.

2.4 HYDROLOGICAL STUDIES PROGRAM

The hydrological studies will provide important input data for the environmental and power studies, including information on probable maximum floods at project sites, minimum expected streamflows, flow regime throughout the historical period of record, and the effects of flow variations and storage on sediment transport and water quality.

The work will consist of data collection, gaging and sampling, data management and mathematical modeling, and analyses to produce data for project design and planning. To improve the accuracy of the hydrological studies, a combination of standard and state-of-the-art analysis techniques will be used. To efficiently manage both the observed data and the data resulting from modeling studies, the latest hydrometeorological data management systems will be used.

A basic approach of the hydrological studies will be continuous simulation of streamflows, sediment transport, and water quality indices. Through continuous simulation all available data on climatic, meteorologic, hydrologic, and water quality processes will be used, and sparse data will be used effectively. Interactions between physical processes in the Susitna basin will be represented in simulation modeling so that field data on one hydrologic process will provide evidence of the behavior of related processes. Computer-based data communications will be used to disseminate data to all of the study groups so that gaging and modeling results will be available when and where they are needed.

A. Models and Other Analysis Tools

The principal models and other analysis tools that will be used in the Susitna project studies are:

- The new HSPF Comprehensive Simulation Programming model, written by Hydrocomp for the U.S. Environmental Protection Agency. Twelve years of work by Hydrocomp personnel on the modeling of large river systems for study of hydrology, sediment transport, and water quality processes went into the development of this model. The technology on which the model is based has been used with good results on more than a thousand watersheds.

- The WESTEX stratified reservoir model, developed by the Hydrologic Engineering Center and the Waterways Experiment Station of the Corps of Engineers.

- The Full Routing Equations (FULEQ) model for dynamic flood routing of unsteady, nonuniform flow.

- The Hydrocomp-developed hydrometeorologic data base management and statistical time series analysis software, collectively called Data Management.

- Glacial water balance and sediment production models.

These models and analysis tools will be integrated into a comprehensive simulation programming system so that all models will use the same computer-based data bank. This planned group of models and analysis tools will be called the Susitna Modeling System (SMS).

The Upper Susitna basin will be represented in the SMS by a combination of four physical elements: land segments, glaciers, reservoirs, and channel reaches. A land segment is a portion of a watershed surface that has homogeneous hydrologic characteristics. For example, a region of forested land with low landslope at 2500-foot elevation would form one segment. Glaciers and reservoirs are unique parts of the overall system. Channel reaches are portions of the channel network that have uniform hydraulic characteristics.

The processes that will be modeled on each physical element and the purposes of the results in the Susitna basin studies are shown in Table A-2-1. The SMS will accept inputs of rainfall, evapotranspiration, temperature, wind movement, and dewpoint data and it will calculate gla-

TABLE A-2-1
SUSITNA MODELING SYSTEM

Process Modeled	Physical Elements: Land Segment	Physical Elements: Glacier	Physical Elements: Reservoir	Physical Elements: Channel	Purpose of Modeling Results
HYDROLOGY					
Continuous hydrographs	X	X	X	X	Hydrologic regime, sediment and water quality studies
Water yield	X	X			Power studies
Floods	X			X	Spillway capacity, dam design, project operation
Minimum flows	X	X			Criticial period, firm power, environmental effects, impact on fisheries
Erosion	X	X			Sediment storage in reservoirs, environmental effects
Sediment transport			X	X	Aquatic ecology, stream channel degradation
Ice formation & transport			X	X	Operation of turbines, spillways, flooding hazards, impact on fisheries
WATER QUALITY					
Temperature		X	X	X	Environmental impacts, aquatic life
Dissolved oxygen			X	X	Environmental impacts, aquatic life
pH	X		X	X	Environmental impacts, aquatic life
Total dissolved solids	X		X	X	Environmental impacts, aquatic life
Nitrogen supersaturation			X	X	Project operation, impact on fisheries

cial water balance, sediment production, snow accumulation, snowmelt, infiltration, overland flow, subsurface flow, and water quality indices. Snow depths, soil moisture, sediment erosion, and continuous hydrographs of streamflow and stage will be produced throughout the watershed. The effects of reservoirs will be found by including each proposed reservoir in the system. The output of the computer model will include mean daily and continuous hourly discharge, data on snowpacks, sediments, water quality, soil moisture storage, and actual evapotranspiration. Continuous graphical output on selected hydrologic and water quality processes will be provided.

B. Benefits of Modeling Analysis and Data Management

The comprehensive SMS will permit studies to be made of the Upper Susitna basin as a total system. In addition, it will provide invaluable understanding of the relationships between the physical elements of the basin and the hydrologic processes that exist in nature. It will also provide data required for design of reservoirs and for environmental studies, including duration plots of flow, sediment, or water quality before and after project construction. The most useful results from any simulation model are often the insights gained into the behavior of the physical system. Simulation accounts for the interactions of a large number of processes. These interactions are not seen and not readily understood unless a comprehensive model system is used.

Determination of the effect of reservoirs on the aquatic ecology of the Susitna basin will require consideration of dissolved oxygen, sediment, and other water quality indices. Continuous modeling analysis of the dynamic behavior of water quality indices will provide a good understanding of the aquatic system and a firm basis for predicting the effect of changes. The SMS will simulate the time and space variations of water quality indices and provide continuous graphical output on selected water quality indices. Simulation of water quality indices in the Susitna basin for a period of years will provide information on the probability of occurrence of critical water quality conditions. This information can be used to evaluate operational policies for the Susitna

Hydroelectric Project to minimize adverse water quality impacts. The effects of alternative operating policies will be seen, and the various alternatives can be optimized.

The SMS will include the HSPF data management software. All available historic data and all data collected during the study will be added to one computer-based data bank. Statistical and graphical analysis routines will be included in the HSPF data management software to perform duration analysis, autocorrelation, trend and frequency analysis, and other studies. The computer-based SMS data bank will be a source of basic information for power studies, environmental studies, and planning of physical facilities. Each office location of the Study Team will be linked to the SMS data bank using telephone lines and communications modems that operate at 120 characters per second. The computer system supporting the data bank will be in continuous operation. Efficient access to the basic data by all members of the Study Groups will save many hours for the professional project staff.

C. Data Collection and Requirements for Additional Data

For modeling or statistical analysis of the Upper Susitna basin, data will be required on all of the physical processes being studied. Long-term records will be required to estimate extreme values of, for example, minimum expected streamflows.

Historic data on streamflows for 27 to 30 years are available for the Susitna River at Gold Creek stream gaging station. Three other streamflow stations in the Upper Susitna basin have operated for up to 10 years. Meteorologic records for the basin are limited, but records of 35 years or more are available for stations near the basin, at Talkeetna, Summit, Gulkana, and McKinely Park. Streamflow and climatological stations are often closed in winter months.

Statistical and modeling analysis of the Upper Susitna basin is feasible with the available historic records. Climatological records missing during the winter can be estimated from records for nearby stations, since hydrologic, sediment transport, and water quality processes are tolerant of estimated data. In winter, accurate storm-by-storm amounts are not needed because precipitation accumulates in the snowpack. Snowmelt that results in runoff from the snowpack does not occur in winter; thus, accurate climatological inputs are not needed. Rivers flow under ice at near 0^oC, and most water quality processes become inactive, due to very slow reaction rates.

The major data needs that will be met with a new network of climatological and stream sampling stations are 1) better definition of temperature, precipitation, and radiation variations from point to point in the basin and 2) baseline data on poorly documented water quality processes, such as dissolved oxygen. The new data will be used to define the local climatology in the basin and to improve the calibration of the SMS.

The U.S. Geological Survey (USGS) will be responsible for the installation and operation of stream gaging stations and for the collection of sediment and water quality data. A total of 11 gages is proposed, to be located at damsites and key points along the Susitna River and its major tributaries. These stations will fully gage the hydrologic, sediment, and water quality processes of the Upper Susitna basin. Three of them are existing stations, currently operated by the USGS as part of the Cooperative Stream Gaging Program, funded by the APA, USGS, Corps of Engineers, and other agencies. Installation and operation of the eight new project gages and continuation of data gathering at the three existing gages will be carried out by the USGS. All 11 stations will operate for the duration of the project studies. The costs are included in the cost estimate for the Hydrological Studies Program.

One of the associate consultants, Dames and Moore, will be responsible for installing the necessary instruments and obtaining the climatologic and meteorologic data required for both the hydrological and environmental studies. To avoid duplication, this work item is presented in the Environmental Studies Program. Four remote meteorologic and seven remote climatologic stations are proposed. These stations will be strategically located within the Susitna basin, and the climatic conditions of each 1000-foot elevation band will be represented. The data obtained will be input to the data management module of the SMS. They will then be analyzed and made available for joint use by both project groups.

Under the Geotechnical Studies Program, the University of Alaska Geophysical Institute will be awarded a subcontract to perform special arctic studies. Their research on glacial processes will provide valuable information and input to the Hydrologic Studies Program in the development of the glacial submodels of the SMS, in studies of the effect of glacial changes on discharge, sediment, and water quality, and in analysis of reservoir and river ice problems.

D. Data Management Methods

All historic meteorologic and hydrologic data available for areas in or near the Upper Susitna basin will be obtained on magnetic tape or computer listings and entered into a computer-based data bank. USGS and National Oceanic and Atmospheric Administration data banks will be sources of historic data. Intercomputer connections will be established to allow rapid collection and entry of data from the new hydrometeorologic stations. Statistical analysis and graphics for time series data are important tools that will be provided to operate on the hydrometeorologic data in the data bank.

E. Selecting and Testing Analysis Tools

Special efforts will be made to establish models and statistical analysis tools suited to the practical needs of the SMS. Common pitfalls, which will be avoided in the Susitna project studies, include the use of models that are too demanding of data for practical purposes and the use of models that omit important processes.

Models of processes unique to the subarctic and arctic environment of the Susitna basin will be created for the SMS. They will include models of glacial processes, river and reservoir ice formation and melt, reservoir stratification, and erosion from frozen ground. The HSPF program structure that will be used in the SMS allows straightforward adaptation of its physically based models to the Alaskan environment.

The SMS will be adapted to represent the Upper Susitna basin using available topographic, soils, and vegetation data. Physical data on the watershed will be obtained from topographic maps and LANDSAT imagery, cross sections of stream channels, and mapping of project areas from field surveys. Historic meteorologic and streamflow records will be used to calibrate rainfall runoff, snowmelt, and sediment erosion and transport processes. The additional data that will be collected in the Upper Susitna basin during the project study period will refine the model calibration by providing more details on the local climate, sediment transport, and water quality processes in the basin.

F. Applying Models and Other Analysis Methods

The SMS will be used to extend streamflow records from about 30 to about 50 years, the length of the meteorologic records in the region. The historic recorded flows and the additional flows that will be obtained by simulation will be used for reservoir sizing and power optimization studies, low flow and flood frequency estimates, and studies of alternative reservoir operation policies. The SMS will accept probable maximum precipitation and meteorologic conditions and be used to produce probable maximum floods for spillway design at the project sites. Alternative watershed developments will be tested by making extended computer runs to show the continuous hydrologic and water quality indices with and without the proposed projects. The computer runs will also show maxima and minima and the statistical properties of the flows and the water quality indices. The extended computer runs will use rainfall data obtained at gages near the Susitna basin for periods of up to 50 years to simulate a corresponding period of streamflow. Data on flood frequency and timing will be provided for diversion tunnel and cofferdam design.

Sediment transport modeling will be used to study sources of sediment, year-to-year variability, and sediment storage requirements for reservoirs. Modeling of water temperature and water quality will be used for environmental studies and studies of ice effects in stream channels and reservoirs.

Downstream hazards of dam failure will be studied using models of dynamic wave movement, and water surface profiles will be produced for tailwater elevation-discharge ratings at the project sites. Communication of modeling and analysis results to members of other study groups will be given special attention. Model results made available for the environmental or power studies will include a summary of model assumptions and estimates of probable accuracy. Thus, specialists in environmental or power planning will be able to use such results to maximum advantage.

2.5 GEOTECHNICAL STUDIES PROGRAM

The first step of the Geotechnical Studies Program will be to collect all available reports, records, maps, remote sensing imagery, aerial photographs, and earthquake data. These items and any other information available from previous investigations and studies associated specifically with the Susitna Hydroelectric Project, as well as geotechnical investigations of a more general nature, will then be reviewed thoroughly. This review will include an evaluation of the conclusions of previous studies.

Previous geological investigations of alternative damsites appear to have been well done. To confirm the selection of the Watana and Devil Canyon sites it will be necessary to perform a reconnaissance inspection and evaluation of all potential damsites within the project area. The number of viable sites can probably be reduced quickly by a study of available data and a brief field inspection. More detailed consideration and possibly some subsurface investigation will be required before the remaining sites can be rated for suitability. For planning purposes the investigation of alternative sites is assumed to show that Watana and Devil Canyon are the most favorable sites from an overall point of view and that most of the field investigations will be performed at these two sites.

Preliminary investigative work will be done on aerial photographs and ERTS satellite imagery during the early part of 1980. At that time a field program will be planned in detail for maximum efficiency. Geologic mapping of both damsites and reservoir areas will begin as early as possible in the 1980 field season. This mapping will contribute to the seismotectonic studies by locating regional and local fault patterns, and to the engineering studies by locating potential geological hazards, such as landslides, unconsolidated or highly permeable deposits, adverse joint or fracture systems, or faulting. The mapping, which will be performed in conjunction with drilling and engineering geophysical investigations, will be used to help locate areas where subsurface investigations could be employed most effectively.

The principal method of subsurface investigation will be core drilling supplemented by seismic refraction measurements between drill holes. During the first (1980) field season, according to present plans, most of the foundation drilling will be performed at the Devil Canyon damsite, whereas at the Watana damsite more emphasis will be devoted to investigations of borrow materials. The work that will be performed during the 1980 field season is expected either to confirm previous design assumptions or to provide additional information upon which to base certain modifications of the design assumptions. The basic assumptions that must be confirmed are, first, whether the foundation rock at Devil Canyon is suitable for the construction of a concrete arch dam, and second, whether sufficient quantities of suitable materials are available near the Watana site for the construction of an embankment dam. Information on the physical properties of the foundation rock and on the probable response of the foundation rock to seismic shaking will be obtained from drill holes, in situ seismic refraction and shear wave measurements at the damsites, and laboratory testing of core samples. Representative samples of proposed borrow materials will be obtained for laboratory testing from test pits and auger holes at both sites. Sufficient information should be obtained during the 1980 field season to permit the start of preliminary design of the major project features for the Definitive Project Studies in the first half of 1981.

The scope of work for the 1981 field season will be planned in detail during the early months of 1981. The purpose of this work will be to provide data to optimize the designs of project features and to produce a definitive project design for the FERC license application. The 1981 field program will stress the refinement of design parameters and the resolution of questions raised by the results of the first season's work. It will also provide the geotechnical data required to make any necessary design modifications. Specific problem areas will be investigated in detail.

Seismotectonic studies will commence at an early date. The objectives of these studies will be 1) to understand the seismotectonics of the project region, through detailed field studies of known and inferred surface faults and identification of yet unknown faults, if any, in the proposed damsite and reservoir areas, and 2) to obtain seismotectonic activity history and fault parameters for seismic risk analysis and development of design earthquakes for the project sites. Because the project area is located in a region of significant seismic activity, requirements of project safety against seismic hazards make it imperative that findings from these studies be realistically and irrefutably valid. Toward that end, renowned Consulting Specialists, Dr. Clarence Allen and Dr. H. B. Seed, will provide expert consultation in the areas of engineering seismology and earthquake engineering. The program will include the study of regional and local faulting and seismotectonic history interpreted in the light of recent knowledge of plate tectonics.

A local seismic monitoring network will be established to provide accurate information on seismic activity in the area and to establish a baseline for comparison of seismic activity before and after filling of the reservoirs. This work will be accomplished in close cooperation with the University of Alaska Geophysical Institute and the U.S. Geological Survey. At the end of the study the instruments used for this work will become a permanent part of Alaska's seismic monitoring network.

Based on the study of regional and local geology and historic seismicity, fault activity and regional seismotectonic trends will be identified and fault capability evaluated. Maximum credible earthquake levels will be estimated for those faults in the project region that are identified as being capable of generating seismic disturbance, as well as for the Denali fault and faults along the Benioff zone. The maximum credible earthquake will be numerically simulated along the capable fault zones to obtain ground motion parameters and ground motion time-histories for the proposed damsites. Computer programs will be used for simulation of near-field seismic ground motions. These programs are capable of handling quite complex cases of earthquake ground motions and source mechanisms. Large and well-documented historical earthquakes will also be simulated under realistic conditions and compared with the simulation under idealized conditions. The ground motion parameters and ground motion time-histories will be used as a base for establishing seismic hazard criteria and selecting design earthquakes for the project sites. The design earthquakes will be developed on the basis of seismic risk analysis of the statistical models of seismic risk. Consulting Specialist Dr. H. C. Shah will provide expert consultation and advice on the seismic risk analysis.

The transmission line and access road alignments proposed in previous studies will be inspected during the first field reconnaissance season to determine whether there are any geotechnical considerations that would necessitate modification of those alignments. This inspection will entail primarily surface investigations, but some seismic refraction measurements may have to be made to clarify subsurface conditions.

Special investigations will be made to ensure that there are no geological conditions or insurmountable hazards from glacial activity, ice, permafrost, or sedimentation that would preclude economical construction of the project. Recognized experts from the University of Alaska Geophysical Institute will be responsible for evaluating special arctic hazards that may influence design and operation.

Frazil ice, anchor ice, aufeis, and sheet ice forms may be expected to cause ice-related problems during the construction phase and also to have a significant impact on design of the cofferdams and on design and operation of the reservoirs. Field research on river ice dynamics and an in-depth analysis of potential ice problems can be used in determining the proper design, construction, and operational procedures to eliminate or minimize ice-related problems.

Thermal finite difference, or finite element, models of various project features will be constructed to determine possible permafrost-associated problems, such as thawing, settlement, drainage, and slumping.

The Susitna Glacier and the East Fork and West Fork Glaciers are major sources of water for the Susitna River. They also provide a buffer action that tends to stabilize the flow of the river. The heat and mass fluxes and general dynamics of these glaciers will be studied to understand their effect on the river. This study will involve measurement of the rates of accumulation, ablation, and ice flow. The potential for forming glacier-dammed lakes that can drain abruptly and produce flash floods will also be investigated.

2.6 PLAN FORMULATION STUDIES (STAGE 1)

A. Objectives

The objective of the Plan Formulation Studies is to determine the optimum utilization of Susitna hydroelectric resources to meet future demand for power in the market area, taking into consideration all reasonable energy supply alternatives. To this end, energy alternatives, both with and without Susitna, will be examined on a multi-objective basis, taking into account:

- National economic efficiency,
- Regional development,
- Environmental quality, and
- Social factors.

The selected plan will be the one that best satisfies the multi-objective criteria and provides the most acceptable solution for future energy supply to maximize benefits to the State and the people of Alaska.

B. General Approach

The first step will be to determine a reasonable growth scenario for the regional economy to form the basis of a definitive load forecast for the power market. Adequate provision will be allowed for alternative growth scenarios to provide a range of possible load growth rates for sensitivity analysis. The impact of conservation and price elasticity on load growth will be evaluated, and provision will be made for analysis of the effect of alternative energy sources on electrical load demand. The interaction of economic variables and energy forecasts will be analyzed by use of an the economic model developed by the University of Alaska Institute for Social and Economic Research. A correlation will be established between reasonable projections for important economic indicators relevant to Alaska and the growth of energy demand.

The introduction of Susitna generation to the existing hydrothermal system will be staged according to load growth constraints and the requirements of a continuing construction program. Alternative expansion plans, without Susitna generation, will be formulated to provide equivalent system reliability and satisfy both demand and energy requirements.

The principal tool that will be used in comparing generation expansion alternatives is a computer model that will simulate the operation of the hydrothermal system. This model will utilize a formal data base, which will require extensive work to develop. The ouput of the hydrothermal simulation model will be used in a related but separate program that will determine the present values of the various alternative expansion programs (construction sequences) under consideration.

Other means that will be used in the comparison include a list of the environmental impacts that would result from the implementation of the various alternatives and an evaluation of the effects of implementation on regional economic development. Social aspects related to implementation will also be considered.

The preparation of a data base for the optimization and simulation studies will entail contributions from many separate study groups and specialists. The scope of work is outlined below, with the exception of hydrological studies, which are described in Subsection 2.4 above.

C. Economic Parameters

Since the reliability and usefulness of the hydrothermal system simulation is critically dependent on the real-world validity of the input data, assumptions, and correlations, considerable effort will be directed toward acquiring sound basic data and developing realistic economic parameters. The following is a sample of typical data sources on the Alaskan economy:

Scott, Michael J. "Southcentral Alaska's Economy and Population, 1965-2025: A Base Study and Projection," for Economics Task Force of Southcentral Alaska Water Resources Study (Level B), 1978.

Kresge, David T. "Alaska's Growth to 1990," Alaska Review of Business and Economic Conditions, Vol. XIII, No. 1 (January 1976).

Kresge, David T., Seiver, Daniel A. "Planning for a Resource Rich Region: The Case of Alaska," American Economic Review Papers and Proceedings, Vol. 68, No. 2 (May 1978).

Kresge, David T., Morehouse, Thomas A., and Rogers, George W., Issues in Alaskan Development. Seattle: University of Washington Press, 1977.

Goldsmith, Oliver S. "Oil and Gas Consumption in Alaska: 1976-2000," with Tom Lane, for State of Alaska, Department of Natural Resources (January 1978).

Goldsmith, Oliver S. "Energy Intensive Industry for Alaska," with Kent Miller, for State of Alaska, Division of Energy and Power Development. Department of Commerce and Economic Development (July 1978).

Goldsmith, Oliver S. "The MAP Econometric Model of Alaska: A Documentation," for Alaska Outer Continental Shelf Office of Bureau of Land Management (June 1979).

Interactions between power/energy pricing policies and the project investment decisions implicit in model outputs will be analyzed through the application of rapidly converging iterative processes. Likewise, consideration will be given to shadow prices, which might arise as a result of poltical decisions (such as wage and price controls) or exogenous factors, so that their impact may be made explicit. Another interactive set of relationships, to be analyzed in some depth, will be those covering the various aspects of demographics, including net population changes in Alaska due to immigration/emigration, age distributions, and similar socioeconomic factors. Project-related factors, such as labor force characteristics, wage scales, and union and open shop trends, will also be taken into consideration.

D. Power Market Survey

The anticipated future growth in power and energy consumption in Alaska will have an important bearing on the selection of alternatives for development. Therefore, considerable effort will be exerted to obtain an accurate and reliable forecast. To achieve this, the Study Team plans to make use of existing studies prepared by the APA and by the University of Alaska Institute of Social and Economic Research (ISER). Features of both studies will be incorporated into a single forecasting methodology to yield a long-range energy demand forecast for the market area. Key personnel of ISER are expected to make substantial contributions to the development of this forecast. In addition, extensive use will be made of the MAP econometric model developed for the Alaskan economy by ISER.

In the course of the power market survey, contacts will be established with the Railbelt utilities and other agencies, such as the APA, to obtain their views on the future demand for power and energy.

The forecasting methodology will be derived from correlations of macroeconomic variables with specific energy consumption projections, based on definite economic scenarios depicted by the MAP econometric model. The final load forecasts will have an internal consistency with economic projections relative to tangible industrialization programs and reasonable consumption patterns in a future where conservation and frugality may well be accepted social practice. Price elasticity will be examined in the context of the Alaskan consumer economy and related to projections of future energy demand.

A range of uncertainly will be established for the load forecasts to enable sensitivity analysis on load growth potential to be performed.

E. Susitna Project Data

Development of data on the Susitna Hydroelectric Project alternative will be a major undertaking, requiring contributions from a large number of specialists. The Study Team envisions that the required studies will be performed in three steps:

- Initial screening of alternatives.
- Preliminary layouts and basic designs.
- Development of cost parameters and technical considerations.

1. Initial Screening of Alternatives - The initial screening of alternatives will be based on previous reports on the development of the Susitna River and, in particular, on recent reports by the U.S. Army Corps of Engineers. The Corps' layouts at the Watana and Devil Canyon sites will be studied in detail. Alternative locations and designs of major structures will be evaluated on the basis of the best available information on topography and geology. Staged development at each site will be considered. Major environmental impacts associated with each alternative will be assessed. Similar evaluations will be made of other potential sites, including the Vee and Denali sites. Preliminary conclusions will be presented to the APA for review and comment. The end result of this screening process will be the selection of several alternative construction sequences for further, more detailed studies, as discussed below.

2. Preliminary Layouts and Basic Design - To obtain meaningful results from the simulation studies, including identification of the most suitable layouts and designs, each site will be studied in considerable detail. Much of this work will be performed by the Preliminary Design Group assisted by the Geotechnical Studies Group. However, overall control of this part of the study will be maintained by the Plan Synthesis Group, which will review and evaluate results on an overall basis.

3. Development of Cost Parameters and Technical Characteristics - Based on the layout studies discussed above, data on the various Susitna Hydroelectric Project alternatives will be developed and tabulated for use in optimization and simulation studies. Cost parameters will be developed, not only for the dams, power plants, and associated equipment and structures, but also for such features as access roads, transmission lines, land acquisition, and remedial environmental measures. Required technical project data will include reservoir area and volume curves, generating capacities, tailwater rating curves, values of hydraulic losses and transmission losses, efficiency curves, operating criteria and constraints, and construction schedules.

F. Alternative Energy Sources

Data on potential alternatives to meet future load growth in the Railbelt market area will be obtained in a manner similar to that described above for the Susitna Hydroelectric Project. Recent readily available reports and publications will be the primary data sources. The following energy sources will be included in the study:

- Coal - This fuel, consisting mainly of bituminous and subbituminous matter, is an abundant Alaskan resource. It is conceivable that coal-fired thermal plants could make an important contribution to meeting the future growth in power and energy demand of the Alaskan Railbelt power system. Therefore, this alternative will be analyzed in some detail to provide reasonably accurate data for the system optimization studies.

- Natural gas - This fuel is presently used for more than half of the power generation in the Railbelt area. A thermal generating system consisting of a mix of coal-fired and gas-fired power plants might be an economical alternative to the development of large hydro projects, such as Susitna. Therefore, data on gas-fired combustion turbine installations will be developed in some detail for use in the system optimization studies. The conversion of natural gas to liquefied natural gas for export will also be an important consideration in the evaluation of this resource.

- Conservation - Conservation, the potential equivalent of a low-cost generation source, will be dealt with in conjunction with the power market study to determine its impact on future energy demand.

- Geothermal - The Pacific "Ring of Fire" passes under the southern coastal section of Alaska and along the Aleutian chain, giving rise to potential geothermal developments. The potential for decentralized generation from geothermal resources will be assessed, and the possibility of multipurpose use of geothermal resources for energy and steam heating will be evaluated for the dispersed communities of southern Alaska.

- Hydroelectric - The possibility of large- or small-scale hydroelectric power developments at sites other than Susitna will be thoroughly evaluated to establish a data base for evaluation of alternative hydro developments to the Susitna project. However, any other large hydro projects, such as development of the Copper River, are assumed to be not directly competitive with the Susitna project.

- Tidal power - Geographically, the upper reaches of Cook Inlet provide a possible location for a tidal power development designed to take advantage of the tidal range. Findings and recommendations of previous studies of this resource will be reviewed to determine whether tidal power constitutes a viable alternative energy source.

- Wood, peat and solid-waste conversion - The potential for conversion of biomass and municipal organic wastes into energy will be considered in the study. Direct combustion of wood residues for energy generation will be evaluated, as well as conversion of such materials to liquid fuels for chemical storage. The power generation potential of peat-fired thermal plants will be analyzed, and various alternative uses for solid waste will be assessed as supplementary energy supplies.

- Solar - The potential for solar energy utilization in Alaska will be assessed to determine the viability of practical approaches to the conversion of solar radiation to heat and electric energy for various applications. The possible use of solar energy for water and space heating, on a supplementary basis to oil, gas, and electricity, will be examined, as well as the possibility of small-scale photovoltaic conversion to electric energy.

Quantification of the results for alternative energy usage will be projected in terms of state-of-the-art technology.

- Wind - There is great potential for the utilization of wind energy in Alaska if means can be found to harness it economically and safely. The possibility of dispersed small-scale generation for local communities and remote installations will be assessed, in addition to larger scale, multiple-unit installations in small towns and in outlying areas of larger urban centers.

- Fuel cells - The application of fuel cells at urban load centers holds much promise. Within the time frame of the Susitna project, new and improved technology for fuel cell installations is expected to become commercially available. The different types of fuel cells will be evaluated, and the most appropriate fuel supply for installations in Alaska will be determined.

- Nuclear - The controversial nature of large-scale nuclear plants precludes serious consideration of their use in Alaska, particularly when siting is examined in relation to seismic hazards. However, for completeness of the study of alternative sources, nuclear power will be examined in the light of experience with small-scale nuclear reactors for heat and power applications in the Antarctic.

G. Power Studies and System Optimization

The objectives of the power studies and the system optimization analyses will be to define alternative capacity expansion programs or alternative construction sequences that will meet the future load growth and to determine the life cycle costs for each of the construction sequences.

The existing electric systems in the Anchorage and Fairbanks areas consist largely of thermal plants. In addition to the thermal plants, there are two small hydro stations, having a total nominal installed capacity of 45 MW. At the present time there is no transmission interconnection between the Anchorage and Fairbanks areas.

Possible future system configurations include:

- Continued independent systems, with no transmission interconnection and no major hydroelectric development.
- Transmission interconnection but no major hydroelectric development.
- Transmission interconnection with major hydroelectric development.

Any of the above configurations may encompass small hydro projects. However, the Susitna Hydroelectric Project, with a potential capacity on the order of 1600 MW is the only major hydro development that will be analyzed in the initial part of the evaluation of alternative capacity expansion programs. The Study Team has assumed that other major hydro projects, such as potential developments on the Copper River, will not be implemented until after completion of the Susitna project.

Each of the alternative capacity expansion programs or construction sequences may be envisaged as consisting of three parts. The first part, extending into the 1990's and loosely related to completion of the Susitna Hydroelectric Project, represents a time period for which input data and cost estimates will be determined with a reasonable degree of accuracy. The second part, extending from the 1990's to 2010, represents a time period for which input data and cost estimates will be less accurate than those of the first part. The third part, extending beyond 2010, represents a time period utilized for the sole purpose of making the sequences comparable.

The establishment of a data base, the use of a hydrothermal simulation model, and the computation of present values are discussed in more detail below and illustrated graphically on Exhibits A-2-2 and A-2-3.

1. <u>Data Base</u> - Input data, which will be obtained from various sources, as discussed above, will be placed in a data base suitable for use by the hydrothermal simulation model and the economic analysis programs. The procedures that will be used in establishing the data base are described below.

Project data for hydro stations, thermal plants, transmission lines, and other works will be developed and stored in separate data banks. Chronologic data, such as hydrologic data and load and energy forecast information, will be developed and recorded in two main types of data banks:

- Data banks for all basic hydrologic data.

- Data banks for hydrothermal simulation procedures, including selected and processed hydrologic data, water demand data, load and energy forecast data, and selected results of hydrothermal simulation.

A 50-year hydrologic record, developed from 30 years of recorded streamflows, extended utilizing the longer meteorologic record, will represent the main hydrologic input data and the basis for simulation of alternative development scenarios.

Synthetic hydrologic data over a period of several thousand years could be generated, but would be of interest only if it could be shown with some degree of certainty that presently available models could produce reasonably realistic stochastic data. However, a series of pitfalls is known to exist in applying such statistical models to northern climates where special problems, such as glaciers, discontinuities in flow during spring breakup periods, and annual persistence, exist. It is possible that meteorologic data could be generated for several thousand years and converted to streamflows only during drought periods, but determining whether this is practicable would in itself involve considerable effort. Thus, the stochastic approach is considered to be a possible supplemental tool rather than a basic tool for this study, and it was not considered in the time and cost estimates.

Other types of data are those related to the actual construction sequence under consideration. The ultimate configuration at the end of the construction sequence (in the year 2010) must be considered, together with the order and timing of the individual elements within the sequence--that is, the dates of installation of the hydro stations, thermal plants, transmission lines, and other works. For the hydrothermal simulation, data related to hydro project combinations, hydrothermal configurations, and expansion program details will be required.

The cash flows related to capital expenditures will be required for each construction sequence because the total capital expenditure for a particular element may be quite different in one sequence than it is in another.

The annual thermal consumption costs and the other annual operating costs that will be derived from hydrothermal simulation will be stored in a separate data bank for use in the economic analysis program, along with other data mentioned above.

An accurate maintenance schedule will be established for each construction sequence, and reserve capacities will be determined on the basis of modern loss-of-load probability theory. Since these computations will be based on capacities, the input data will be recomputed after hydrothermal simulation has been done once and seasonal capacity reductions have been established more accurately. Although maintenance schedules and reserve capacities are closely related to the hydrothermal simulation proper they may be considered as input data for practical purposes.

Similarly, transmission losses will be estimated prior to simulation and recomputed after simulation, based on the actual movement of energy over the transmission lines.

Economic criteria represent a type of input data. They will include such items as ranges of both fuel costs and discount rates, escalation procedures, unit costs for fixed and variable expenditures, adjustments at the end of each construction sequence to ensure true comparability, and procedures for the economic operation of thermal and hydrothermal systems.

To summarize, establishing the data base will involve the placement in readily accessible locations on computer devices of all input data required to facilitate thermal and hydrothermal simulation, economic analyses, and related computational tasks.

2. Hydrothermal Simulation - The study of new installations and operational procedures for a hydrothermal system is complex because, for example, changes in one element are reflected throughout the entire system. Also, the advantages of one alternative may be felt immediately, whereas those of another may not become fully effective for many years. Computer models are essential to simulate the operation of a hydrothermal system because of the tremendous amount of computational work involved, the large number of alternatives to be studied, the continuing nature of the studies in future years, and the increasingly complex character of the computations as the system develops.

Simulation of the operation of a hydrothermal system considers many different hydrothermal configurations, with new dams, hydro stations, thermal plants, and other works being added in the future as a function of time, and with water and energy demands also increasing with time. The hydrothermal simulation model that will be used in this study is based on similar versions of simulation models for multireservoir systems and hydrothermal systems already developed and applied extensively in the United States, Canada, and Latin America.

A major hydroelectric development, such as the Susitna Hydroelectric Project, must be analyzed by means of alternative capacity expansion programs in order to realistically compute average annual thermal consumption costs year by year in the future. In such studies the results of the sequential analyses are strongly influenced by the types of installations selected immediately prior to and subsequent to the major hydro development. For example, the type of thermal units installed immediately prior to a major hydroelectric development may be quite different from those that would be installed in the same time period if subsequent installations were to be all or mostly thermal plants. Likewise, the sum of present values for a construction sequence containing a major hydroelectric development, such as the Susitna Hydroelectric Project, depends on the installations selected after the major project. The thermal consumption after the installation of the major hydroelectric development is the principal unknown determined by means of hydrothermal simulation. These data, combined with cash flows of capital expenditures will give the construction sequence with the major hydroelectric project that has the minimum sum of present values of capital and operating costs. Based on the above discussion, all of the construction sequences studied should commence immediately after the point in time to which decisions have already been made, and they should continue a considerable number of years after the completion of the installation of all turbines of the major hydroelectric development. Indeed, the simulation of the operation of the major hydro development must be carried out for a considerable number of years into the future after the installation of the last turbine in order to properly evaluate the benefits of the project under drought, average, and humid conditions. To be realistic, for the Susitna Hydroelectric Project this must be done for installations with different capacities in different construction sequences up to the year 2010.

In the actual computations, operating criteria (rules) are computed prior to each hydrothermal simulation; thus, they represent the results of analyses and not input data. There is an operating rule value for each month of each year in the future for each hydrothermal simulation. The basic operating rule value for a specific month of a specific year represents the reservoir contents, in terms of water volume or energy as the case may be, below which thermal plants must be used to aid the hydro system if the reservoirs are not to be drawn below the empty level should the worst drought of record reappear. In the computation of the basic operating rule values, deficiencies, determined as required flow volume or energy minus available flow volume or energy with respect to natural inflow, are computed first for each month of each year in the future. The deficiencies thus computed are then accumulated in the reverse order of time, the accumulated value being made zero whenever it becomes negative. Accumulated deficiencies are computed for each way of superimposing historic hydrologic years on future years, the total number of positions being equal to the total number of historic hydrologic years. The basic rule value for the month and year under consideration is the largest of the accumlated deficiency values.

Supplementary economic rules are provided in cases in which secondary economies can be gained by factors such as:

- Maintaining head by keeping reservoirs well above rule values.
- Reducing spillage by drawing reservoirs down toward rule values as rapidly as possible.
- Using less water than necessary in some months in order to use more in later months and thus use efficient thermal units in all months.

The actual simulation of the operation of the hydrothermal system is carried out on a month-by-month (or other time-interval) basis in the normal order of time. The number of times the entire simulation is carried out is equal to the number of different ways of superimposing the historic sequence of hydrologic years on the future sequence of years, which is, in turn, equal to the total number of historic years. The same rule values are used for all superpositioning. As an example, if the historic period were from January 1950 to December 1979 (30 years) and the future period from January 1985 to December 2009 (25 years), the following 30 cases, or ways of superimposing the past on the future, would be involved:

Case 1: 1950 on 1985, 1951 on 1986, ... 1974 on 2009

Case 2: 1951 on 1985, 1952 on 1986, ... 1975 on 2009

Case 3: 1952 on 1985, 1953 on 1986, ... 1976 on 2009

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Case 29: 1978 on 1985, 1979 on 1986, ... 1972 on 2009

Case 30: 1979 on 1985, 1950 on 1986, ... 1973 on 2009

Critical combinations of past and future years are indicated by the simulation results, and average energy values are determined as the mean values of all ways of superimposing the past on the future.

The simulation procedures can consider any number of reservoirs or other study points, any number of inlets to and outlets from each reservoir or other study point, any number of hydro stations, any number of thermal units, and any number of special features, such as diversions, pumping plants, reversible turbines, or other system complexities.

The monthly load-duration curve can usually be defined by two linear segments--the first defining the sharp peak and the second defining the gradually sloping main portion of the curve to the right of the peak. When required, the monthly load-duration curve can be approximated by up to seven linear segments.

During the dispatching or production costing procedures for the month under consideration, the hydro and thermal units are stacked in the monthly load-duration curve on the basis of an ordering system. Each unit or plant is assigned a specific order number, which is higher or lower than the order numbers for other units and plants in the system. For example, more efficient thermal units have higher order numbers than less efficient thermal units; hydro stations below reservoirs that are fuller with respect to probability of filling have higher order numbers than hydro stations below reservoirs that are less full; hydro stations have higher order numbers than thermal stations when reservoirs are above basic operating rules, but hydro stations have lower order numbers than thermal stations when reservoirs are below basic operating rules because thermal stations can operate in the lower part of the load-duration curve at such times.

Thermal stations with minimum capacity requirements are stacked in the monthly load-duration curve in two parts. At times, simply stacking one unit or plant above the other (or one part of one unit above one part of another unit) may introduce inaccuracies that warrant the introduction of refinements. A hydro subsystem with adequate storage capacity, such as two hydro stations below a large reservoir, can be stacked on a total capacity basis. The total energy so derived can subsequently be divided between the hydro stations. In other cases, the individual stations can be stacked in order within the area reserved for the hydro subsystem. In special cases, when water and energy are restricted during specific months, such as in the case of run-of-the-river hydro stations, units and stations can be stacked on a binary search basis so that the full capacity is stacked and the corresponding stacked area is equal to the available energy. In such cases, the capacity is stacked in the base, in the peak, at the midpoint vertically, at the quarter point, at the eighth point, and so forth, until the area in the load-duration curve is equal to the available energy within the allowable tolerance. When such a procedure is required, each stacked unit or plant is withdrawn from the monthly load-duration curve after its position has been determined, leaving a residual monthly load-duration curve of irregular shape. The procedure is then repeated with the next station.

In general, the sequence of rule computations and hydrothermal simulation is carried out twice. The results of the first simulation are used to recompute the rules, and the recomputed rules are then used in a second, more accurate simulation.

It is evident that the Susitna study will require detailed simulation and will not lend itself to the use of mathematical optimization models. Nevertheless, mathematical programming techniques may be useful to supplement the detailed simulation and to serve as a guide, particularly in the case of subproblems. Mathematical programming techniques include linear programming, dynamic programming, mixed-integer programming, and the "out-of-kilter" algorithm. For the Susitna study, mathematical programming techniques are regarded only as a possible supplemental tool, and no allowances for their use have been included in the time and cost estimates.

3. Economic Analysis - The objectives of the economic analyses will be to determine the sum of present values of capital and operating costs for each capacity expansion program under consideration and to present the results in the form of a multi-objective table. The inputs for these analyses are derived from the hydrothermal simulation and from separate data banks. The main input from the hydrothermal simulation will be the average annual thermal fuel consumption for the construction sequence under consideration. Supplementary input from the hydrothermal simulation will include the characteristics of failures and the average annual operating characteristics of hydro and thermal plants and transmission lines. Input data from separate data banks will include cash flows of capital costs for hydro, thermal, and transmission facilities, unit costs of fuel and O&M, divided into fixed and variable operating costs for various types of generation, ranges of discount rates and cost escalation factors, and related information.

The average annual thermal consumption will be provided by the hydrothermal simulation model for each year of the construction sequence (for instance, for 1985, 1986, 1987, ... 2007, 2008, and 2009). The total thermal consumption for all units and the thermal consumption for each individual unit or group of identical units at the same geographic point will be provided for each year. Similar annual operating characteristics will be provided in the case of other works of the hydrothermal system to serve as a basis for calculating average annual operating costs. The interface procedures between the hydrothermal simulation model and the economic analysis computer program are illustrated on Exhibit A-2-3.

As noted above, the economic analysis computer programs will retrieve data from the interface data file created by the hydrothermal simulation computer model and from separate data banks. Tables of cash flows of capital expenditures and summary tables of capital and operating costs will be printed for the construction sequence under consideration. Present values will then be computed for each year and for the total construction sequence and printed in a separate table for each combination of cost escalation rate, discount rate, and unit fuel cost. Summary tables listing the sum of present values for the construction sequence for all escalation rates, discount rates, and unit fuel costs will then be printed.

Primary benefits will not be evaluated in the analyses described above, because all construction sequences will satisfy the principal requirement of meeting the load and energy demands of the market forecast under consideration. Secondary benefits will be treated as negative costs. For example, in the case of excess hydro energy, above and beyond that required to satisfy the energy demand forecast in the market survey, there may or may not be a market for all of the excess energy; if there is, the value of the excess energy will be subtracted from annual costs.

Failures to meet forecast load and energy demands will be defined in the hydrothermal simulation procedures, and their characteristics related to severity and length will be costed in the economic analysis procedures.

A large number of capacity expansion programs may be evaluated by the computer models and programs described above because the final decision of which expansion program to select will not be based on the single criterion of the lowest sum of present values, but will include factors such as whether to permit the use of natural gas as a fuel, whether to accept a degree of air pollution, whether to promote the creation of jobs and development in a specific geographic area, and whether the environment is considered as being improved on a net basis by the construction of hydro reservoirs and plants and transmission lines. These various aspects are discussed under "Plan Formulation" below.

H. Plan Formulation

Formulation of the best plan of development from the many alternatives that will be considered will require careful evaluation of the relative merits of the various alternatives in meeting the study objectives. For this purpose all of the apparently most attractive developments will be presented in a formal manner, with a listing of both tangible and intangible factors, in accordance with the following format:

- Economic development from overall Federal and State viewpoints.
- Environmental quality.
- Social well-being.
- Regional development.

Economic development values will be obtained from the project data base and from present worth studies. Environmental quality values will generally be expressed as a combination of subjective judgments and quantitative values. Evaluation of social factors will also be largely a matter of judgment, due to the lack of procedures for quantifying factors. This evaluation will incorporate statistical data and descriptive material as necessary to show impacts, such as effects on income distribution and on health and safety. It may focus on the special problems and needs of specific cultural groups. Regional development values consist of both monetary and nonmonetary effects and include second-round economic impacts, such as numbers of jobs created.

For the next step in the Plan Formulation Studies there is no system optimization tool that can be brought into play. One suggested procedure is to study the best solution or solutions with emphasis on one objective, the best solution or solutions with emphasis on another objective, the best solution or solutions with emphasis on two objectives, and so forth. All "best" plans would be candidates, as long as no preferences are established with respect to the above-described objectives. Since there is no well-defined relationship between the objectives and overall socioeconomic goals, the final selection of a capacity expansion program will be made on the basis of a thorough analysis of tradeoffs among the objectives by multidisciplinary and multi-institutional teamwork.

Upon completion of the evaluation, the overall most attractive alternative will be subjected to sensitivity tests of the basic assumptions regarding such aspects as price of fuel, construction costs, demand forecasts, discount rates, and future cost escalation.

The results of the Plan Formulation Studies will be presented in a draft report for review by the APA. Questions will undoubtedly come up as a result of the review, and some supplementary studies may be necessary. The final report will address all such questions, present a complete account of the studies performed, and make firm recommendations on the optimum development sequence. The Plan Formulation Report is expected to comprise a series of volumes covering the subject areas listed below:

SUMMARY REPORT

APPENDIXES

A. Hydrology
B. Geology
C. Economics and Power Market Studies
D. Susitna Project Studies
E. Coal and Gas Alternatives
F. Alternative Energy Sources
G. Transmission Alternatives
H. System Optimization Studies
I. Environmental Studies

2.7 DEFINITIVE PROJECT STUDIES (STAGE 2)

A. Objective

The objective of the Definitive Project Studies will be to define the Susitna Hydroelectric Project in sufficient detail to permit determination of its feasibility and preparation of an FERC license application.

B. Scope of Design Work

The studies will be based on the project selected in the Plan Formulation Stage, assuming that the Susitna Hydroelectric Project is recommended for early implementation. The end products of the physical planning during the Definitive Project Studies Stage will include:

- Preliminary designs of all major features, supplemented by stability and stress analyses for the dams.
- Layout drawings of all project components and appurtenant facilities.
- Quantity estimates.
- Cost estimates to a level of accuracy suitable for project authorization and for use as a basis for financing.
- Construction schedules.
- Refined power and energy estimates, based on detailed reservoir operation studies, including peaking capability investigations.
- Economic analyses and financial planning and information.

Most of the work listed above will be performed by the Preliminary Design and Geotechnical Studies Groups. However, the Plan Synthesis Group will provide the overall direction and supervision of these studies.

C. Execution

Beginning with basic parameters established in the Plan Formulation Report, supplemented by more detailed reservoir operation studies, the principal project features will be subject to final optimization and sizing.

During the time allocated to the Definitive Project Studies, ongoing field investigations will provide additional data on the specific sites of dams, spillways, power plants, and other important structures scheduled for development. These investigations will also include determination of the quality and quantitiy of available construction materials (principally for use in determining embankment dam zoning and sideslope requirements) and an indication of the extent of necessary foundation treatment at selected sites. Finally, the field investigations will yield pertinent information on the physical characteristics of the foundation materials so as to permit detailed stability and stress analyses to progress.

Preliminary design studies will be initiated on all principal components. Hydrologic design data will be refined, and interrelated project features will be optimized--for example, river diversion during construction and spillway crest provisions versus dam crest elevations. Preliminary designs and layouts of primary components will be made to refine outline geometry. As field investigation information becomes available, stability and stress analyses will be undertaken for the major structures.

From detailed reservoir and system operation studies, installed generating capacities will be fixed. Final sizing of intakes, waterways, and power plants will proceed in conjunction with the preparation of power plant layout drawings.

Concurrent with the development of the final generating plant layouts will be preliminary design work on transmission plant--that is, transmission lines and substations. Similarly, access roads will be studied in some detail.

Layout drawings of all project features will be prepared and refined. These drawings will form the basis for quantity takeoffs and final project costing, and for construction scheduling.

The Definitive Project Studies will also include in-depth investigations of any residual adverse socioecological aspects highlighted in the Plan Formulation Report. Facilities and provisions will be developed to mitigate adverse impacts insofar as economically feasible or as directed by the APA.

D. Development of Preliminary Dam Designs

In the refinement of layout drawings, quantity estimates, and project costing, it will be necessary to progress into rather extensive preliminary designs for the dams, particularly since these structures will probably be of considerable height. These special considerations are discussed below with respect to the principal dam types anticipated to be encountered.

1. Concrete Dams (Arch Dam Type) - For concrete arch dams similar to the one that has been proposed for Devil Canyon, the preparation of preliminary layouts will be guided initially by trial load analyses. IECO uses the version of complete trial load analysis termed Arch Dam Stress Analysis System (ADSAS), developed by the U.S. Bureau of Reclamation. These analyses will be supplemented later by three-dimensional finite element, static and dynamic stress analyses. Structural modeling for verification of analytical results will be required eventually, but not prior to submittal of the FERC license application.

2. Concrete Dams (Gravity Dam Type) - As in the case of arch dams, stability and static and dynamic finite element stress analyses will be undertaken to refine the concrete outlines for gravity dam type structures. Structural models probably will not be required.

3. Embankment Dams - Preliminary design of embankment-type dams similar to the one that has been proposed for Watana will be guided

principally by the availability of construction materials. Analytical stability and static and dynamic finite element stress analyses will be performed to finalize embankment geometry.

E. Definitive Project Report

The Definitive Project Report, which will include drawings and text describing in detail all project features, will demonstrate the technical and economic feasibility of the Susitna Hydroelectric Project. It will form the basis for the preparation of related FERC exhibits. The Study Team expects that the Definitive Project Report will consist of a series of volumes covering the subject areas listed below:

SUMMARY REPORT

APPENDIXES

A. Project Drawings
B. Hydrology, Sedimentation and River Regime
C. Reservoir Operation and Power Studies
D. Geological and Geotechnical Investigations
E. Studies of Alternative Layouts and Designs
F. Electrical and Mechanical Equipment
G. Transmission Lines
H. Construction Program
I Cost Estimates
J. Economic Analysis and Financial Evaluation

Note: Exhibit W will serve as the Environmental Report.

2.8 PREPARATION OF FERC LICENSE APPLICATION (STAGE 3)

To the greatest extent possible, data and information contained in the Definitive Project Report will be utilized, without change, for incorporation in the various FERC application exhibits. The documentation requirements of FERC will have been considered during preparation of the Definitive Project Report so that a minimum time schedule for completion of the FERC application can be maintained. Environmental studies and documentation will be prepared initially in FERC format so that no changes will be required during the License Application Stage of the work.

The proposed study program is designed to provide for preparation of an FERC application that will address all technical, economic, financial, social, and environmental elements associated with the development of the Susitna Hydroelectric Project as one source of electric power generation to meet the forecasted needs of the area. The documents will provide sufficient information for the various State and Federal agencies to ascertain that all aspects of project implementation within their particular jurisdictions have been adequately considered. The financial plan as prepared for the financial analysis of the Definitive Project Studies will form the basis for negotiations of power sale agreements and arrangements for funding of project construction.

2.9 FOLLOW-ON PHASES

Although the objective of the Plan of Study is to present the detailed program up to the FERC license application, the Request for Proposal specifically asks that work items be identified and schedules and costs be estimated for the Susitna Hydroelectric Project up to the initiation of construction. Thus, the follow-on work has been divided into two phases:

- FERC Licensing.
- Final Design and Contract Document Preparation.

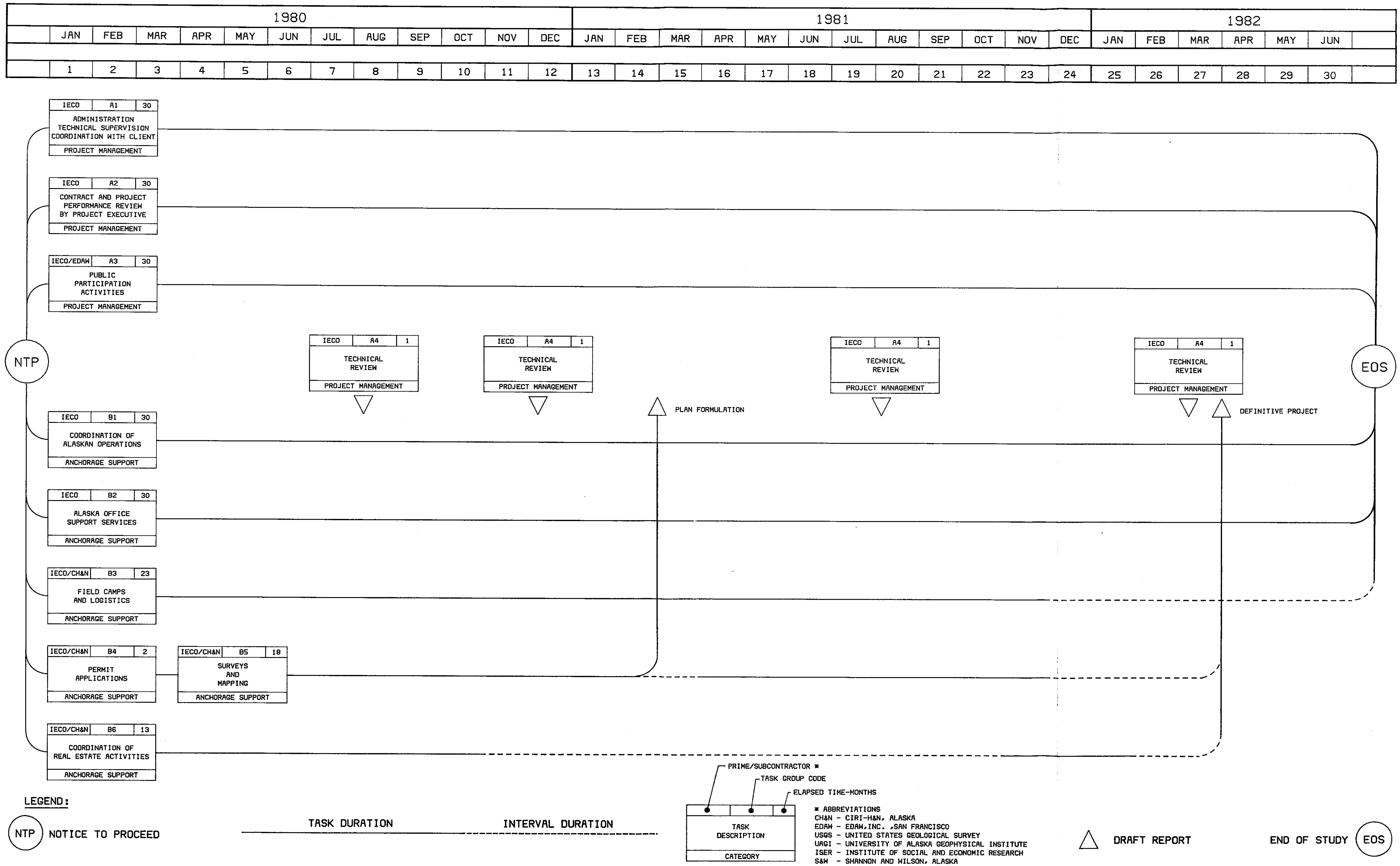
The major activities foreseen during these phases are described in Part A, Section 5; a tentative schedule is presented in Part A, Section 6; and a rough estimate of costs is presented in Part A, Section 3.

The limitations of planning such future work at this time must be recognized. The assumptions and hypotheses on which the data presented are based are stated in the respective sections of the Plan of Study.

INTERNATIONAL ENGINEERING COMPANY, INC.

SUSITNA HYDROELECTRIC PROJECT
PLAN OF STUDY
FLOW DIAGRAM

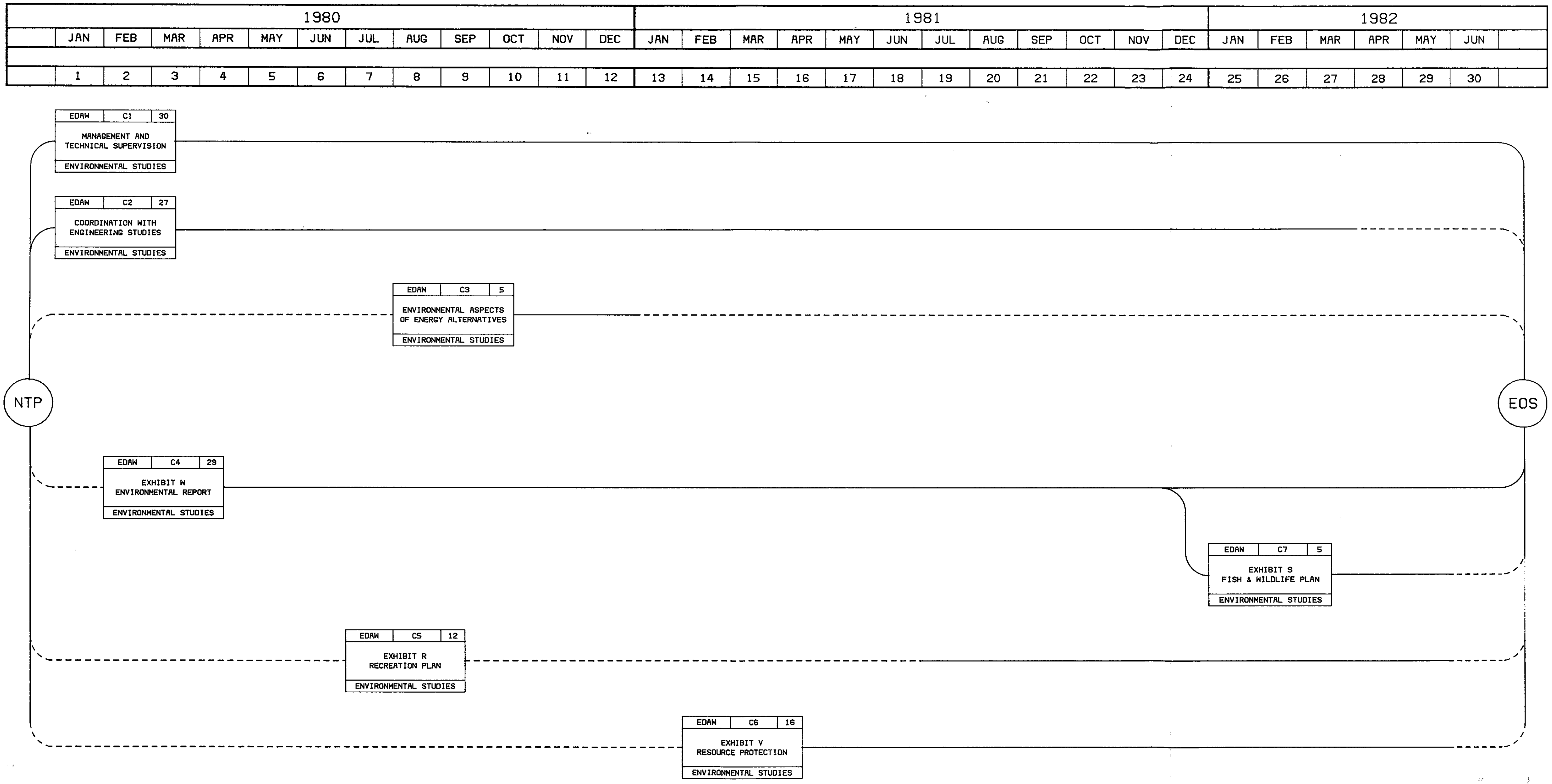
EXHIBIT A-2-1
SHEET 1 OF 6



INTERNATIONAL ENGINEERING COMPANY, INC.

SUSITNA HYDROELECTRIC PROJECT
PLAN OF STUDY
FLOW DIAGRAM

EXHIBIT A-2-1
SHEET 2 OF 6



LEGEND:

NTP NOTICE TO PROCEED

TASK DURATION

INTERVAL DURATION

PRIME/SUBCONTRACTOR *
TASK GROUP CODE
ELAPSED TIME-MONTHS
TASK DESCRIPTION
CATEGORY

* ABBREVIATIONS
CH&N - CIRI-H&N, ALASKA
EDAW - EDAW, INC. ,SAN FRANCISCO
USGS - UNITED STATES GEOLOGICAL SURVEY
UAGI - UNIVERSITY OF ALASKA GEOPHYSICAL INSTITUTE
ISER - INSTITUTE OF SOCIAL AND ECONOMIC RESEARCH
S&W - SHANNON AND WILSON, ALASKA

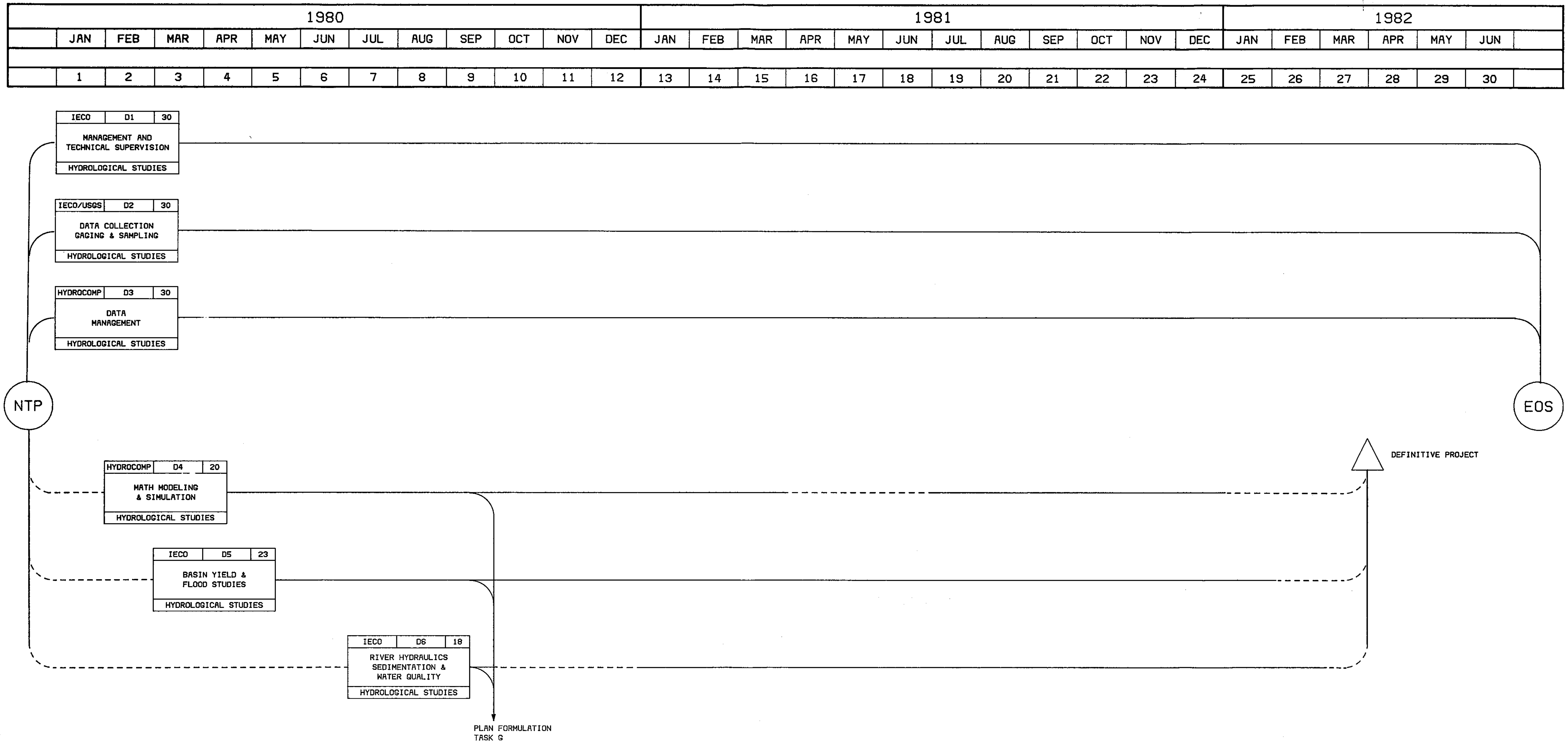
△ DRAFT REPORT

END OF STUDY EOS

INTERNATIONAL ENGINEERING COMPANY, INC.

SUSITNA HYDROELECTRIC PROJECT
PLAN OF STUDY
FLOW DIAGRAM

EXHIBIT A-2-1
SHEET 3 OF 6



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DRAFT REPORT

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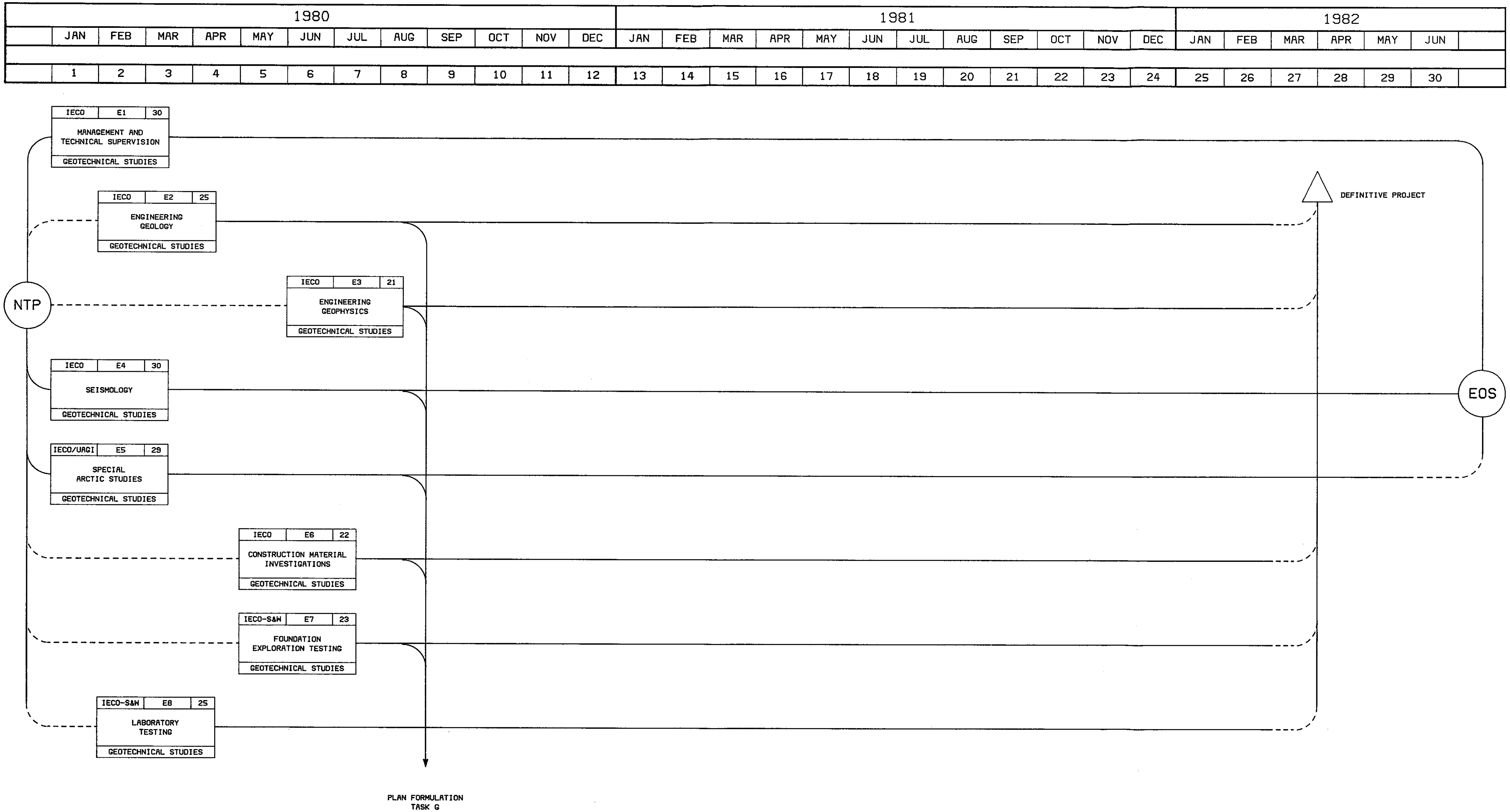
INTERNATIONAL ENGINEERING COMPANY, INC.

SUSITNA HYDROELECTRIC PROJECT
PLAN OF STUDY
FLOW DIAGRAM

EXHIBIT A-2-1
SHEET 4 OF 6



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END OF STUDY EOS

INTERNATIONAL ENGINEERING COMPANY, INC.

SUSITNA HYDROELECTRIC PROJECT
PLAN OF STUDY
FLOW DIAGRAM

EXHIBIT A-2-1
SHEET 5 OF 6

1980												1981												1982					
JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
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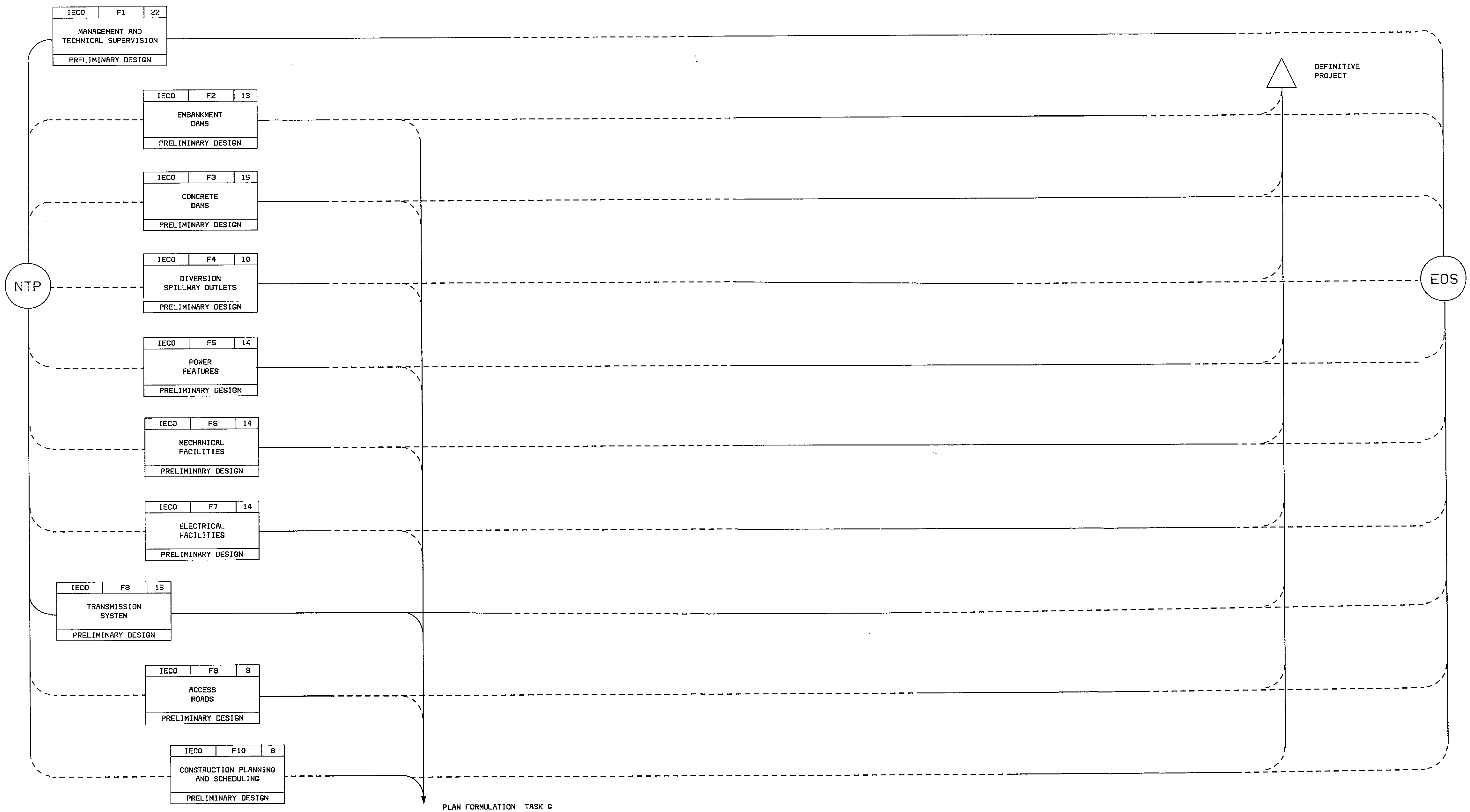


INTERNATIONAL ENGINEERING COMPANY, INC.

SUSITNA HYDROELECTRIC PROJECT
PLAN OF STUDY
FLOW DIAGRAM

EXHIBIT A-2-1
SHEET 6 OF 6

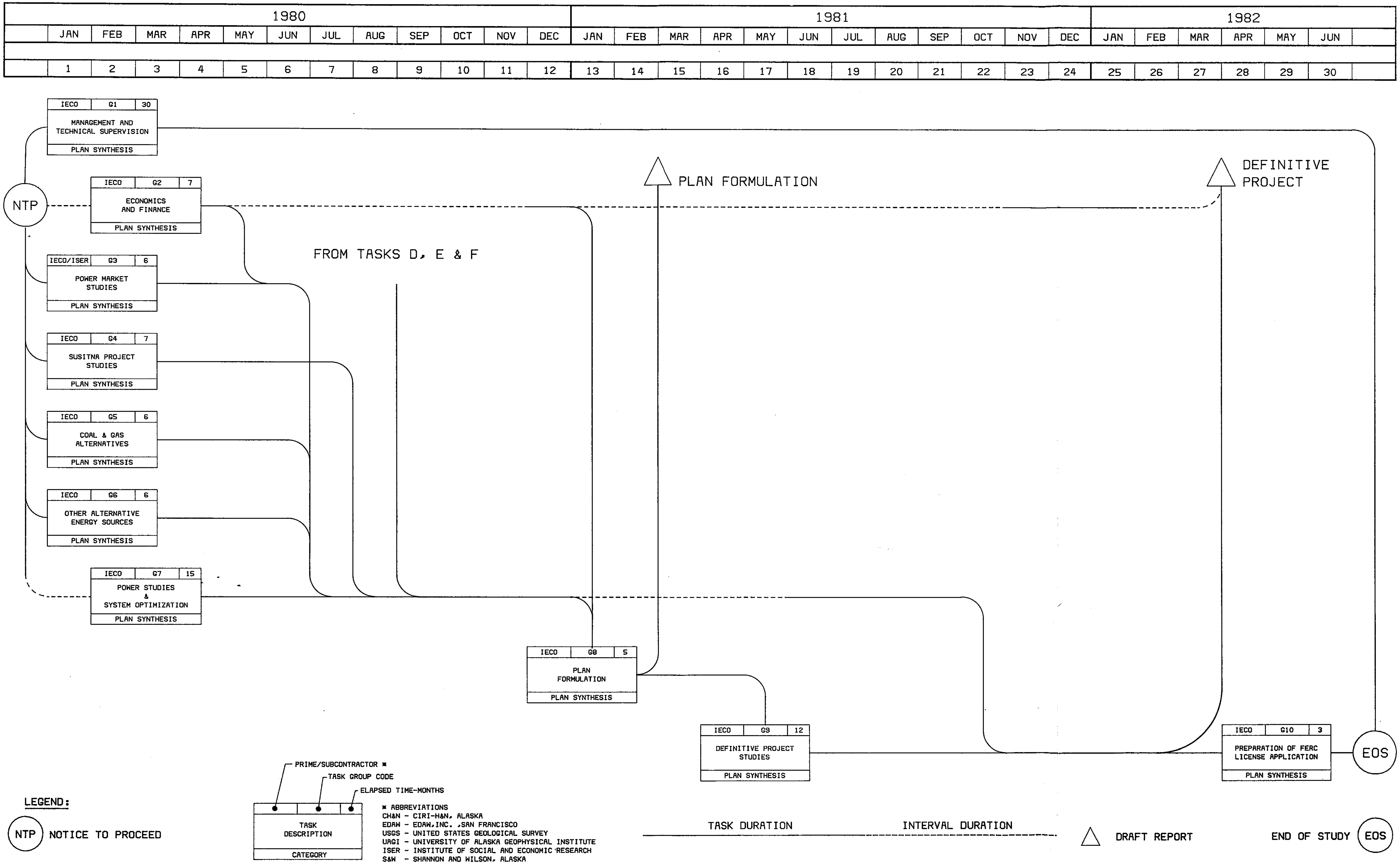
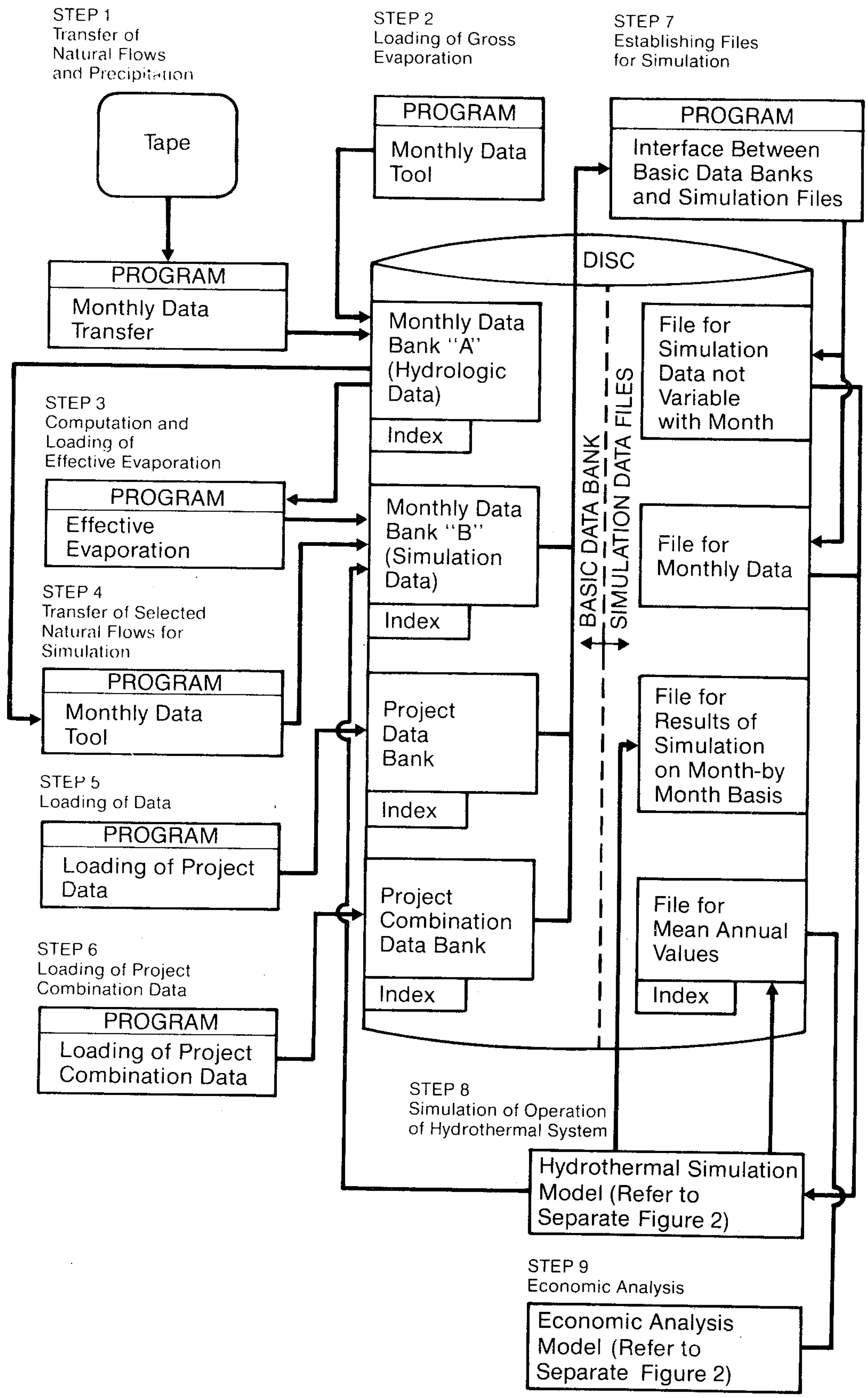


EXHIBIT A-2-2

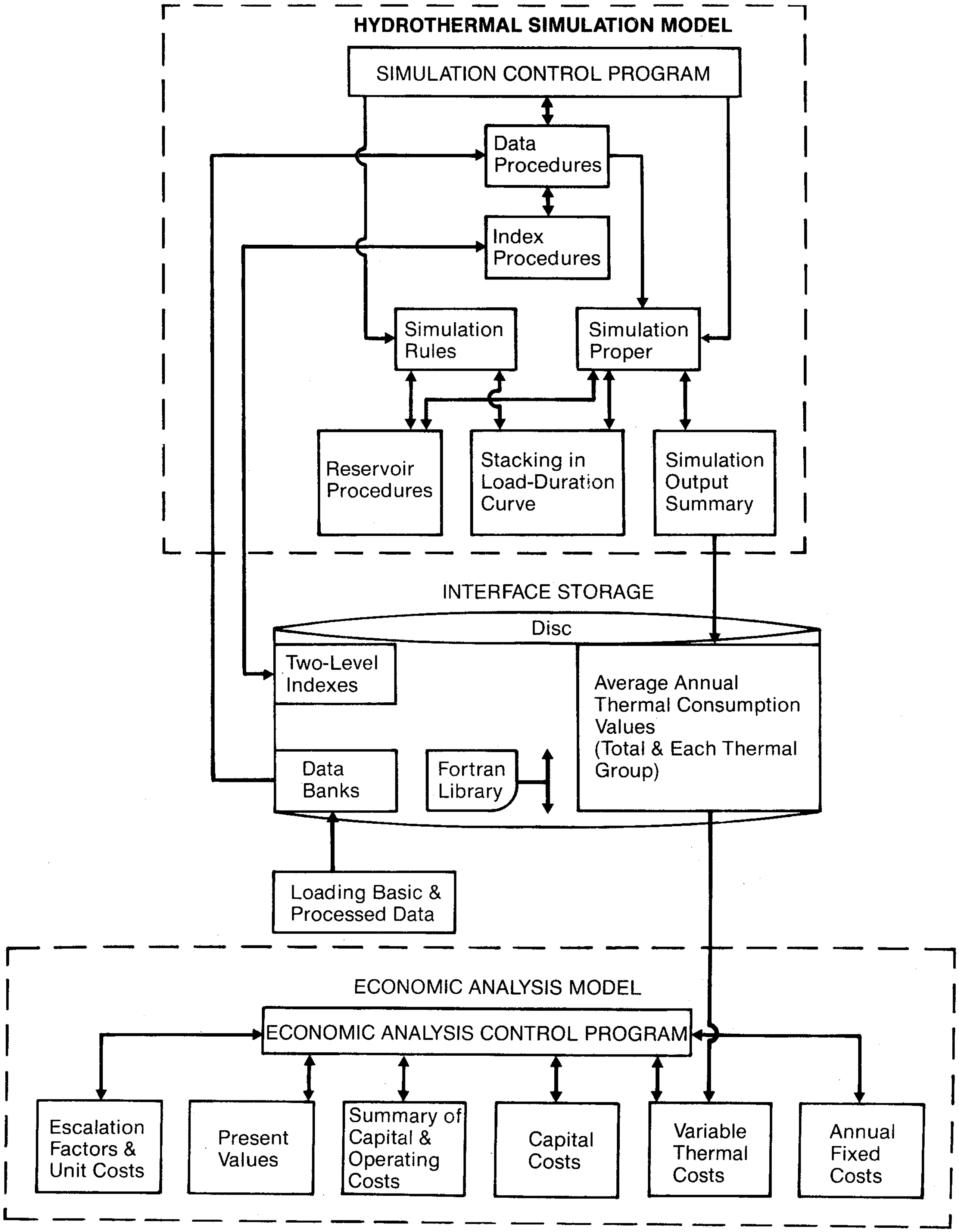
Susitna Hydroelectric Project
Plan of Study

Interrelation between Data Base and Hydrothermal Simulation



Susitna Hydroelectric Project
Plan of Study

Interrelation between Hydrothermal Simulation and Economic Analyses



Section 3 - Budget Summary

3.1 COST ESTIMATE FOR THE PLAN OF STUDY

Table A-3-1 summarizes the estimated costs for the Plan of Study. The estimated man-days of effort, reimbursable salary cost (including overhead and fee), estimated reimbursable expenses, and total cost are given for each task included in the Plan of Study, and these costs are subtotaled by assignment and category. The costs estimated by subcontractors are shown in the reimbursable expense column where applicable.

Because of uncertainty over the escalation factors that may be applicable during the period covered by the Plan of Study, the costs are presented on the basis of current (1979) price levels. The commercial terms presented in the suggested contractual form in Part B, Section 4, were followed in costing the work items.

No contingency factor has been applied to the estimated costs. The values shown are based on reasonable estimates of the work required, the difficulties to be expected, and the complexity of the studies. Changes may be warranted as individual work plans and schedules are reviewed and discussed with representatives of the APA and involved regulatory agencies.

At the end of Table A-3-1 is a summary of the APA costs for administration and review, including coordination with the Alaska Department of Fish and Game.

The total estimated cost for the entire Plan of Study phase of the work over the two-and-a-half-year period is $ 22,366,000. The total costs estimated for the various participants in the Susitna study and the APA are tabulated below:

	Estimated Cost ($)
Prime Consultant - IECO	5,731,000
Associated Consultants	
EDAW, Inc., and Dames & Moore	3,808,000*
Hydrocomp, Inc.	621,000
Supporting Subcontractors	
CIRI/H&N	8,250,000
University of Alaska Geophysical Institute	315,000
University of Alaska Museum	268,000
University of Alaska Institute of Social and Economic Research	20,000
Shannon and Wilson, Inc.	140,000
Specialized Concrete Laboratory	40,000
Drilling Subcontract	1,000,000
Governmental Agencies	
USGS	555,000
APA Budget Items (for Administration and Review)	1,618,000
	22,366,000

3.2 BUDGET FOR THE PLAN OF STUDY

The estimated costs for the activities comprising the Plan of Study have been summarized into estimated quarterly budget figures over the period

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* Includes an amount for participation of the Alaska Department of Fish and Game.

of the Plan of Study. The tasks have been grouped into major disciplines or specific work groups to facilitate comparison of the summarized costs for the various programs. The quarterly breakdown is presented in Table A-3-2 and Exhibit A-3-1, and the total budget for the Plan of Study is shown in Exhibit A-3-2.

The accummulated cost up to the second quarter of 1981, basically the period covered by the Plan Formulation Stage, is $12,595,000. For the Definite Project Studies Stage, up to the second quarter of 1982, the accummulated cost is $7,679,000, with an additional $474,000 estimated for the last quarter. None of these figures include APA administration and review costs. Since many of the activities will be carried on throughout the Plan of Study Phase and apply to more than one of the three Plan of Study stages, the cost figures cited do not reflect the cost of any one stage of the Plan of Study.

3.3 ESTIMATED COSTS FOR THE FOLLOW-ON PHASES

The Request for Proposal asks for an estimate of the costs for the project up to award of the construction contract. Thus, the IECO Team has prepared a "preliminary planning-type" estimate of costs for the Follow-on Phases. This very approximate estimate, which is based on current (1979) prices, is presented in Table A-3-3. Because of the nature of the estimate, a reasonable contingency factor should be applied when using it. In order that the estimated costs can be viewed in the proper perspective, the assumptions on which they are based are outlined below:

- The FERC licensing process will require two-and-a-half years until issuance of the license.

- No legal challenges resulting in delays in project implementation will be brought against the project.

- The project for which an FERC license will be sought will consist of hydroelectric developments at the Watana and Devil Canyon sites, with the initial development to be at the Watana site.

- The final design and contract documents will be prepared only for the initial development (Watana), the access road, and the transmission line.

- The field camp planned for use in the Plan of Study Phase will not be dismantled. Instead, it will be "mothballed" for future use in performing additional field work needed during final design.

- No unexpected or extraordinarily difficult problems, technical or environmental, will surface during the course of the Plan of Study or be imposed as a result of the FERC licensing process.

Exhibit A-3-3 shows graphically the estimated accummulated total expenditure for the budget presented for the Plan of Study and for the estimated costs for the Follow-on Phases.

SUSITNA HYDROELECTRIC PROJECT
PLAN OF STUDY
COST SUMMARY

CATEGORY A - PROJECT MANAGEMENT

TASK NO.	TASK TITLE	Reimbursable Salary Cost Man-days	Reimbursable Salary Cost Cost ($1000)	Other Reimbursable Expenses ($1000)	Total Costs ($1000)	Total Cost Summary ($1000)
A-1	PROJECT MGR & DEPUTY MGR					
A-1-1	Management, Admin & Tech Supervision	370	165	10	175	
A-1-2	Coordination with Client	75	45	5	50	
	SUBTOTAL					225
A-2	PROJECT EXECUTIVE					
A-2-1	Contract & Project Perf Review	(a)	(a)	(a)	(a)	
	SUBTOTAL					
A-3	PUBLIC PARTICIPATION					
A-3-1	Public Information & Participation	55	25	10	35	
A-3-2	Public Agency Coordination	30	15	-	15	
A-3-3	Staff Support	260	80	5	85	
A-3-4	Environ Input to Public Participation	152	49	32	81	
	SUBTOTAL					216
A-4	IECO TECH REVIEW BOARD					
A-4-1	Project Technical Reviews	16	10	-	10	
	SUBTOTAL					10
	TOTAL CATEGORY A					451

(a) Costs included as overhead

TABLE A-3-1
Sheet 2 of 10

SUSITNA HYDROELECTRIC PROJECT
PLAN OF STUDY
COST SUMMARY

CATEGORY B - ANCHORAGE SUPPORT

TASK NO.	TASK TITLE	Reimbursable Salary Cost Man-days	Reimbursable Salary Cost Cost ($1000)	Other Reimbursable Expenses ($1000)	Total Costs ($1000)	Total Cost Summary ($1000)
B-1	PRINCIPAL-IN-CHARGE					
B-1-1	Coordination Support Operations	30	17	5	22	
	SUBTOTAL					22
B-2	OFFICE SUPPORT					
B-2-1	Furnish Support Services	75	25	50	75	
	SUBTOTAL					75
B-3	FIELD CAMPS AND LOGISTICS					
B-3-1	IECO Coordination	30	16	-	16	
B-3-2	Plan & Establish Field Camp	-	-	3,621 (a)	3,621	
B-3-3	Furn Field Pers Housing & Subsistence	-	-	1,916 (a)	1,916	
B-3-4	Provide Field Logistic Support	-	-	1,849 (a)	1,849	
	SUBTOTAL					7,402
B-4	PERMITS					
B-4-1	IECO Coordination	6	2	-	2	
B-4-2	Prep & Process Permit Applications	-	-	14 (a)	14	
	SUBTOTAL					16
B-5	SURVEY AND MAPPING					
B-5-1	IECO Coordination & Review	50	20	5	25	
B-5-2	Furnish Reservoir Mapping	-	-	128 (a)	128	
B-5-3	Furnish Access Road Prelim Mapping	-	-	48 (a)	48	
B-5-4	Furnish Trans Line Corr Photo Mosaic	-	-	16 (a)	16	
B-5-5	Furnish Damsite Mapping	-	-	28 (a)	28	
B-5-6	Furnish River Cross Sections	-	-	179 (a)	179	
B-5-7	Furnish Access Road Detail Mapping	-	-	246 (a)	246	
B-5-8	Furnish Support - Field Investigations	-	-	95 (a)	95	
	SUBTOTAL					765
B-6	REAL ESTATE					
B-6-1	IECO Coordination	6	2	-	2	
B-6-2	Land Ownership Status	-	-	55 (a)	55	
B-6-3	Boundary Description	-	-	20 (a)	20	
B-6-4	Land Acquisition Costs	-	-	35 (a)	35	
	SUBTOTAL					112
	TOTAL CATEGORY B					8,392

(a) Subcontract estimate by CIRI-H&N

SUSITNA HYDROELECTRIC PROJECT
PLAN OF STUDY
COST SUMMARY

CATEGORY C - ENVIRONMENTAL STUDIES

TASK NO.	TASK TITLE	Reimbursable Salary Man-days	Reimbursable Cost Cost ($1000)	Other Reimbursable Expenses ($1000)	Total Costs ($1000)	Total Cost Summary ($1000)
C-1	PRINCIPAL-IN-CHARGE					
C-1-1	Management & Tech Supervision	(a)	(a)	(a)	(a)	
C-1-2	Project Orientation	45	13	1	14	
	SUBTOTAL					14
C-2	COORDINATE WITH ENGR STUDIES	40	12	2	14	
C-2-1	Coordination Environ Input to Design	40	12	2	14	
	SUBTOTAL					28
C-3	ENVIRON-ENERGY ALTS-DEMAND					
C-3-1	Socioecon Aspects - Energy Forecasts	55	15	3	18	
C-3-2	Environ Evaluation of Alternatives	160	44	7	51	
	SUBTOTAL					69
C-4	EXH. W-ENVIRONMENTAL REPORT					
C-4-1	Climatology	781	231	314	545	
C-4-2	Hydrology	40	11	3	14	
C-4-3	Geology	80	23	3	26	
C-4-4	Seismology	38	11	2	13	
C-4-5	Soils & Sedimentation	44	22	4	26	
C-4-6	Water Quality	44	13	10	23	
C-4-7	Aquatic Resources-Anadrom Fisheries	2,971	929	89	1,018 (b)	
C-4-8	Aquatic Resources-Resid Fisheries	1,468	442	75	517	
C-4-9	Aquatic Resources-Upper Cook Inlet Estuary	80	40	-	40	
C-4-10	Vegetation	280	84	11	95	
C-4-11	Wildlife Resources-Large Mammals	648	194	50	244	
C-4-12	Wildlife Resources-Birds & SM Mammals	249	75	35	110	
C-4-13	Land Use	120	41	10	51	
C-4-14	Land Ownership	130	44	11	55	
C-4-15	Recreation	65	21	5	26	
C-4-16	Transportation	126	38	9	47	
C-4-17	Air Quality & Noise	30	9	3	12	
C-4-18	Population & Demography	100	32	8	40	
C-4-19	Economics	310	88	15	103	
C-4-20	Cultural Resources	1,320	171	167	338	
C-4-21	Public Safety	40	12	2	14	
C-4-22	Visual Resources	175	56	14	70	
C-4-23	Trans Routing Environ Aspects	461	138	35	173	
C-4-24	Prepare Final Report	850	247	25	272	
	SUBTOTAL					3,872

(a) Included within Assignments of C-4, primarily Task C-4-24.
(b) Costs for POS only; an additional $323,000 will be required to complete follow-on anadromous fish studies.

SUSITNA HYDROELECTRIC PROJECT
PLAN OF STUDY
COST SUMMARY

CATEGORY C (CONTINUED)

TASK NO.	TASK TITLE	Reimbursable Salary Man-days	Cost ($1000)	Other Reimbursable Expenses ($1000)	Total Costs ($1000)	Total Cost Summary ($1000)
C-5	EXHIBIT R - RECREATION PLAN					
C-5-1	Form Goals & Operation Objective	16	4	2	6	
C-5-2	Determine Recreation Land Use Suitability	48	11	4	15	
C-5-3	Assess Recreation Demand	16	5	2	7	
C-5-4	Develop Conceptual Recreation Schemes	40	10	1	11	
C-5-5	Review Alternative Plans	11	2	2	4	
C-5-6	Select & Refine Preferred Plan	49	12	3	15	
C-5-7	Prepare Final Report	54	12	3	15	
	SUBTOTAL					73
C-6	EXHIBIT V - RESOURCE PROTECTION					
C-6-1	Formulate Goals & Objectives	10	3	2	5	
C-6-2	Analysis Fed, State & Local Guidelines	15	5	-	5	
C-6-3	Cultural Resource Identification	3	1	-	1	
C-6-4	Trans Line Corridor Analysis	15	4	2	6	
C-6-5	Visual Resource Identification	10	3	1	4	
C-6-6	Prepare Final Report	12	3	2	5	
	SUBTOTAL					26
C-7	EXHIBIT S - FISH & WILDLIFE PLAN					
C-7-1	Describe Pre-Proj Biological Setting	10	3	2	5	
C-7-2	Assess Impacts to Fish & Wildlife	10	3	2	5	
C-7-3	Prepare Mitigation Plan	12	4	1	5	
C-7-4	Coordinate With Nat Resources Agencies	10	3	2	5	
C-7-5	Prepare Final Report	8	2	1	3	
	SUBTOTAL					23
	TOTAL CATEGORY C					4,105

SUSITNA HYDROELECTRIC PROJECT
PLAN OF STUDY
COST SUMMARY

CATEGORY D - HYDROLOGICAL STUDIES

TASK NO.	TASK TITLE	Reimbursable Salary Man-days	Reimbursable Cost Cost ($1000)	Other Reimbursable Expenses ($1000)	Total Costs ($1000)	Total Cost Summary ($1000)
D-1	PRINCIPAL-IN-CHARGE					
D-1-1	Management & Tech Supervision	180	56	8	64	
	SUBTOTAL					64
D-2	DATA COLL, GAGING & SAMPLING					
D-2-1	IECO Coordination & Review	85	27	2	29	
D-2-2	Install & Oper Stream Gaging Sta	535	179	267	446	
D-2-3	Sed & Water Qual Data Sampling	145	49	60	109	
	SUBTOTAL					584
D-3	DATA MANAGEMENT					
D-3-1	Collect & Compile Exist Hydromet Data	110	34	12	46	
D-3-2	Compile Data From New Hydromet Sta	75	25	8	33	
D-3-3	Establish Computer Based Data Library	495	154	50	204	
	SUBTOTAL					283
D-4	MATH MODELING & SIMULATION					
D-4-1	Dev Comprehensive Watershed Model	105	34	12	46	
D-4-2	Dev Models for Arctic Conditions	320	112	39	151	
D-4-3	Calibrate & Verify Models	325	106	35	141	
	SUBTOTAL					338
D-5	BASIN YIELD & FLOOD STUDIES					
D-5-1	Prelim Hydrologic Investigations	25	8	3	11	
D-5-2	PMP & PMF For Project Sites	115	36	12	48	
D-5-3	Statistical & Graphical Analysis	195	62	20	82	
D-5-4	Glacial Water Balance	65	21	7	28	
D-5-5	Correlate & Extend Streamflow Data	125	39	13	52	
	SUBTOTAL					221
D-6	RIV HYDR, SEDIMENT & WAT QUAL					
D-6-1	TW Rating & WS Profiles	35	11	4	15	
D-6-2	Res Sediment & Stratification Studies	150	50	16	66	
D-6-3	D/S Sediment Transp & Water Quality	170	56	20	76	
D-6-4	Ice Formation & Breakup	95	31	10	41	
D-6-5	Reservoir Fill & Emerg Drawdown	15	4	1	5	
D-6-6	D/S Hazards From Dam Failure	95	31	10	41	
	SUBTOTAL					244
	TOTAL CATEGORY D					1,734

TABLE A-3-1
Sheet 6 of 10

SUSITNA HYDROELECTRIC PROJECT
PLAN OF STUDY
COST SUMMARY

CATEGORY E - GEOTECHNICAL STUDIES

TASK NO.	TASK TITLE	Reimbursable Salary Man-days	Cost ($1000)	Other Reimbursable Expenses ($1000)	Total Costs ($1000)	Total Cost Summary ($1000)
E-1	PRINCIPAL-IN-CHARGE					
E-1-1	Management & Tech Supervision	140	53	5	58	
	SUBTOTAL					58
E-2	ENGINEERING GEOLOGY					
E-2-1	Review Geol Aspects of Alternatives	18	8	1	9	
E-2-2	Evaluate Alternative Damsites	52	25	1	26	
E-2-3	Reconn-Trans Line & Access Road	22	10	1	11	
E-2-4	Geologic Mapping-Watana Site	220	106	2	109	
E-2-5	Geologic Mapping-Devil Canyon Site	220	106	2	109	
	SUBTOTAL					264
E-3	ENGINEERING GEOPHYSICS					
E-3-1	Seismic Refraction Survey-Watana	120	52	4	56	
E-3-2	Shear Wave Hammer Testing-Watana	80	35	3	38	
E-3-3	Seismic Refrac Survey-Devil Canyon	120	52	3	55	
E-3-4	Shear Wave Hammer Testing-Devil Canyon	80	35	3	38	
	SUBTOTAL					187
E-4	Seismology					
E-4-1	Seismotectonic Studies	25	8	1	9	
E-4-2	Estab Loc Seismic Monitoring System	104	48	300 (a)	348	
E-4-3	Regional Seismicity Study	20	6	-	6	
E-4-4	Earthquake Simulation	25	8	4	12	
E-4-5	Seismic Risk Analysis & Design Eq	25	8	4	12	
	SUBTOTAL					387
E-5	SPECIAL ARCTIC STUDIES					
E-5-1	IECO Coordination & Review	80	26	-	26	
E-5-2	River & Reservoir Ice Problem Studies	-	-	125 (b)	125	
E-5-3	Mass Balance & Dynam Behavior of Glaciers	-	-	130 (b)	130	
E-5-4	Permafrost Problem Studies	-	-	60 (b)	60	
	SUBTOTAL					341
E-6	CONSTRUCTION MATL INVESTIG					
E-6-1	Sources for Watana	200	82	2	84	
E-6-2	Sources for Devil Canyon	140	58	2	60	
E-6-3	Sources for Access Roads	20	8	1	9	
	SUBTOTAL					153
E-7	FOUNDATION EXPLORATION & TEST					
E-7-1	Investigations at Watana Damsite	480	175	347 (c)	522	
E-7-2	Investigations at Devil Canyon Damsite	960	350	688 (c)	1,018	
	SUBTOTAL					1,540
E-8	LABORATORY TESTING					
E-8-1	Plan, Coordinate & Review Test Program	75	24	-	24	
E-8-2	Test Samples for Watana Site	-	-	80	80	
E-8-3	Test Samples for Devil Canyon	-	-	60	60	
E-8-4	Conduct Mass Concrete Tests	-	-	40	40	
	SUBTOTAL					204
	TOTAL CATEGORY E					3,134

(a) Seismograph instruments and installations
(b) Subcontract to Geophysical Institute - U. of Alaska
(c) Includes drilling subcontract

SUSITNA HYDROELECTRIC PROJECT
PLAN OF STUDY
COST SUMMARY

CATEGORY F - PRELIMINARY DESIGN

TASK NO.	TASK TITLE	Reimbursable Salary Cost Man-days	Reimbursable Salary Cost Cost ($1000)	Other Reimbursable Expenses ($1000)	Total Costs ($1000)	Total Cost Summary ($1000)
F-1	PRINCIPAL-In-CHARGE					
F-1-1	Management & Tech Supervision	150	60	6	65	
	SUBTOTAL					65
F-2	EMBANKMENT DAMS					
F-2-1	Provide Design Input to Plan Formulation	65	18	1	19	
F-2-2	Evaluate Design Alternatives-Watana	115	32	-	32	
F-2-3	Stability Analysis-Watana Dam	200	56	19	75	
F-2-4	Prelim Design & Matl Reqmts-Watana Dam	65	18	-	18	
F-2-5	Prelim Cofferdam Design-Watana	50	14	-	14	
F-2-6	Eval Design Alt-Devil Canyon Saddle Dam	90	25	-	25	
F-2-7	Stab Analysis-Devil Canyon Saddle Dam	40	11	1	12	
F-2-8	Prelim Des & Matl Req-Devil (Can-Sad Dam)	50	14	-	14	
F-2-9	Prelim Cofferdam Design-Devil Canyon	65	18	-	18	
	SUBTOTAL					227
F-3	CONCRETE DAMS					
F-3-1	Prov Design Input to Plan Formulation	130	36	-	36	
F-3-2	Arch Dam Layout-Devil Canyon	110	31	-	31	
F-3-3	Stress & Stability Stud-Devil Canyon Dam	570	160	20	180	
F-3-4	Prelim Design-Devil Canyon Dam	130	36	-	36	
F-3-5	Criteria & Proc. for Struct Model Tests	45	13	-	13	
	SUBTOTAL					296
F-4	DIVERSION SPILLWAYS & OUTLETS					
F-4-1	Provide Design Input to Plan Formulation	90	25	-	25	
F-4-2	Diversion Scheme Study-Watana Site	90	25	2	27	
F-4-3	Diversion Scheme Study-Devil Canyon	90	25	2	27	
F-4-4	Prelim Design-Watana Spillway	130	36	2	38	
F-4-5	Prelim Design-Devil Canyon Spillway	130	36	2	38	
F-4-6	Prelim Design-Watana Outlet Facilities	90	25	2	27	
F-4-7	Prelim Design-Devil Canyon Outlet Facil	90	25	2	27	
	SUBTOTAL					209
F-5	POWER FEATURES					
F-5-1	Provide Design Input to Plan Formulation	280	78	-	78	
F-5-2	Power Feature Layout-Watana PP	150	42	1	43	
F-5-3	Prelim Design-Watana PP	130	37	-	37	
F-5-4	Power Feature Layout-Devil Canyon PP	130	37	1	38	
F-5-5	Prelim Design-Devil Canyon PP	130	37	-	37	
	SUBTOTAL					233

SUSITNA HYDROELECTRIC PROJECT
PLAN OF STUDY
COST SUMMARY

CATEGORY F (CONTINUED)

TASK NO.	TASK TITLE	Reimbursable Salary Cost Man-days	Reimbursable Salary Cost Cost ($1000)	Other Reimbursable Expenses ($1000)	Total Costs ($1000)	Total Cost Summary ($1000)
F-6	MECHANICAL FACILITIES					
F-6-1	Provide Design Input to Plan Formulation	15	4	-	4	
F-6-2	Mech Design Studies-Watana Dam	10	3	-	3	
F-6-3	Prelim Design-Watana Dam Mech Facilities	15	4	-	4	
F-6-4	Mech Design Studies-Devil Canyon Dam	10	3	-	3	
F-6-5	Prelim Design-Devil Canyon Dam Mech Facil	15	4	-	4	
	SUBTOTAL					18
F-7	ELECTRICAL FACILITIES					
F-7-1	Provide Design Input to Plan Formulation	50	17	-	17	
F-7-2	Elec Design Studies-Watana Dam	20	6	-	6	
F-7-3	Prelim Design-Watana Dam Elec Facilities	10	3	-	3	
F-7-4	Elec Design Studies-Devil Canyon Dam	15	4	-	4	
F-7-5	Prelim Design-Devil Canyon Dam Elec Facil	10	3	-	3	
	SUBTOTAL					33
F-8	TRANSMISSION SYSTEM					
F-8-1	Transmission System Study	230	84	10	94	
F-8-2	Trans Line Route Study	120	40	2	42	
F-8-3	Prelim Tower & Foundation Studies	240	73	4	77	
F-8-4	Trans Line Conductor & Cost Studies	80	25	3	28	
F-8-5	Switchyards & Substations	220	70	2	72	
	SUBTOTAL					313
F-9	ACCESS ROADS					
F-9-1	Provide Design Input to Plan Formulation	140	40	-	40	
F-9-2	Preliminary Design-Access Roads	200	55	5	60	
F-9-3	Preliminary Design-Bridges	180	50	-	50	
	SUBTOTAL					150
F-10	CONSTRUCTION PLANNING & SCHED					
F-10-1	Provide Cost Input to Plan Formulation	55	18	-	18	
F-10-2	Constr Schedule and Cost-Access Roads	40	14	1	15	
F-10-3	Constr Sched and Costs- Watana	170	56	1	57	
F-10-4	Constr Sched and Costs-Devil Canyon	170	56	1	57	
F-10-5	Constr Sched and Costs-Trans Line	75	25	1	26	
F-10-6	Constr Plan for Constr Camp Infrastruct	-	-	59 (a)	59	
	SUBTOTAL					232
	TOTAL CATEGORY F					1,776

(a) Subcontract Estimate by CIRI-H&N

SUSITNA HYDROELECTRIC PROJECT
PLAN OF STUDY
COST SUMMARY

CATEGORY G - PLAN SYNTHESIS

TASK NO.	TASK TITLE	Reimbursable Salary Cost Man-days	Reimbursable Salary Cost Cost ($1000)	Other Reimbursable Expenses ($1000)	Total Costs ($1000)	Total Cost Summary ($1000)
G-1	PRINCIPAL-IN-CHARGE					
G-1-1	Management & Tech Supervision	280	98	2	100	
	SUBTOTAL					100
G-2	ECONOMICS & FINANCE					
G-2-1	Interaction of Alaska Econ with Proj	75	22	3	25	
G-2-2	Economic Review of Alternatives	80	24	1	25	
G-2-3	Econ Analysis of Definitive Project	40	12	1	13	
G-2-4	Prep Financial Analysis & Finan Plan	50	15	1	16	
	SUBTOTAL					79
G-3	POWER MARKET STUDIES					
G-3-1	Review & Update Energy Demand Data	100	28	2	30	
G-3-2	Forecast Socioecon Factors for Alaska	-	-	20 (a)	20	
G-3-3	Forecast Future Energy & Power Demands	120	35	2	37	
	SUBTOTAL					87
G-4	SUSITNA PROJECT STUDIES					
G-4-1	Review & Eval Data on Susitna Project	60	17	1	18	
G-4-2	Prepare Basic Layouts of Alternatives	350	98	2	100	
G-4-3	Dev Data for Proj Optimization Studies	150	42	3	45	
	SUBTOTAL					163
G-5	COAL & GAS ALTERNATIVES					
G-5-1	Review & Eval Coal & Gas Alternatives	175	50	5	55	
	SUBTOTAL					55
G-6	OTHER ALT ENERGY SOURCES					
G-6-1	Review & Evaluate Other Energy Sources	195	55	5	60	
	SUBTOTAL					60
G-7	POWER STUDIES & SYSTEM OPTIMIZATION					
G-7-1	Prepare Data Base	70	20	10	40	
G-7-2	Hydrothermal Simulation	300	85	40	125	
G-7-3	Present Values for Constr Sequences	200	56	30	86	
G-7-4	Operation Studies for Definitive Proj	150	42	20	62	
	SUBTOTAL					313
G-8	PLAN FORMULATION					
G-8-1	Evaluate Results of Studies	50	15	2	17	
G-8-2	Prepare Draft Plan Formulation Report	75	22	3	25	
G-8-3	Prepare Final Plan Formulation Report	75	21	7	28	
	SUBTOTAL					70

(a) Subcontract to ISER - U. of Alaska

SUSITNA HYDROELECTRIC PROJECT
PLAN OF STUDY
COST SUMMARY

CATEGORY G - (CONTINUED)

TASK NO.	TASK TITLE	Reimbursable Salary Cost Man-days	Reimbursable Salary Cost Cost ($1000)	Other Reimbursable Expenses ($1000)	Total Costs ($1000)	Total Cost Summary ($1000)
G-9	DEFINITIVE PROJECT STUDIES					
G-9-1	Coordinate & Synthesize Def Proj	250	70	5	75	
G-9-2	Coord Documentation for FERC Applic	150	15	-	15	
G-9-3	Prepare Definitive Project Report	100	28	7	35	
	SUBTOTAL					125
G-10	PREPARE FERC LICENSE APPLIC					
G-10-1	Assist APA in Exhbits A thru G & T	60	18	2	20	
G-10-2	Prepare Exhibits H thru O & U	160	45	5	50	
G-10-3	Incorporate Exhibits R, S, V & W	10	3	3	6	
G-10-4	Provide FERC Application Documents	30	8	20	28	
	SUBTOTAL					104
	TOTAL CATEGORY G					1,156
	TOTAL CONSULTANT'S COSTS FOR POS (Categories A thru G)					20,748
	APA COSTS					
1	Administration	-	-	250	250	
2	Indep Seismic Risk Anal	-	-	1,000	1,000	
3	Land Use	-	-	90	90	
4	Inspector	-	-	90	90	
5	ADF&G Coordination	-	-	188	188	
	SUBTOTAL					1,618
	GRAND TOTAL FOR PLAN OF STUDY					22,366

Susitna Hydroelectric Project
Plan of Study

Quarterly Budget
(Thousands of Dollars)

TASK GROUP	QUARTERLY BUDGET										TOTAL
	1	2	3	4	5	6	7	8	9	10	
MANAGEMENT, SUPPORT & MISCELLANEOUS (Tasks A-1, A-2, A-4, B-1, & B-2)	24	29	37	39	38	38	40	29	31	27	332
PUBLIC PARTICIPATION PROGRAM (Task A-3)	21	21	22	22	22	22	22	22	21	21	216
CAMPS, LOGISTICS, R.E. & PERMITS (Tasks B-3, B-4, & B-6)	3083	708	773	303	315	652	761	933	1	1	7530
SURVEY & MAPPING (Task B-5)	-	152	152	-	-	231	230	-	-	-	765
ENVIRONMENTAL (Category C)	610	535	481	484	487	376	339	407	244	142	4105
HYDROLOGICAL (Category D)	232	246	240	157	217	183	183	143	74	59	1734
GEOTECHNICAL (Category E)	54	384	929	378	202	217	445	236	195	94	3134
ECONOMICS & POWER MARKET (Tasks G-2 & G-3)	70	52	-	8	7	-	-	13	16	-	166
POWER STUDIES & PLANNING (Tasks G-1, G-4 through G-8)	142	218	125	113	47	50	48	6	6	6	761
PRELIMINARY DESIGN (Category F and Tasks G-9 & G-10)	126	222	42	-	26	331	506	433	195	124	2005
APA COSTS	162	162	162	162	162	162	162	162	162	100	1618
TOTAL QUARTERLY BUDGET	4524	2729	2963	1666	1523	2262	2736	2384	945	634	22,366

SUSITNA HYDROELECTRIC PROJECT

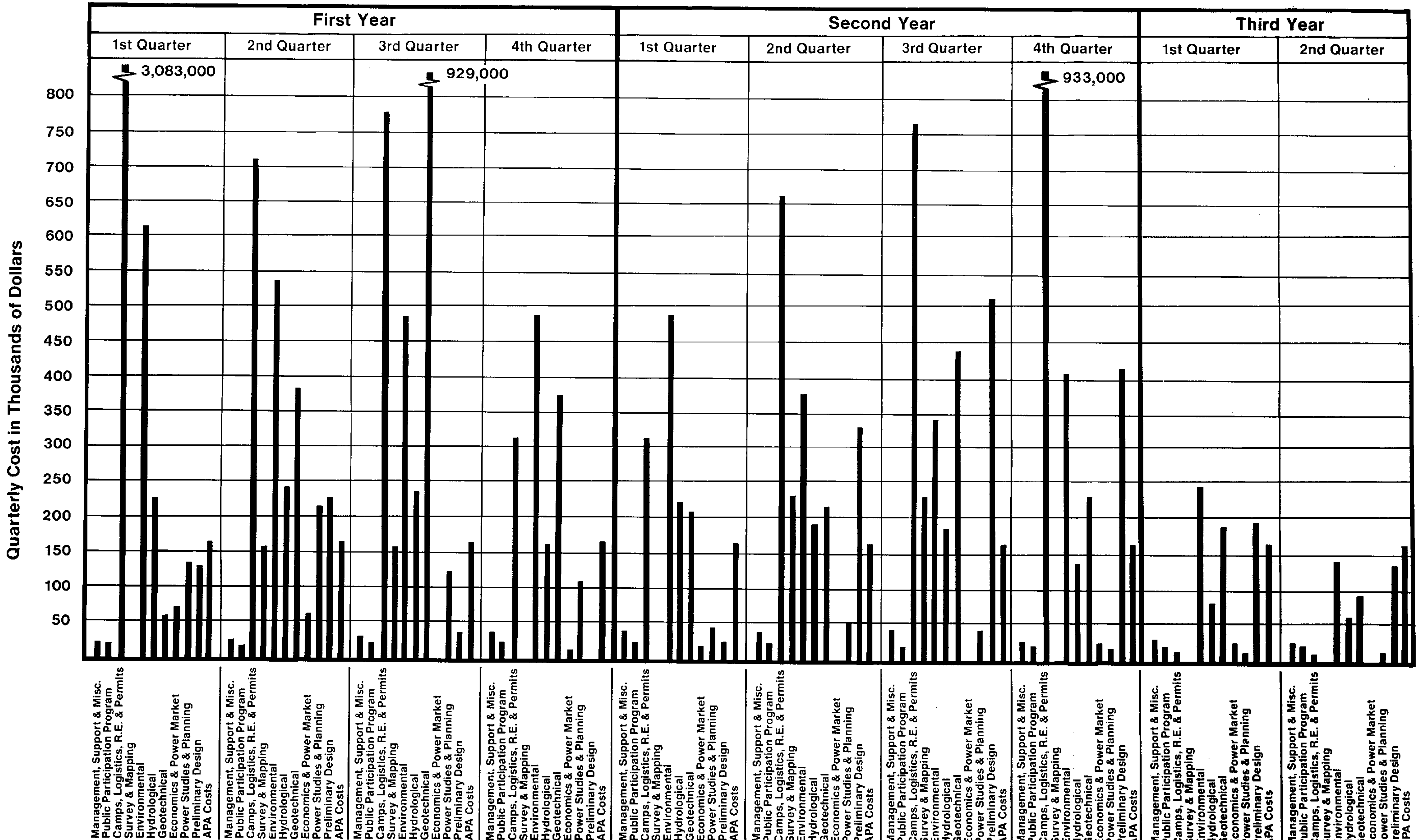
FOLLOW-ON PHASES

ESTIMATED COST SUMMARY

PRINCIPAL ACTIVITIES		APPROX. COST
I	FERC LICENSE APPLICATION	
I-1	On-going Alaska Power Authority Administrative and Legal Activities	$ 900,000
I-2	Miscellaneous On-going Activities & Costs	550,000
I-3	Perform Follow-on Environmental Studies from PLAN OF STUDY PHASE	1,100,000
I-4	Handling FERC Licensing Legal Matters - Special Counsel	500,000
I-5	Furnish Supplemental Information to Answer FERC Requests - Engr. and Envir. Consultants	150,000
I-6	Prepare Testimony and Appear as Expert Witness - Engr. & Envir. Consultants	50,000
I-7	Develop Supporting Supplemental Data - Structural Model Tests - Devil Canyon Arch Dam	200,000
I-8	Develop Supporting Supplemental Data - Hydraulic Model Studies - Watana Spillway	130,000
	SUB TOTAL	$3,580,000
II	FINAL DESIGN AND CONTRACT DOCUMENT	
II-1	Perform Additional Geotechnical Foundation and Burrow Exploration for Final Design	2,000,000
II-2	Furnish Field Camp and Logistics for Additional Exploration	2,000,000
II-3	Perform Final Design and Prepare Contract Drawings and Specifications - Construction and Procurement	4,500,000
II-4	Prequalification of Contractors, Bid Advertisement and Bid Evaluation	100,000
II-5	Negotiation of Power Sale Contracts and Bond Issue	50,000
II-6	Preparation for Sale of Bonds - Financial Consultants and Bond Counsel	1,000,000
	SUB TOTAL	$ 9,650,000
	TOTAL	$13,230,000

Susitna Hydroelectric Project
Plan of Study

Quarterly Budget Summary

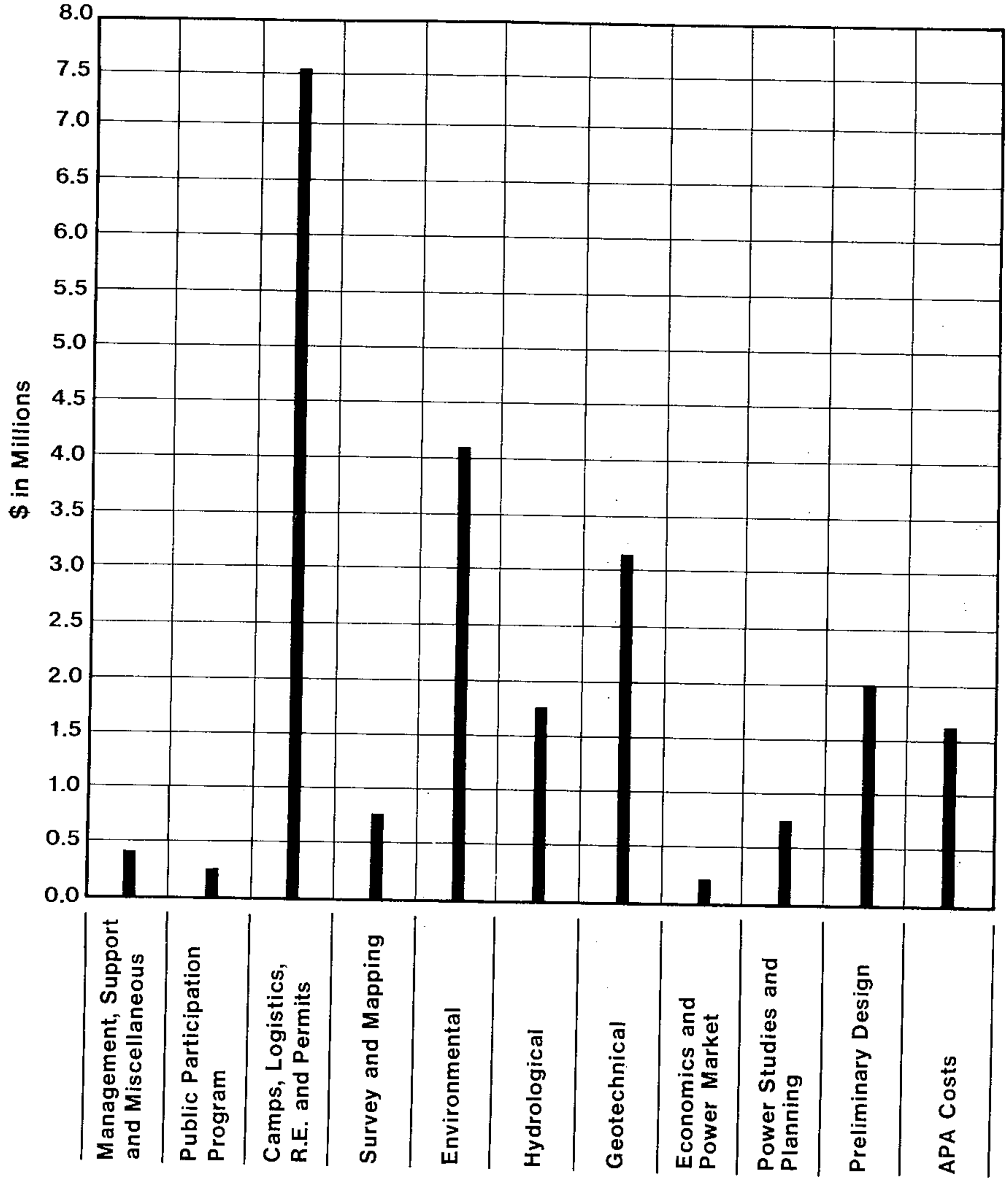


INTERNATIONAL ENGINEERING COMPANY, INC.

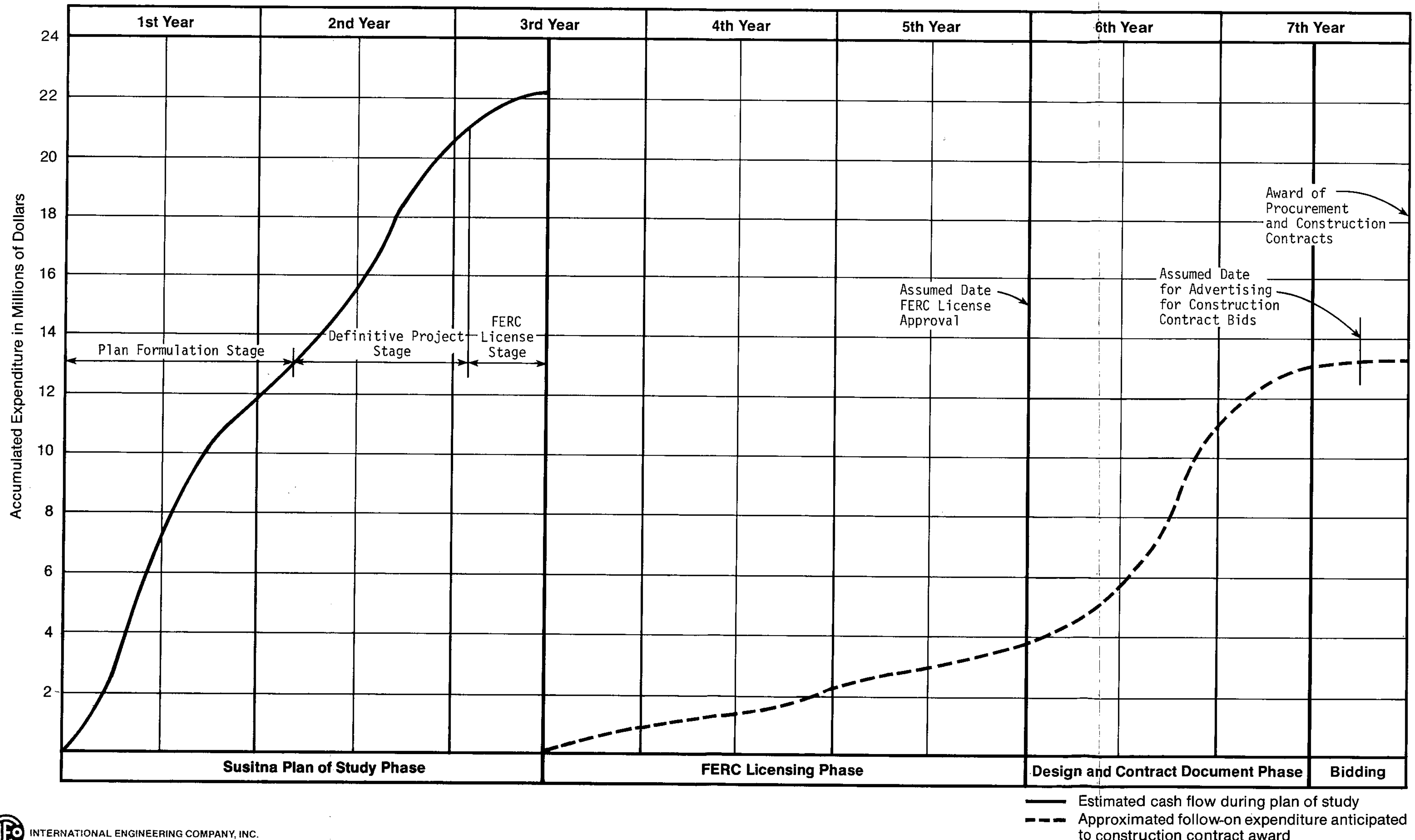
EXHIBIT A-3-2

Susitna Hydroelectric Project
Plan of Study

Total Budget Summary



Susitna Hydroelectric Project
Plan of Study
Accumulated Expenditure Schedule



INTERNATIONAL ENGINEERING COMPANY, INC.

Section 4 - Logistical Plan

A project of the type and magnitude of the Susitna Hydroelectric Project in the Alaskan environment poses many difficult logistical problems. The remote location of the project area, the severe climatic conditions, the rugged terrain, and the constraints imposed by regulatory agencies are all factors affecting logistics. Consequently, thorough planning and scheduling will be essential.

Based on discussions with the Bureau of Land Management (BLM) and Cook Inlet Region, Inc., the IECO Team anticipates that title to most of the land in the reservoir area, including that upon which the field camp will be located, will be conveyed to Cook Inlet Region, Inc., and village corporations before January 1980. Entry to and use of this land will be governed by agreements between the Natives and the APA. Since these agreements have not yet been finalized, the exact stipulations are not known. No difficulties are anticipated in obtaining permission to use the land for a camp and for various exploration and reconnaissance activities, so long as the interests of the Natives are protected.

If, for any reason, title to the land is not conveyed prior to commencement of work on the project, the logistical plan will be modified to accommodate BLM requirements. Specifically, the size of the camp at Watana will be reduced to the maximum number of people allowed. The airstrip planned for the camp will be eliminated, and supplies will be flown in by helicopter or by amphibian aircraft using lakes rather than a landing strip.

Although title to much of the land is expected to be conveyed to the Natives, BLM land will have to be crossed to perform some of the work. Plans of operation will be prepared in accordance with the stipulations of Temporary Use Permit AK-017-9025, between the BLM and the APA. These plans will describe the activities, times of occurrence, locations, and measures that will be taken to minimize environmental disturbance. Plans of operation will be prepared for such items as overland transportation, air operations, fire prevention and suppression, wetlands surveys, biological studies, and personnel housing and transportation (temporary camps). Environmental briefings will be held periodically on various field activities during the course of the study, and all BLM stipulations governing the operations of personnel and equipment during performance of the studies will be observed.

In addition to land owned by Natives and the BLM, other land in the project area may be owned by the State of Alaska or by private parties. Early in the project, landownership throughout the project area will be determined, and the land will be classified by the following general ownership categories: Federal land, Native land, State land, private land.

The stipulations of the BLM temporary use permit will be observed where BLM land is involved; requirements of the agreement between the APA and Native owners will be met where Native land is used. If State land is affected, requirements of the State Division of Lands will be followed. Permits for work on sanitary aspects of camp construction will also be obtained from the State. Private landowners will be contacted when applicable, and rights-of-entry will be obtained.

The planning and furnishing of field camps and logistical support will be the responsibility of the joint venture of Cook Inlet Region, Inc./ Holmes and Narver (CIRI/H&N).

4.1 FIELD CAMP

The main field camp will be established near the Watana damsite in the Fog Lakes area. At various times during the project, field personnel may be housed at existing facilities, such as High Lake Camp, a hunting lodge near the Devil Canyon damsite, and Tsusena Lake Lodge, situated close to the Watana damsite. Personnel may also be housed at facilities in the town of Talkeetna or other communities in the Susitna Valley. The Watana site was chosen for several reasons, including proximity to the Watana damsite, fairly central location with respect to the entire project area, reasonably level terrain, and proximity to a large lake that can furnish an adequate supply of water for the camp, as well as a landing area for amphibian aircraft in the summer and aircraft equipped with either wheels or skis in the winter. The location is also ideal for expanding the camp to a construction camp during construction of Watana Dam.

Planning for the camp has been based on a total of 26,175 man-days, not counting the survey crews and camp personnel. The camp will include the following:

- Base camp with a peak capacity of 60, including the capability of accommodating women. In addition to two-man living quarters, latrine, arctic walkways, personal laundry, and kitchen/dining facilities, the base camp will have:

  - Generator and generator shelter.
  - Water system with heated storage.
  - Sewage/incinerator system with lagoon.
  - Warehouse/shop facility, 20 feet by 40 feet.
  - Four offices, each 200 square feet (total 800 square feet).
  - Recreation hall/conference room to include movie/T.V. equipment, pool table, and Ping-Pong table.
  - Laundry facilities for sheets, towels, and kitchen linen.
  - Fuel storage for:

    Jet fuel (three 25,000-gallon bladder tanks)
    Gasoline (one 10,000-gallon bladder tank)
    Diesel fuel (six 25,000-gallon bladder tanks)
    Aviation gasoline (ten 55-gallon drums)
    Propane (two 500-gallon tanks).

- Communications system providing:

  - Ground-to-air communications support for both fixed-wing and helicopter operations.
  - Communications between the base camp and various field sites, a distance of 60 miles maximum. (Fifteen mobile units will be provided.)
  - Communications between the base camp and Talkeetna, a distance of 60 miles.

- A 3000-foot-long airstrip capable of accommodating Twin Otter-type aircraft.

- Helicopter pad.

All the design work and procurement of modular units and attendant life support systems (power plants, water plant, sewage treatment plant, and communications system) will be done immediately after contract award. The modular units and equipment for the Watana camp will be transported overland by Cat-train from the Denali Highway to the Fog Lakes area. The Watana camp will be fully operational by April 1980. This camp will be the main base of field operations, as well as the point of in-depth study of the Watana site and the surrounding area. As presently planned, the camp will be closed in the winter, and the small number of personnel working during this time will be housed in Talkeetna or at a lodge in the area, if such housing arrangements are cost-effective.

The total impact on Talkeetna will be minimal because only a small number of personnel will be housed there. These personnel will include individuals engaged in reconnaissance studies of the Anchorage-Fairbanks transmission line and individuals engaged in environmental studies on the lower Susitna, as well as a few individuals working on phases of the study during the winter months when the Watana camp is expected to be shut down.

The following alternatives will be evaluated prior to the start of field operations:

- Housing field crews working in the Devil Canyon area at High Lake Lodge. Also, housing personnel at Tsusena Lake Lodge if restrictions are imposed on the number of personnel allowed at Watana.

- Transporting camp modules by Hercules aircraft instead of overland by Cat-train. (Two subalternatives will be evaluated: truck or rail transport to Palmer or Talkeetna, then air transport to the site versus direct air transport from Anchorage to the Fog Lakes site.)

- Using an arctic-type sewage treatment plant with chlorinated effluent instead of a sewer treatment plant with a lagoon system for wastewater effluent. This approach will depend upon obtaining the necessary permit for the arctic-type plant.

- Using Fog Lake as the water supply source instead of drilling a water well.

- Eliminating some or all of the arctic walkways and reconfiguring the camp to minimize exposure to the most severe ambient conditions.

- Burying solid wastes instead of incinerating them, if the proper permit can be obtained.

If any of these alternatives are found to be cost-effective, they will be included in the logistical plan.

4.2 LOGISTICS

Logistical support will be required to provide appropriate means of transporting the supplies, equipment, personnel, and materials needed to support the project activities.

As stated above, the camp units and all equipment will be transported overland to the field site by Cat-train in early 1980. Personnel movement and resupply functions will be accomplished by fixed-wing aircraft. During winter periods, frozen lakes will serve as landing strips for Hercules and Twin Otter-type aircraft. The Hercules aircraft will be used primarily for fuel resupply on a 4- or 5-month cycle. The Twin Otter-type aircraft will be used to transport personnel and/or camp resupply items. Smaller fixed-wing aircraft, such as Cessna 185's, will be provided for use in environmental field work. A 3000-foot-long airstrip will be constructed to accommodate the Twin Otter-type aircraft during summer operations.

Helicopters will be provided to transport field crews between the base camp and the work sites. A heavy-lift helicopter will be provided to move drill rigs.

Other modes of personnel transportation will include snow machines for winter field studies and boats for aquatic studies.

To ensure both maximum utilization of the transportation vehicles and maximum cost-effectiveness, detailed transportation schedules will be developed prior to the start of field operations.

The IECO Team expects to use the following equipment for logistic support:

Fixed-wing aircraft

- Twin Otters (two flights per week in the summer and one flight per week in the fall for the movement of personnel and resupply items).

- Hercules (as required for fuel resupply).

- Two Cessna 185's, one with and one without photomount (total time approximately 430 hours).

Helicopters (Total 46 months of helicoper support)

- Bell Jet Ranger helicopter or equivalent (one full-time from February 1980 to January 1982 and one additional from April to October each season).

- Hughes 500 helicopter or equivalent (May to October 1980 and 1981).

Miscellaneous equipment

- One Caterpillar D-3 with low ground pressure tracks and backhoe/auger.
- Two snowmobiles.
- Three Avon rafts with outboard motors.
- One jet sled/jet boat.

In addition, arctic clothing and other services, such as warehousing in Anchorage, will be provided.

Section 5 - Detailed Activity Descriptions

The system used in this proposal to identify and describe all the components of the complex Plan of Study divides the various activities into broad categories and then further divides them into assignment groups according to areas of responsibility, based on either an individual or a specific type of work. The Table of Organization (Exhibit B-2-1), described in Part B, Section 2, employs the same division into general categories and assignments. Thus, the responsibility for individual activities, designated as tasks, can be readily identified and related to the appropriate area in the Table of Organization.

5.1 TASK OR ACTIVITY DESCRIPTIONS

The individual activities are described in appropriate detail on task description sheets contained in an accompanying volume. These descriptions contain the basic information used to write the task orders or job descriptions for IECO's engineering manpower planning and control system.

At least one task is assigned to each assignment block in the Table of Organization. In cases where the work will be accomplished primarily by a subcontractor, an IECO employee is designated responsible for coordination, and a task is set up for this coordination activity along with the tasks describing the specific work to be accomplished by the subcontractor.

Although in some cases the organization of the assignment groups and the individual tasks reflects sequential activities for a particular item of work, it is not the Study Team's intent to try to convey such information or the interrelation between the various activities by the order in which the tasks are listed.

The task description sheets for the Plan of Study and the Follow-on Phases are indexed as follows:

- Category A - Project Management
- Category B - Anchorage Support
- Category C - Environmental Studies
- Category D - Hydrological Studies
- Category E - Geotechnical Studies
- Category F - Preliminary Design
- Category G - Plan Synthesis
- Follow-on Phases

5.2 ALASKA POWER AUTHORITY ACTIVITIES

Support from the APA will be required in several areas during the project studies and preparation of the FERC license application. Specific activities to be carried out by the APA are discussed briefly in the following paragraphs.

A. Subcontracts with Other Agencies

The IECO Team expects that the Alaska Department of Fish and Game and the U.S. Geological Survey will perform work under subcontracts administered by the APA. These subcontracts will be awarded early and will continue throughout the Plan of Study. Work to be performed by the agencies is described in the various task descriptions.

B. FERC License Application

The APA will have primary responsibility for the preparation of Exhibits A through G and Exhibit T of the FERC license application, all of which cover mainly the legal and financial documentation. Assisted by the IECO Team, the APA can expect to accomplish this activity during the last 3 months of the study period.

C. Consultant's Review Boards

The APA staff will select the members of a Board of Consultants that will monitor the technical aspects of the engineering and environmental work. Regular meetings will be scheduled at approximately 6-month intervals, with other special meetings scheduled as required. The APA, with the assistance of the IECO Team, will direct the Board meetings. Similarly, selection of a Seismic Review Board or of an independent geotechnical firm for seismic risk analysis, as well as arrangements for an independent construction cost estimate, will be at the discretion and direction of the APA.

D. General Administration

The APA will perform general administration of the various contracts and will assist IECO in coordinating project activities with activities of other agencies throughout the course of the study.

E. Public Participation and Information

The APA will play a leading role in establishing a Citizens Advisory Panel and have major involvement in the Public Participation Program, with representation at all public and interagency meetings.

F. Financing Plan

The APA will participate in the formulation of the financing plan for implementation of the project. This plan will include an assessment of potential power purchasers. The APA staff and their financial consultants and bond counsel will review and approve the recommended plan, which will be included in the FERC application. A major effort will be required from November 1981 to February 1982. The plan will be finalized during the Design and Contract Document Phase.

G. Permits

The APA will assist the IECO Team in obtaining the various permits required from the Bureau of Land Management, State agencies, Native landowners, etc.

Section 6 - Program Schedule

The maximum economy and greatest benefit to the State of Alaska will be achieved by moving the Plan of Study program ahead as rapidly as possible, consistent with the achievement of the stated objectives. The Study Team has therefore assumed that the program will move from the Plan Formulation Stage into the Definitive Project Studies Stage without appreciable delay, once the draft of the Plan Formulation Report has been issued. Likewise, preparation of the FERC license application will follow closely on the completion of the draft Definitive Project Report.

6.1 SCHEDULE FOR PLAN OF STUDY

A detailed work schedule showing all the tasks, arranged by category and assignment group, is presented on Exhibit A-6-1. This schedule shows that 30 months will be required to complete all of the tasks included in the Plan of Study program. Plan Formulation (Stage 1) will be complete and the draft report ready by the end of February 1981. The Definitive Project Studies will start by the beginning of April 1981, and 12 months will be required for completion of the draft of the Definitive Project Studies Report. If the results support the filing of an FERC license application, work will begin immediately on the preparation of that application. Since the preparatory work will have been essentially completed during the Definitive Project Studies Stage, preparation of the FERC license application can be completed in 3 months. Environmental studies for the preparation of Exhibits W, R, S, and V will, of course, be carried out throughout the period of the Plan of Study.

Exhibit A-6-2 gives detailed schedule breakdowns for some of the more important environmental study areas. Task C-4-7, Aquatic Resources - Anadromous Fisheries, is the only task that will not be completed within the 30-month period of the Plan of Study. The data accumulated during the Plan of Study will permit an interim assessment to be made of the existing anadromous fisheries, including determination of the impact of the proposed project on these fisheries and development of possible mitigation measures. The final report addressing this subject will be filed as supplemental information during the FERC licensing process, following completion of the follow-on work.

6.2 SCHEDULE FOR FOLLOW-ON PHASES

The schedule of the principal activities necessary to carry on the project through both the FERC Licensing Phase and the Final Design and Contract Document Preparation Phase (prior to award of the construction contract) is shown on Exhibit A-6-3. This schedule is of necessity highly speculative and may be taken as representative of a realistic time period only if the project moves through the three stages of the Plan of Study on an optimistic development scenario. A two-and-a-half-year period is allowed for the FERC Licensing Phase since formal hearings will undoubtedly be required for a project of this magnitude.

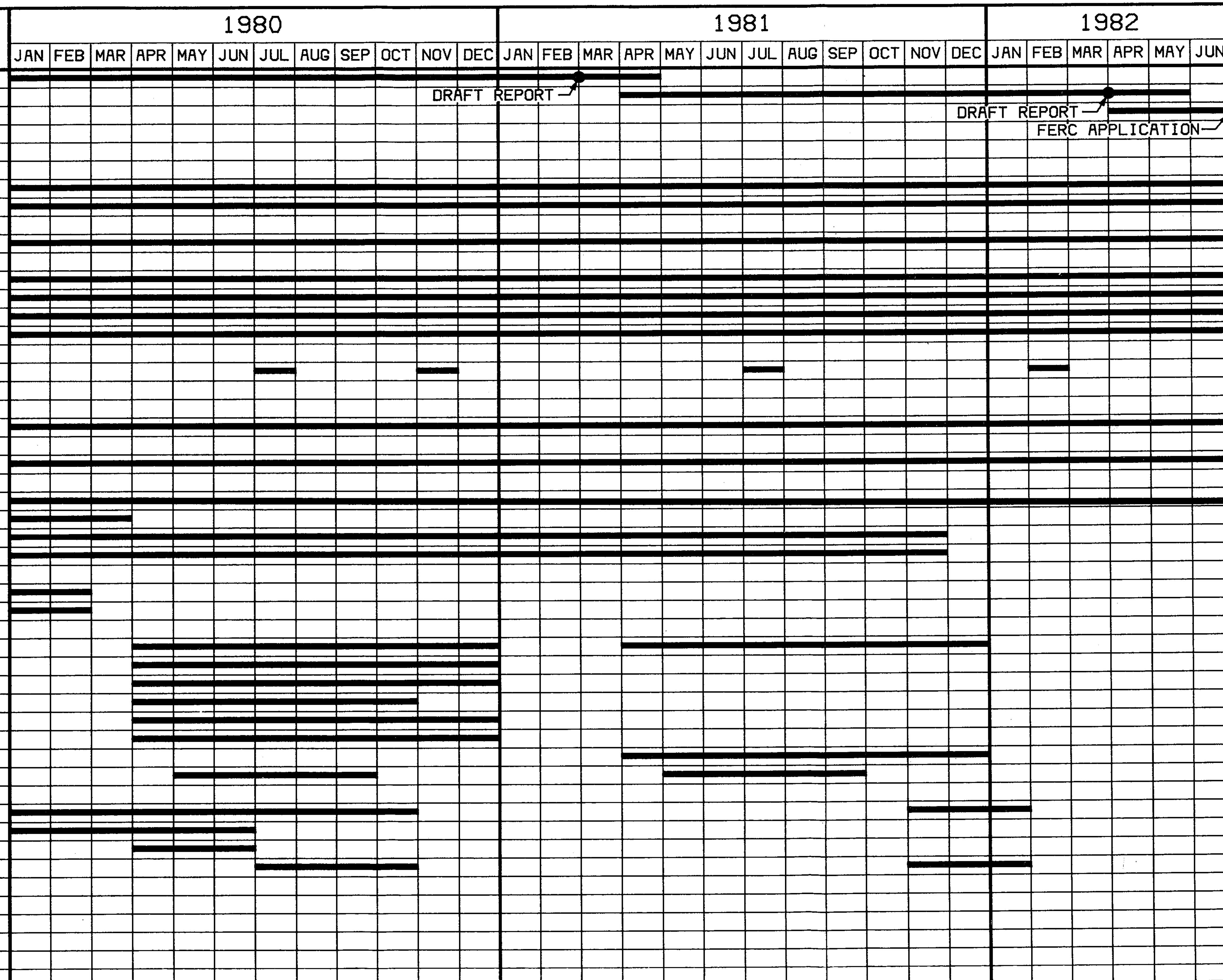
The Final Design and Contract Document Phase for producing the required construction bidding documents on the first dam and power plant of the planned project (assumed to be Watana Dam) will take a minimum of 18 months, followed by 3 to 6 months for the bidding and evaluation before award. Such details as scheduling of early construction of the access road and diversion tunnel or early procurement of major equipment items have not been considered. The assumptions on which the Follow-on Phases are based do not warrant such refinement at this time.

INTERNATIONAL ENGINEERING COMPANY, INC.

SUSITNA HYDROELECTRIC PROJECT
PLAN OF STUDY
SCHEDULE

EXHIBIT A-6-1
SHEET 1 OF 6

CATEG	ASSIGN	TASK	
			PLAN FORMULATION
			DEFINITIVE PROJECT
			FERC APPLICATION
A			PROJECT MANAGEMENT
	1		PROJECT MGR & DEPUTY MGR
		1	MANAGEMENT, ADMIN & TECH SUPERVISION
		2	COORDINATION WITH CLIENT
	2		PROJECT EXECUTIVE
		1	CONTRACT & PROJECT PERF REVIEW
	3		PUBLIC PARTICIPATION
		1	PUBLIC INFORMATION & PARTICIPATION
		2	PUBLIC AGENCY COORDINATION
		3	STAFF SUPPORT
		4	ENVIRON INPUT TO PUBLIC PARTICIPATION
	4		IECO TECH REVIEW BOARD
		1	PROJECT TECHNICAL REVIEWS
B			ANCHORAGE SUPPORT
	1		PRINCIPAL-IN-CHARGE
		1	COORDINATION SUPPORT OPERATIONS
	2		OFFICE SUPPORT
		1	FURNISH SUPPORT SERVICES
	3		FIELD CAMPS AND LOGISTICS
		1	IECO COORDINATION
		2	PLAN & ESTABLISH FIELD CAMP
		3	FURN FIELD PERS HOUSING & SUBSISTANCE
		4	PROVIDE FIELD LOGISTIC SUPPORT
	4		PERMITS
		1	IECO COORDINATION
		2	PREP & PROCESS PERMIT APPLICATIONS
	5		SURVEY AND MAPPING
		1	IECO COORDINATION & REVIEW
		2	FURNISH RESERVOIR MAPPING
		3	FURNISH ACCESS ROAD PRELIM MAPPING
		4	FURNISH TRANS LINE CORR PHOTO MOSAIC
		5	FURNISH DAMSITE MAPPING
		6	FURNISH RIVER CROSS SECTIONS
		7	FURNISH ACCESS ROAD DETAIL MAPPING
		8	FURNISH SUPPORT - FIELD INVESTIGATIONS
	6		REAL ESTATE
		1	IECO COORDINATION
		2	LAND OWNERSHIP STATUS
		3	BOUNDARY DESCRIPTION
		4	LAND ACQUISITION COSTS



INTERNATIONAL ENGINEERING COMPANY, INC.

SUSITNA HYDROELECTRIC PROJECT
PLAN OF STUDY
SCHEDULE

1980: JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
1981: JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
1982: JAN FEB MAR APR MAY JUN

CATEG	ASSIGN	TASK	
C			ENVIRONMENTAL STUDIES
	1		PRINCIPAL-IN-CHARGE
		1	MANAGEMENT & TECH SUPERVISION
		2	PROJECT ORIENTATION
	2		COORDINATE WITH ENGR STUDIES
		1	COORDINATION ENVIRON INPUT TO DESIGN
		2	COORDINATION ENGR INPUT TO ENVIRON REPORTS
	3		ENVIRON-ENERGY ALTS-DEMAND
		1	SOCIOECON ASPECTS - ENERGY FORECASTS
		2	ENVIRON EVALUATION OF ALTERNATIVES
	4		EXH. W-ENVIRONMENTAL REPORT
		1	CLIMATOLOGY
		2	HYDROLOGY
		3	GEOLOGY
		4	SEISMOLOGY
		5	SOILS & SEDIMENTATION
		6	WATER QUALITY
		7	AQUATIC RESOURCES-ANADROM FISHERIES
		8	AQUATIC RESOURCES-RESID FISHERIES
		9	AQUATIC RESOURCES-UPPER COOK INLET ESTUARY
		10	VEGETATION
		11	WILDLIFE RESOURCES-LARGE MAMMALS
		12	WILDLIFE RESOURCES-BIRDS & SM MAMMALS
		13	LAND USE
		14	LAND OWNERSHIP
		15	RECREATION
		16	TRANSPORTATION
		17	AIR QUALITY & NOISE
		18	POPULATION & DEMOGRAPHY
		19	ECONOMICS
		20	CULTURAL RESOURCES
		21	PUBLIC SAFETY
		22	VISUAL RESOURCES
		23	TRANS ROUTING ENVIRON ASPECTS
		24	PREPARE FINAL REPORT
	5		EXHIBIT R-RECREATION PLAN
		1	FORM GOALS & OPERATION OBJECTIVE
		2	DETERMINE RECREATION LAND USE SUITABILITY
		3	ASSESS RECREATION DEMAND
		4	DEVELOP CONCEPTUAL RECREATION SCHEMES
		5	REVIEW ALTERNATIVE PLANS
		6	SELECT & REFINE PREFERRED PLAN
		7	PREPARE FINAL REPORT

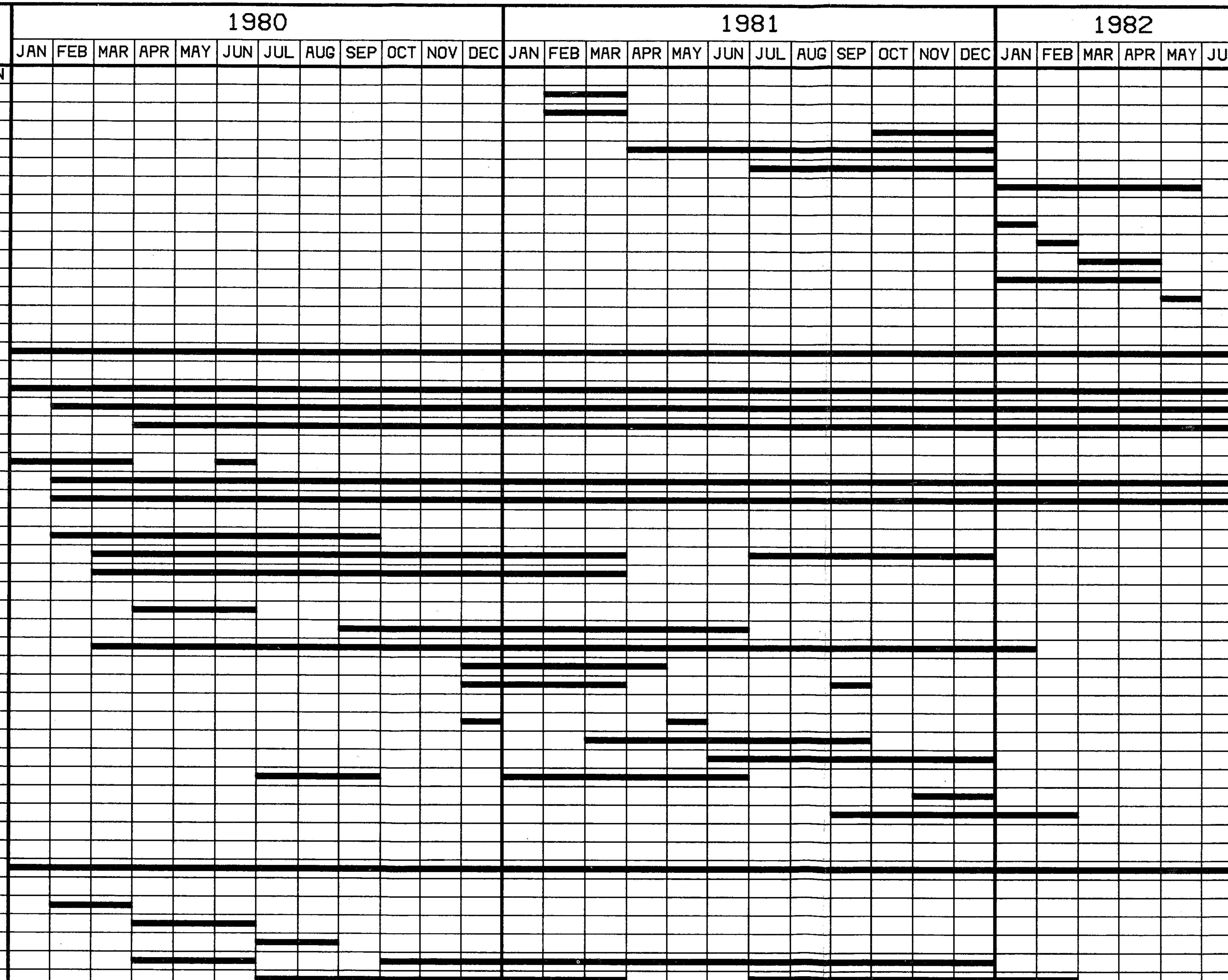
INTERNATIONAL ENGINEERING COMPANY, INC.

SUSITNA HYDROELECTRIC PROJECT
PLAN OF STUDY
SCHEDULE

EXHIBIT A-6-1

SHEET 3 OF 6

CATEG	ASSIGN	TASK	
C	6		EXHIBIT V - RESOURCE PROTECTION
		1	FORMULATE GOALS & OBJECTIVES
		2	ANALYSIS FED, STATE & LOCAL GUIDELINES
		3	CULTURAL RESOURCE IDENTIFICATION
		4	TRANS LINE CORRIDOR ANALYSIS
		5	VISUAL RESOURCE IDENTIFICATION
		6	PREPARE FINAL REPORT
	7		EXHIBIT S-FISH & WILDLIFE PLAN
		1	DESCRIBE PRE-PROJ BIOLOGICAL SETTING
		2	ASSESS IMPACTS TO FISH & WILDLIFE
		3	PREPARE MITIGATION PLAN
		4	COORDINATE WITH NAT RESOURCES AGENCIES
		5	PREPARE FINAL REPORT
D			HYDROLOGICAL STUDIES
	1		PRINCIPAL-IN-CHARGE
		1	MANAGEMENT & TECH SUPERVISION
	2		DATA COLL, GAGING & SAMPLING
		1	IECO COORDINATION & REVIEW
		2	INSTALL & OPER STREAM GAGING STA
		3	SED & WATER QUAL DATA SAMPLING
	3		DATA MANAGEMENT
		1	COLLECT & COMPILE EXIST HYDROMET DATA
		2	COMPILE DATA FROM NEW HYDROMET STA
		3	ESTABLISH COMPUTER BASED DATA LIBRARY
	4		MATH MODELING & SIMULATION
		1	DEV COMPREHENSIVE WATERSHED MODEL
		2	DEV MODELS FOR ARCTIC CONDITIONS
		3	CALIBRATE & VERIFY MODELS
	5		BASIN YIELD & FLOOD STUDIES
		1	PRELIM HYDROLOGIC INVESTIGATIONS
		2	PMP & PMF FOR PROJECT SITES
		3	STATISTICAL & GRAPHICAL ANALYSIS
		4	GLACIAL WATER BALANCE
		5	CORRELATE & EXTEND STREAMFLOW DATA
	6		RIV HYDR, SEDIMENT & WAT QUAL
		1	TW RATING & WS PROFILES
		2	RES SEDIMENT & STRATIFICATION STUDIES
		3	D/S SEDIMENT TRANSP & WATER QUALITY
		4	ICE FORMATION & BREAKUP
		5	RESERVOIR FILL & EMERG DRAWDOWN
		6	D/S HAZARDS FROM DAM FAILURE
E			GEOTECHNICAL STUDIES
	1		PRINCIPAL-IN-CHARGE
		1	MANAGEMENT & TECH SUPERVISION
	2		ENGINEERING GEOLOGY
		1	REVIEW GEOL ASPECTS OF ALTERNATIVES
		2	EVALUATE ALTERNATIVE DAMSITES
		3	RECONN-TRANS LINE & ACCESS ROAD
		4	GEOLOGIC MAPPING-WATANA SITE
		5	GEOLOGIC MAPPING-DEVIL CANYON SITE



INTERNATIONAL ENGINEERING COMPANY, INC.

SUSITNA HYDROELECTRIC PROJECT
PLAN OF STUDY
SCHEDULE

EXHIBIT A-6-1
SHEET 4 OF 6

1980: JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
1981: JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
1982: JAN FEB MAR APR MAY JUN

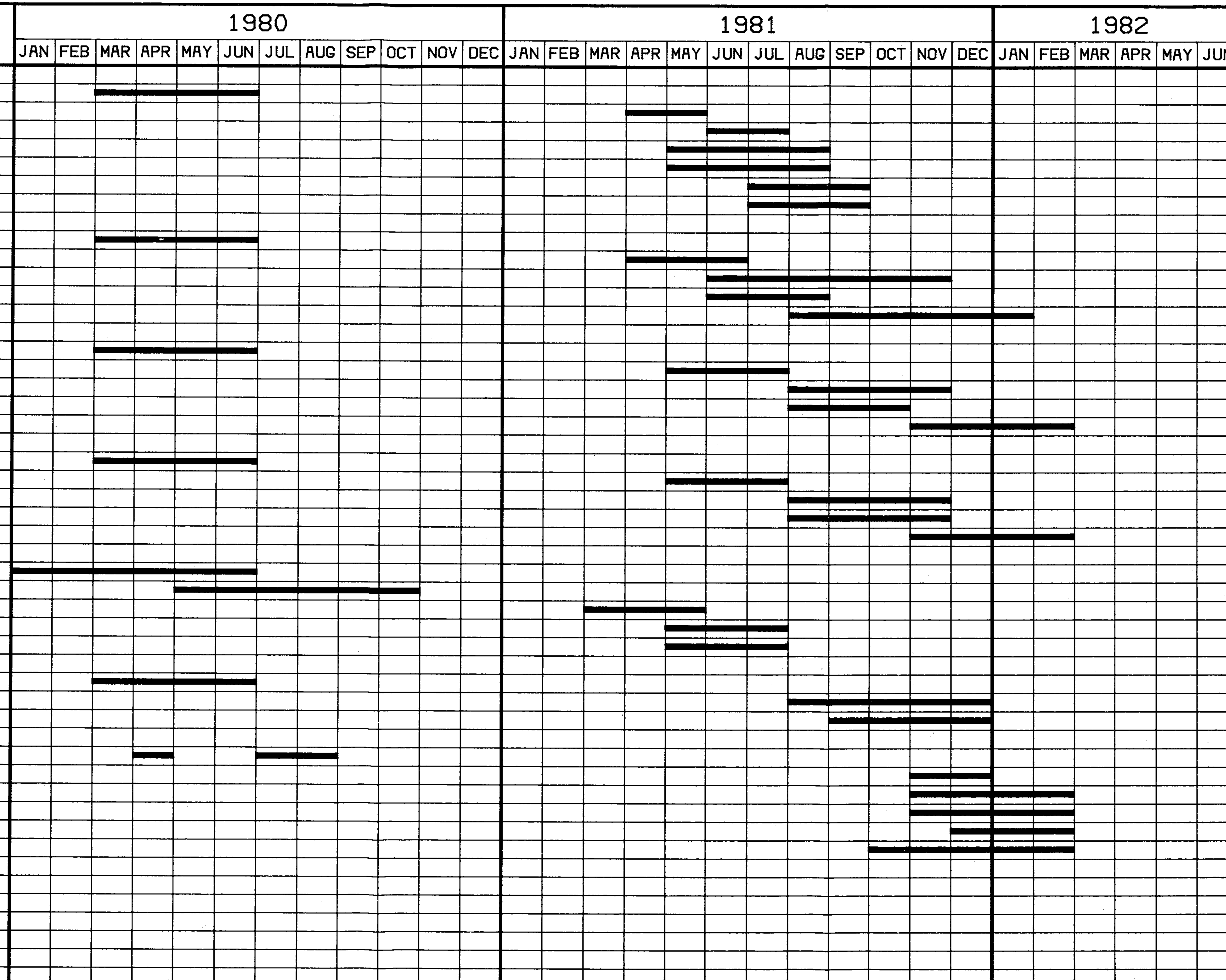
CATEG	ASSIGN	TASK	
E	3		ENGINEERING GEOPHYSICS
		1	SEISMIC REFRACTION SURVEY-WATANA
		2	SHEAR WAVE HAMMER TESTING-WATANA
		3	SEISMIC REFRAC SURVEY-DEVIL CANYON
		4	SHEAR WAVE HAMMER TESTING-DEVIL CANYON
	4		SEISMOLOGY
		1	SEISMOTECTONIC STUDIES
		2	ESTAB LOC SEISMIC MONITORING SYSTEM
		3	REGIONAL SEISMICITY STUDY
		4	EARTHQUAKE SIMULATION
		5	SEISMIC RISK ANALYSIS & DESIGN EQ
	5		SPECIAL ARCTIC STUDIES
		1	IECO COORDINATION & REVIEW
		2	RIVER & RESERVOIR ICE PROBLEM STUDIES
		3	MASS BALANCE & DYNAM BEHAVIOR OF GLACIERS
		4	PERMAFROST PROBLEM STUDIES
	6		CONSTRUCTION MATL INVESTIG
		1	SOURCES FOR WATANA
		2	SOURCES FOR DEVIL CANYON
		3	SOURCES FOR ACCESS ROADS
	7		FOUNDATION EXPLORATION & TEST
		1	INVESTIGATIONS AT WATANA DAMSITE
		2	INVESTIGATIONS AT DEVIL CANYON DAMSITE
	8		LABORATORY TESTING
		1	PLAN, COORDINATE & REVIEW TEST PROGRAM
		2	TEST SAMPLES FOR WATANA SITE
		3	TEST SAMPLES FOR DEVIL CANYON
		4	CONDUCT MASS CONCRETE TESTS
F			PRELIMINARY DESIGN
	1		PRINCIPAL-IN-CHARGE
		1	MANAGEMENT & TECH SUPERVISION
	2		EMBANKMENT DAMS
		1	PROVIDE DESIGN INPUT TO PLAN FORMULATION
		2	EVALUATE DESIGN ALTERNATIVES-WATANA
		3	STABILITY ANALYSIS-WATANA DAM
		4	PRELIM DESIGN & MATL REQUIREMENTS-WATANA DAM
		5	PRELIM COFFERDAM DESIGN-WATANA
		6	EVALUATE DESIGN ALTER-DEVIL CANYON SADDLE DAM
		7	STABILITY ANALYSIS-DEVIL CANYON SADDLE DAM
		8	PRELIM DES & MATL REQ-DEVIL CANYON SADDLE DAM
		9	PRELIM COFFERDAM DESIGN-DEVIL CANYON
	3		CONCRETE DAMS
		1	PROVIDE DESIGN INPUT TO PLAN FORMULATION
		2	ARCH DAM LAYOUT-DEVIL CANYON
		3	STRESS & STABILITY STUDIES-DEVIL CANYON DAM
		4	PRELIMINARY DESIGN-DEVIL CANYON DAM
		5	CRITERIA & PROCEDURES FOR STRUCT MODEL TESTS

INTERNATIONAL ENGINEERING COMPANY, INC.

SUSITNA HYDROELECTRIC PROJECT
PLAN OF STUDY
SCHEDULE

EXHIBIT A-6-1

CATEG	ASSIGN	TASK	
F	4		DIVERSION SPILLWAYS & OUTLETS
		1	PROVIDE DESIGN INPUT TO PLAN FORMULATION
		2	DIVERSION SCHEME STUDY-WATANA SITE
		3	DIVERSION SCHEME STUDY-DEVIL CANYON
		4	PRELIM DESIGN-WATANA SPILLWAY
		5	PRELIM DESIGN-DEVIL CANYON SPILLWAY
		6	PRELIM DESIGN-WATANA OUTLET FACILITIES
		7	PRELIM DESIGN-DEVIL CANYON OUTLET FACIL
	5		POWER FEATURES
		1	PROVIDE DESIGN INPUT TO PLAN FORMULATION
		2	POWER FEATURE LAYOUT-WATANA PP
		3	PRELIM DESIGN-WATANA PP
		4	POWER FEATURE LAYOUT-DEVIL CANYON PP
		5	PRELIM DESIGN-DEVIL CANYON PP
	6		MECHANICAL FACILITIES
		1	PROVIDE DESIGN INPUT TO PLAN FORMULATION
		2	MECH DESIGN STUDIES-WATANA DAM
		3	PRELIM DESIGN-WATANA DAM MECH FACILITIES
		4	MECH DESIGN STUDIES-DEVIL CANYON DAM
		5	PRELIM DESIGN-DEVIL CANYON DAM MECH FACIL
	7		ELECTRICAL FACILITIES
		1	PROVIDE DESIGN INPUT TO PLAN FORMULATION
		2	ELEC DESIGN STUDIES-WATANA DAM
		3	PRELIM DESIGN-WATANA DAM ELEC FACILITIES
		4	ELEC DESIGN STUDIES-DEVIL CANYON DAM
		5	PRELIM DESIGN-DEVIL CANYON DAM ELEC FACIL
	8		TRANSMISSION SYSTEM
		1	TRANSMISSION SYSTEM STUDY
		2	TRANS LINE ROUTE STUDY
		3	PRELIM TOWER & FOUNDATION STUDIES
		4	TRANS LINE CONDUCTOR & COST STUDIES
		5	SWITCHYARDS & SUBSTATIONS
	9		ACCESS ROADS
		1	PROVIDE DESIGN INPUT TO PLAN FORMULATION
		2	PRELIMINARY DESIGN-ACCESS ROADS
		3	PRELIMINARY DESIGN-BRIDGES
	10		CONSTRUCTION PLANNING & SCHED
		1	PROVIDE COST INPUT TO PLAN FORMULATION
		2	CONSTR SCHEDULE AND COST-ACCESS ROADS
		3	CONSTR SCHED AND COSTS-WATANA
		4	CONSTR SCHED AND COSTS-DEVIL CANYON
		5	CONSTR SCHED AND COSTS-TRANS LINE
		6	CONSTR PLAN FOR CONSTR CAMP INFRASTRUCT

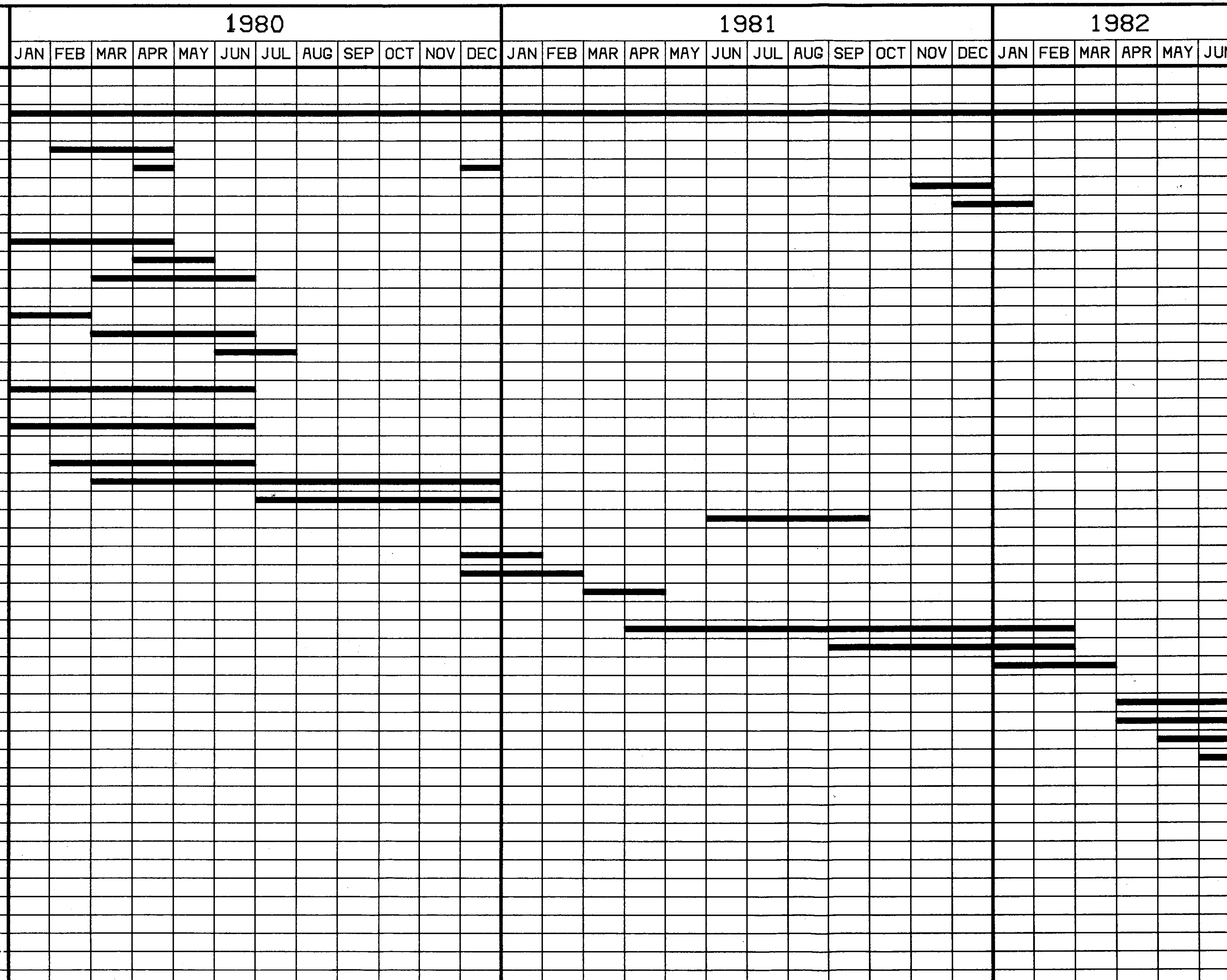


SUSITNA HYDROELECTRIC PROJECT
PLAN OF STUDY
SCHEDULE

INTERNATIONAL ENGINEERING COMPANY, INC.

EXHIBIT A-6-1

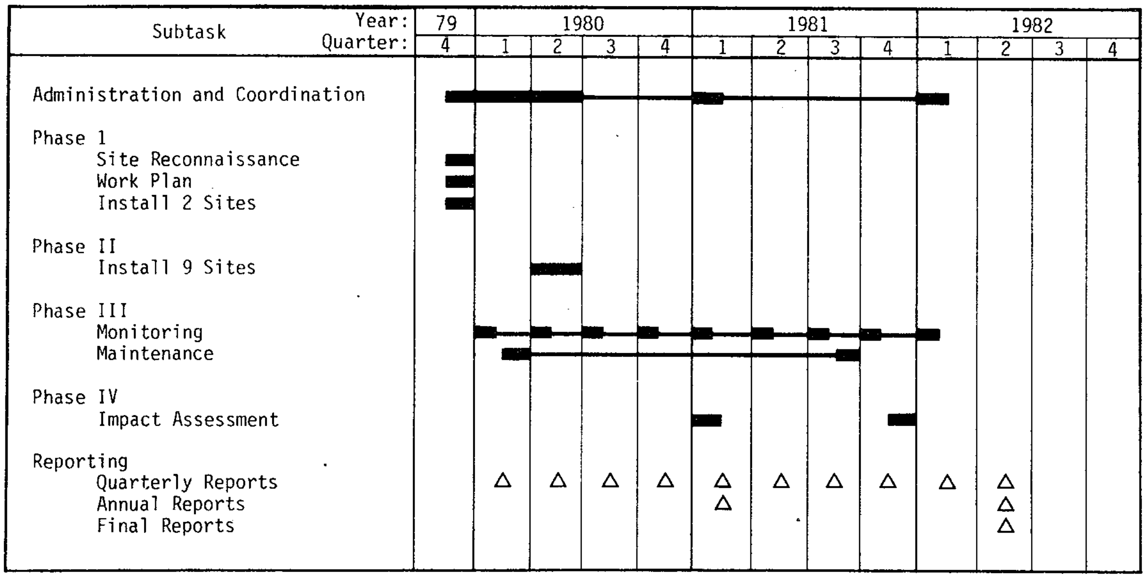
CATEG	ASSIGN	TASK	
G			PLAN SYNTHESIS
	1		PRINCIPAL-IN-CHARGE
		1	MANAGEMENT & TECH SUPERVISION
	2		ECONOMICS & FINANCE
		1	INTERACTION OF ALASKA ECON WITH PROJECTS
		2	ECONOMIC REVIEW OF ALTERNATIVES
		3	ECON ANALYSIS OF DEFINITIVE PROJECT
		4	PREP FINANCIAL ANALYSIS & FINANCING PLAN
	3		POWER MARKET STUDIES
		1	REVIEW & UPDATE ENERGY DEMAND DATA
		2	FORECAST SOCIOECON FACTORS FOR ALASKA
		3	FORECAST FUTURE ENERGY & POWER DEMANDS
	4		SUSITNA PROJECT STUDIES
		1	REVIEW & EVAL DATA ON SUSITNA PROJECT
		2	PREPARE BASIC LAYOUTS OF ALTERNATIVES
		3	DEV DATA FOR PROJ OPTIMIZATION STUDIES
	5		COAL & GAS ALTERNATIVES
		1	REVIEW & EVAL COAL & GAS ALTERNATIVES
	6		OTHER ALT ENERGY SOURCES
		1	REVIEW & EVALUATE OTHER ENERGY SOURCES
	7		POWER STUDIES & SYSTEM OPTIMIZ
		1	PREPARE DATA BASE
		2	HYDROTHERMAL SIMULATION
		3	PRESENT VALUES FOR CONSTR SEQUENCES
		4	OPERATION STUDIES FOR DEFINITIVE PROJECT
	8		PLAN FORMULATION
		1	EVALUATE RESULTS OF STUDIES
		2	PREPARE DRAFT PLAN FORMULATION REPORT
		3	PREPARE FINAL PLAN FORMULATION REPORT
	9		DEFINITIVE PROJECT STUDIES
		1	COORDINATE & SYNTHESIZE DEF PROJ STUDIES
		2	COORD DOCUMENTATION FOR FERC APPLICATION
		3	PREPARE DEFINITIVE PROJECT REPORT
	10		PREPARE FERC LICENSE APPLIC
		1	ASSIST APA IN EXHIBITS A THRU G & T
		2	PREPARE EXHIBITS H THRU O & U
		3	INCORPORATE EXHIBITS R, S, V & W
		4	PROVIDE FERC APPLICATION DOCUMENTS



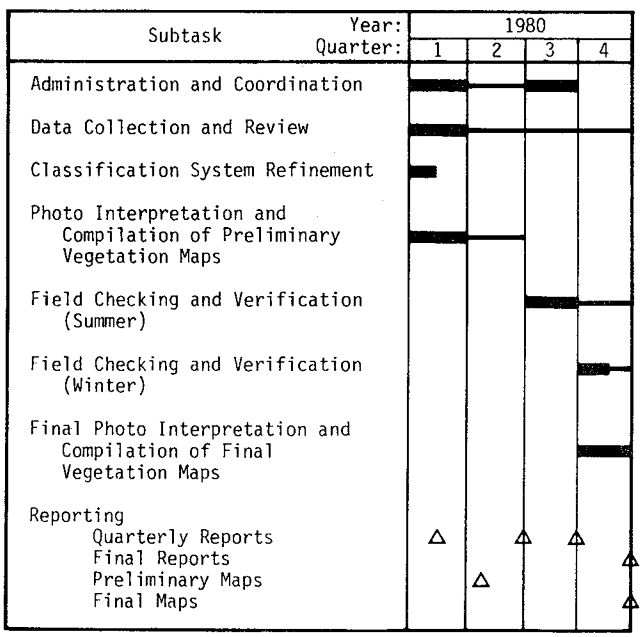
Susitna Hydroelectric Project
Plan of Study

Specific Detailed Environmental Task Schedules

Task C-4-1 Meteorological/Climatological Studies



Task C-4-10 Vegetation Mapping

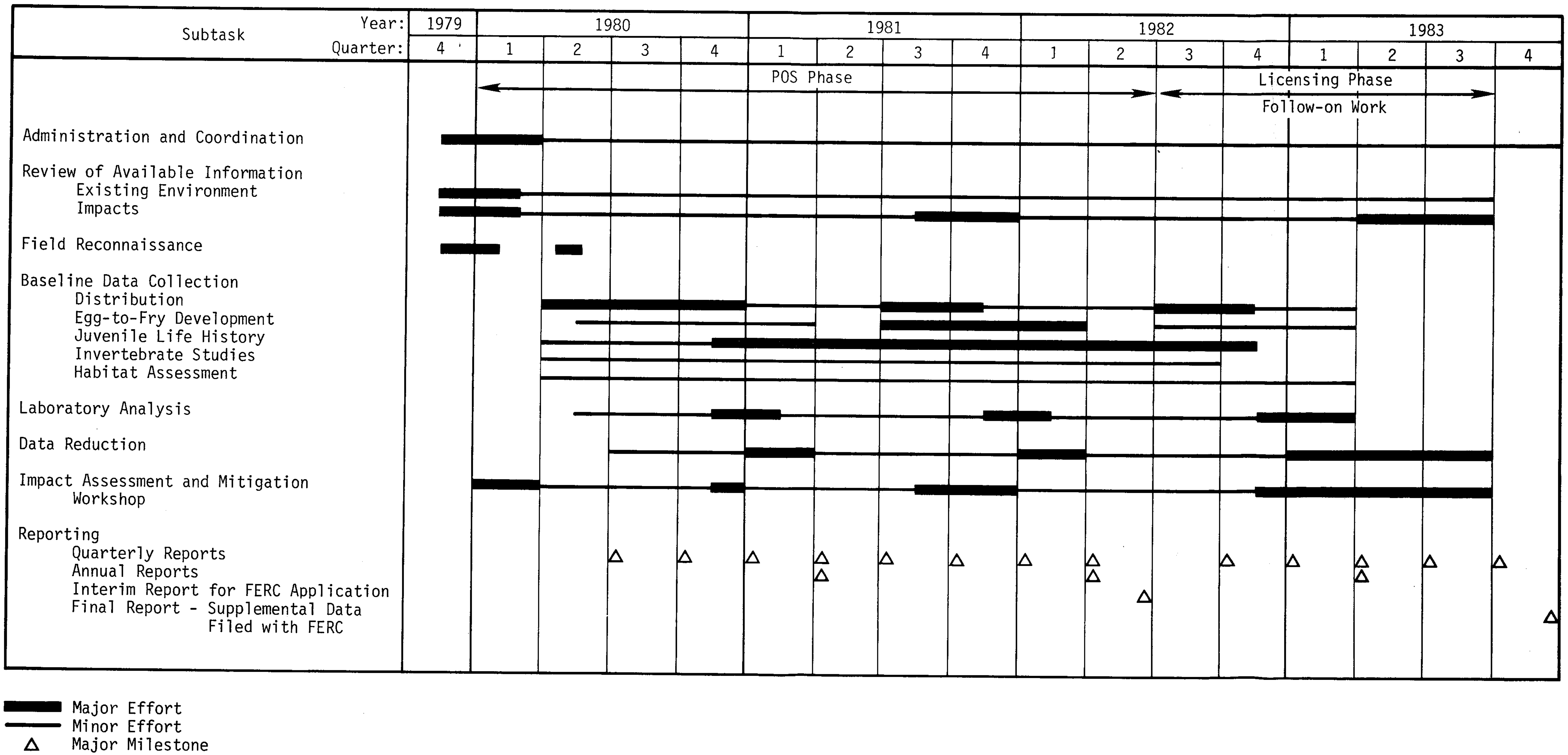


▬ Major Effort
— Minor Effort
△ Major Milestones

Susitna Hydroelectric Project
Plan of Study

Specific Detailed Environmental Task Schedules

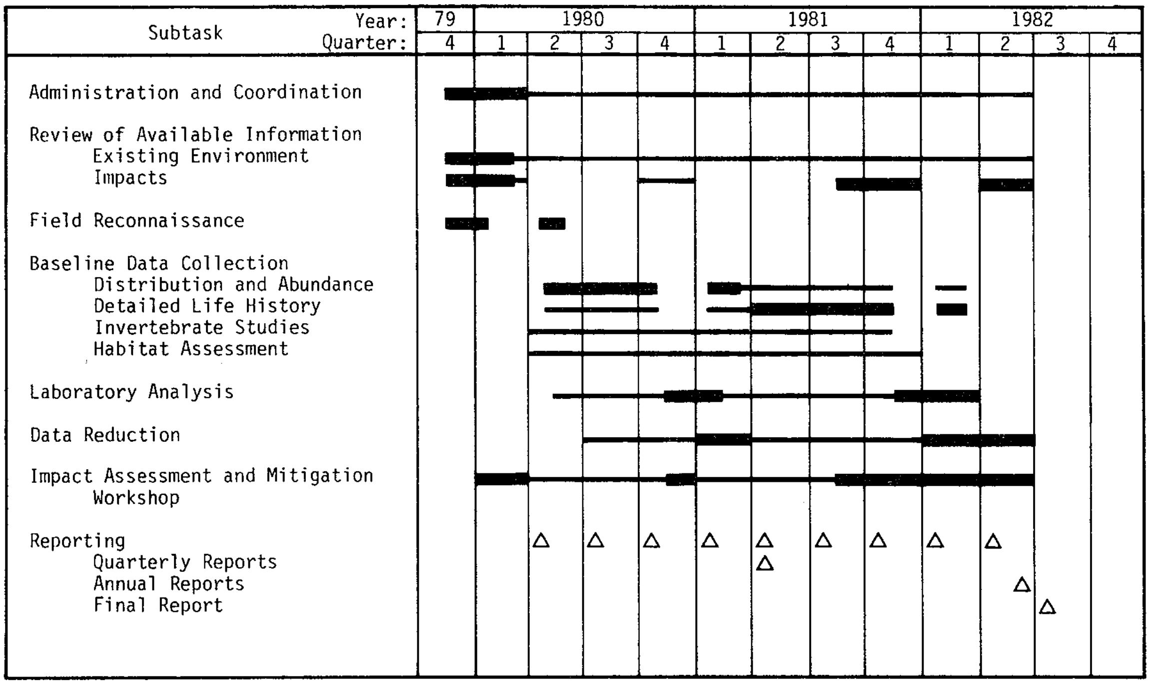
Task C-4-7 Anadromous Fisheries Assessment



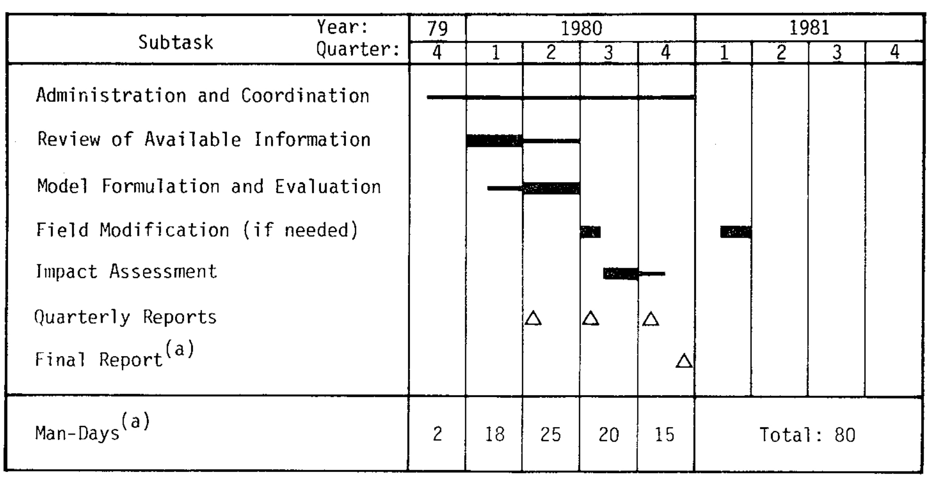
Susitna Hydroelectric Project
Plan of Study

Specific Detailed Environmental Task Schedules

Task C-4-8 Resident Fisheries Assessment



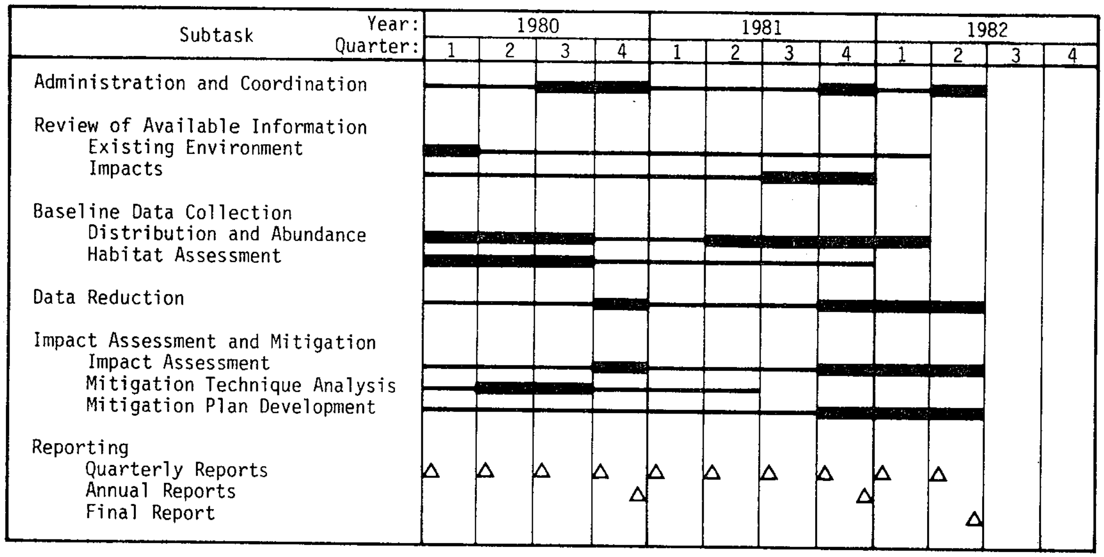
Task C-4-9 Estuarine Model Study



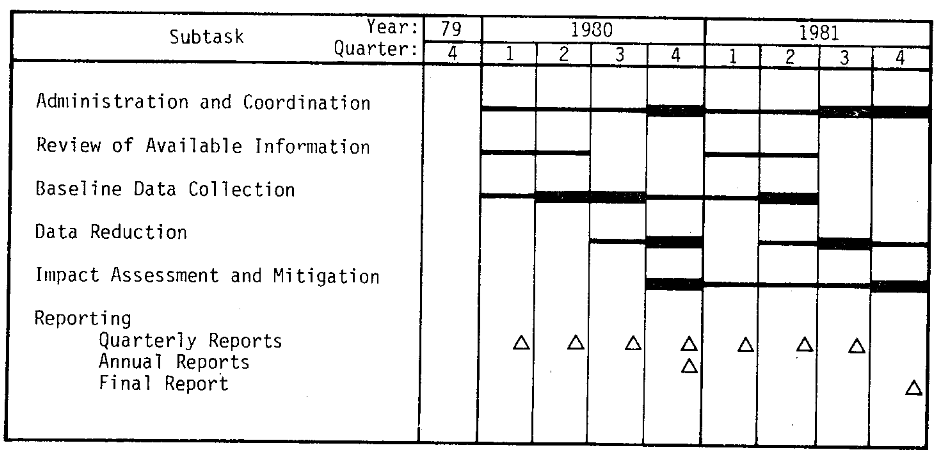
Major Effort
Minor Effort
Δ Major Milestones
(a) Assumes optional field studies not required

Specific Detailed Environmental Task Schedules

Task C-4-11 Large Mammal Assessment

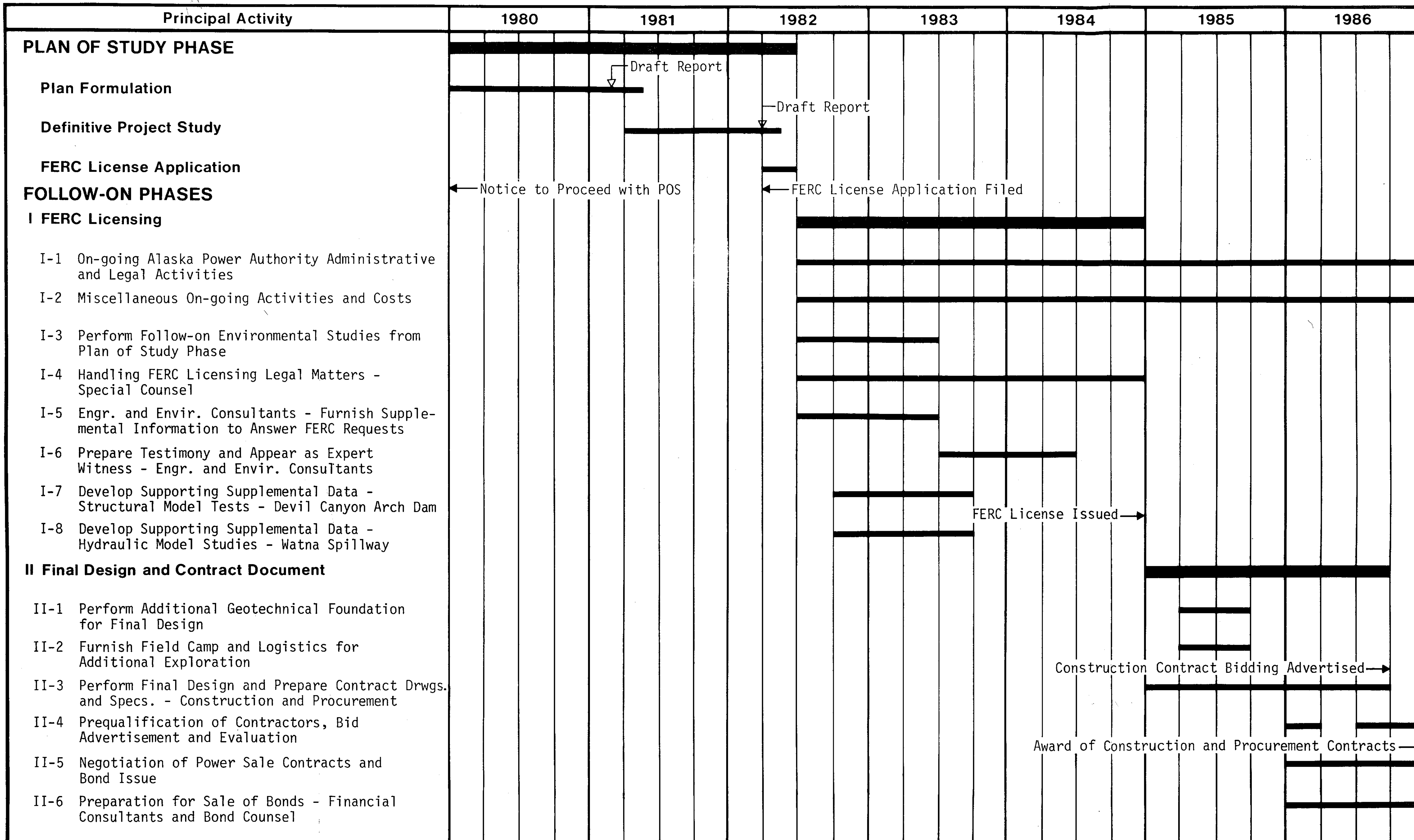


Task C-4-12 Bird and Small Mammal Assessment



Major Effort
Minor Effort
△ Major Milestones

Schedule to Construction Contract Award



Implementation of the Plan of Study:

1. Key Personnel Assignments
2. Organizational Structure of the Study Team
3. Coordination Procedures
4. Proposed Contractual Language

Section 1 - Key Personnel Assignments

The Study Team will be made up of personnel drawn from IECO, as prime consultant, and the associated consultants, comprising EDAW, Inc., Dames and Moore, and Hydrocomp. Additional support staff will be made available by the supporting subcontractors for assignments in their respective areas of expertise.

Thumbnail sketches for Study Team key personnel and special consultants are presented on the following pages, under the following headings:

- IECO - Key Personnel
- Associated Consultants - Key Personnel
- Special Consultants

Each of the Study Team key personnel is listed under one of the following general activity or study areas:

- Management
- Anchorage Support Operations
- Environmental Studies
- Hydrological Studies
- Geotechnical Studies
- Preliminary Design
- Plan Synthesis

Each of the Study Team key personnel is also assigned to a specific task area under one of the general activities. Thus, the readers will be able to identify the specific assignment for each of the key personnel, and from the thumbnail sketch for a particular person they will be able to quickly assess that person's qualifications.

The special consultants for whom thumbnail sketches are presented are those that have already agreed to work with the Study Team on the

Susitna project. Other special consultants of equally high caliber may be selected at a later date, if and when special problem areas arise.

IECO Key Personnel

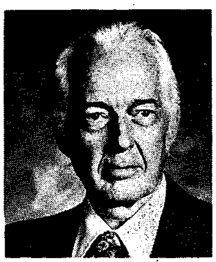
Management

Project Manager

Eric B. Kollgaard — Principal Engineer

Mr. Kollgaard, Chief of the Dam Design Department, has over 24 years of experience in the field of water and land resources development, with particular emphasis on the design of dams, spillways, water intake structures, powerhouses, pumping plants, and other major structures associated with water resources development projects. He has extensive experience in stress and structural analyses, including two-dimensional and three-dimensional finite element analyses of dams and their foundations, dynamic response analyses, structural model testing, and investigations for determining the safety of existing dams. Mr. Kollgaard has been project manager on the Copper Creek Hydroelectric Project, the raising of Ross Dam, and the Windy Gap Water Supply Project. He is also the Home Office Coordinator for the Paute Hydroelectric Project in Ecuador.

Deputy Project Manager



R. W. Retherford - Vice President - Arctic District

Mr. Retherford's experience in the power industry includes design, construction, operations, economics, and rate analysis as applied to power studies, transmission and distribution systems and hydroelectric plants. His design and construction experience in Arctic conditions is extensive, beginning in the early '50's when he was a systems engineer for Chugach Electric Association. Mr. Retherford has received numerous awards in recognition of his valuable contributions to advancing engineering in Alaska.

Project Executive

R. B. Christensen - Vice President

Mr. Christensen has been Vice-President and Regional Manager for North America since 1974. He is responsible for the development and executive management of domestic work, which includes hydro power, water resources projects, power transmission lines, and transportation projects. He is currently Project Executive for the Idaho Falls Hydro Project, the Brownlee Powerhouse Expansion, and the Wiley Hydro Project.

Technical Review Board

Chairman

Archie A. Stone - Executive Vice President, Engineering

Mr. Stone has overall responsibility for all engineering activities of International Engineering Company, Inc. He has been with IECO since 1947. From 1969 to 1977 he served as Vice President and Manager of operations of IECO's engineering subsidiary in Brazil, responsible for a staff of more than 1000 engineers and technicians providing overall direction for many of the largest hydroelectric projects in Latin America. Principal among these is the 12,600 MW Itaipu Hydroelectric Project for which he was Project Executive.

Board Member

Warren M. Emerson - Chief Engineer, Water Resources Division

Mr. Emerson has been engaged in the construction and the design of projects covering the field of hydroelectric power development and flood control since 1955. He was Assistant Superintendent of the Hydro Division at IECO's Brazilian affiliate in Rio de Janeiro and Chief of the Civil Engineering Department, responsible for all civil works in Brazil. He served as Project Manager of the Itumbiara Project, a 350-ft high, 4-mile long earth and rockfill dam with a 2,080-MW powerhouse. Mr. Emerson has been with IECO for 24 years.

Board Member

Edwin S. Smith - Chief Engineering, Geotechnical Division

Mr. Smith is Chief Engineer of the Geotechnical Division of IECO with staff of 45 professionals under his direction. During his 27 years with IECO, Mr. Smith has worked on over 20 major dam projects. His assignments on these projects have included materials investigations, stability studies, filtration seepage analysis and control, dam design, spillway model studies, rock mechanics investigations, and embankment earthquake engineering. He is presently directing a dynamic response analysis of Dinkey Creek Dam (115 m-high rockfill with concrete face) in California.

Board Member

Olov G. Berglund - Chief Engineer, Power Systems Division

Mr. Berglund has over 35 years of experience in the electric power industry, both in equipment fabrication and project design. His experience covers hydroelectric generators, synchronous condensers, frequency converters, HVDC transmission systems, and project startup. Mr. Berglund is an experienced engineering manager for hydroelectric power plants, power systems, power transmission and substations, and transportation systems.

Anchorage Support Operations

Principal-in-Charge

Ray S. Samuelson - Principal Engineer

Mr. Samuelson has a broad background in planning, design and construction of major civil engineering projects. Recent assignments include the design of a rockfill dam in Alaska and an earthfill dam in Wyoming. Mr. Samuelson's earlier experience includes a period with the California Division of Safety of Dams where he was responsible for review and analysis of dam designs, and responsible for contract administration for Oroville Dam. He is presently assigned to IECO's Anchorage, Alaska office.

Office Support

Dwane Legg - Electrical Engineer

Mr. Legg is the Director of Engineering Management of IECO's Anchorage office, responsible for the day to day technical and administrative operation, including monitoring of contracts, cost estimates, quality review, planning, reporting and personnel functions. He is an experienced contract administrator and planner with special emphasis on engineering administration.

Permits

Richard Burg - Civil Engineer

Mr. Burg is attached to the Anchorage office where he has participated such projects as Solomon Gulch, Terror Lake and Tyee Lake Hydroelectric projects. This work required him to become familiar with the various State and Federal regulatory agencies, as well as the FERC, and the requirements for obtaining permits associated with project field activities.

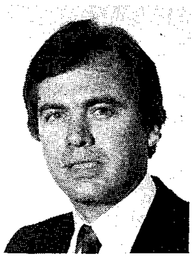
Surveys

Pierre Clauzon - Chief, Surveys and Mapping

Mr. Clauzon is experienced in all phases of surveying, including topographic, photogrammetric, geodetic, oceanographic and lot surveys. Assigned as Senior Field Engineer, Mr. Clauzon was responsible for topographic and photogrammetric surveys for IECO's Paute Hydroelectric Project and the National Transmission Line System in Ecuador. Later, as Chief Inspector and Principal Field Engineer on the Itaipu Hydroelectric Project, he assured coordination of liaison between the owner and the contractors while he controlled and supervised all topographic, photogrammetric and cadastral surveys as well as land evaluation.

Environmental Studies

Coordination With Engineering Studies



Donald R. Sanders - Senior Engineering Geologist

Since joining International Engineering Company, Inc., Mr. Sanders has been involved in coordinating and reviewing geological and hydrological input to environmental documents required for several hydroelectric projects on the Snake River in Southern Idaho and on Kodiak Island, Alaska. He also acts as in-house advisor on all projects requiring environmental studies. Prior to joining IECO, Mr. Sanders was Project Manager on a variety of environmental studies throughout the United States.

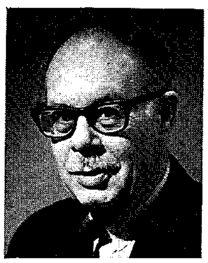
Hydrological Studies

Principal-in-Charge

Cyril J. Chan - Chief Hydrologist

Mr. Chan has extensive experience in water resources planning which includes hydroelectric power development, reservoir operations, flood analyses, backwater and tailwater studies, river hydraulics and flood routing, probable maximum flood determinations, streamflow correlations, sysnthesis; probabilistic analyses and stochastic generation of flows, mathematical basin models, computer program development and applications, and financial and economic analyses. He is a 16 year veteran with IECO and has conducted hydrological studies for such major projects as the 12,800-MW Itaipu Hydro Project, the 2,100-MW Itumbiara Hydro Project, and the Nicaragua Power Master Plan. Mr. Chan is Chief of the Hydrology Department.

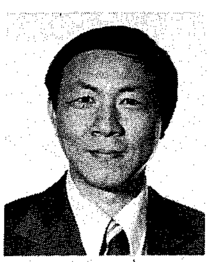
Data Collection, Gaging and Sampling



William Peterson - Senior Hydrologist

Mr. Peterson has been involved in hydraulic and hydrologic investigations since 1949. He spent 13 years with the U. S. Geological Survey in Hawaii and California where he was involved in formulating rainfall-runoff relations, storm and flood magnitude and frequency, and streamflow measurement. He was hydrometeorologist with the UNDP, and manager of their Hydrological studies of a major river basin in Brazil. During his 6 years with IECO, he has been involved in basin studies, master plans, reservoir operation studies and sediment transport studies.

River Hydraulics and Sedimentation

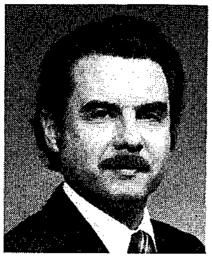


Fang H. Wu - Senior Hydrologist

Mr. Wu's 18 years of experience includes meteorologic and hydraulic data management and analysis, field investigations and monitoring of streamflows and water quality, streamflow generation and synthesis, flood routing, and fluvial hydraulic analyses for control of erosion and sediment deposition. Mr. Wu is familiar with the HEC-6 computer program for analyzing reservoir sediment deposition and river scouring, and has conducted research studies on sediment transport.

Geotechnical Studies

Principal-in-Charge



Joseph S. Long - Chief Geologist

Mr. Long has over 20 years of experience in engineering geology, much of which has been on large hydroelectric and water resource development projects. He has been responsible for exploration, in-situ testing and evaluation of dam, tunnel and power plant sites in South, Central and North America and other parts of the world. Typical recent hydroelectric projects include the 12,800-MW Itaipu Project, the 2,800-MW Sao Simao Hydro Project and the underground powerhouse and arch dam foundations at the Paute Hydro Project in Ecuador.

Engineering Geology

C. Wallace Wade - Principal Engineering Geologist

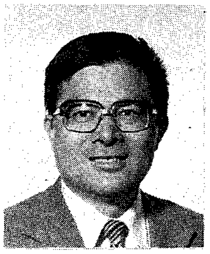
Mr. Wade's primary activities during his 18 years as an engineering geologist have been related to hydroelectric and water resource development projects in the United States and overseas. He has performed site investigations and in-situ testing for dams, tunnels and underground powerhouses in seismically active areas of California and South America. Applicable projects include: Oroville Dam, New Bullards Bar Dam, The Paute Hydro project, and the Tehachapi Tunnels.

Engineering Geophysics

Ernst G. Zurflueh - Senior Geophysicist

Dr. Zurflueh is an experienced geophysicist with particular emphasis in seismology, magnetism and geophysical instrumentation. As a research scientist, he has developed a method of interpretation for magnetic anomalies, and has contributed to the design of a new shear wave measurement technique. Dr. Zurflueh has participated in aeromagnetic and marine seismic exploration projects, has conducted seismic refraction and shear wave velocity studies at a number of nuclear and hydro project sites, and has assisted in setting up microseismic and strong motion recording networks.

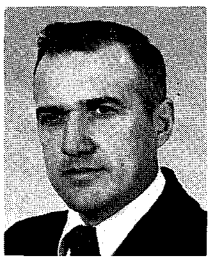
Seismology



Cheh Pan - Senior Geophysicist - Seismologist

Mr. Pan's background in geophysics and seismology includes seismic risk analysis, site stability evaluation, earthquake prediction, computer simulation of seismic near-field ground motions, geodynamics, and seismic data processing. He has participated in the development of a three-dimensional finite element program to simulate seismic ground motions and numerical modeling of fault dynamics, and has developed techniques for seismic site stability analysis.

Construction Materials Investigation



Larry W. Lobdell - Principal Engineer

Since 1969, Mr. Lobdell has acquired extensive experience in the geotechnical design and construction of water resource, thermal power and slurry transport pipeline projects. Aided by over 20 years of practical experience in design and development of construction methods, Mr. Lobdell has rapidly achieved both major project responsibility and a highly successful record of project management. His recent responsibilities include providing design and construction consultation on stabilizing the abutment excavation at the 180-meter high Amaluza Dam in Ecuador; performing safety evaluations of dams in Kodiak, Alaska and in North Dakota; and designing a water supply dam for the city of Kodiak. Mr. Lobdell served as Project Director for design and construction for an 80-million dollar waste disposal system, which included a 400-foot high earth and rockfill dam, for an eastern utility.

Foundation Exploration and Testing

Ralph C. Dow - Senior Geologist

Mr. Dow is an engineering Geologist with over 15 years of experience in the field of dam foundation evaluation and rock mechanics. His experience covers the planning and execution of geological programs pertaining to dams, structural foundations, underground powerhouse caverns, tunnels, slope stabilization and groundwater conditions. During construction he has supervised rock mechanics and blast vibration studies, and evaluated foundations for foundation grouting.

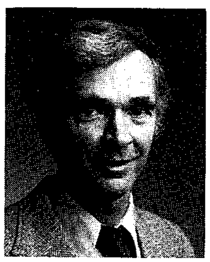
Preliminary Design

Design Coordinator

Ram P. Sharma - Principal Engineer

Mr. Sharma has over 27 years of experience in the field of water and land resources development with particular emphasis on the design and analysis of dams, spillways, power intake structures and other major structures associated with water resources development projects. He has extensive experience in stress and structural analysis including trial load analysis, two-dimensional and three dimensional finite element static and dynamic response analysis of dams and their foundations, structural model testing and investigations and analysis for determining the safety of existing dams. Mr. Sharma is a member of the Committee on Methods of Numerical Analysis of Dams and Committee on Measurements of the United States Committee on Large Dams (USCOLD).

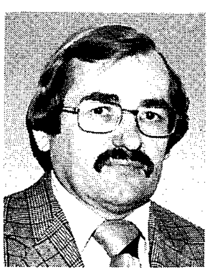
Embankment Dams



Kenneth B. King - Principal Engineer

Mr. King has 20 years of engineering experience in the design of rockfill dams, hydraulic structures and foundations for water resources and power projects. For 6 years he was responsible for all geotechnic work on rockfill dams in Brazil. His duties included preparation of feasibility reports, final design, construction supervision, and evaluation of post-construction instrumentation. He also has been project engineer for water supply projects that included rockfill and embankment dams. Prior to working with IECO, he was employed by the state of California where he was a design engineer on rockfill dams and hydraulic structures.

Concrete Dams



Harry Jackson - Senior Engineer

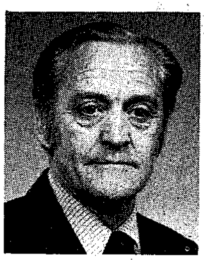
Mr. Jackson has 19 years of professional experience, of which 12 years is with IECO in the design of concrete dams. His specialty is the design and analysis of concrete arch dams by the trial load and three dimensional finite element methods of analysis. He has been associated with the design of new Bullards Bar Dam, the raising of Ross Dam, and stability analysis of Spaulding, Matilija and Pacoima Dams.

Electrical Facilities

William F. Untiedt - Senior Engineer

Mr. Untiedt has been engaged in the design of hydroelectrical projects and HV and EHV switchyards since 1957. He has been assigned as Project Electrical Engineer in the Hydro Division at IECO's Brazilian affiliate in Rio de Janeiro, and in the San Francisco office, responsible for the project electrical basic design, estimating and construction design, as well as startup engineer. He has assisted in the design of major power plants such as the 12,800-MW Itaipu, the 1500-MW Agua Vermelha, and the 1000-MW Blenheim - Gilboa plant.

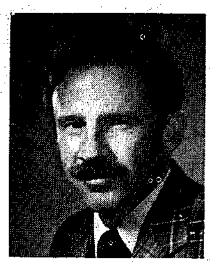
Transmission System



Gosta I. Israelson - Principal Engineer

Mr. Israelson, Chief of the Transmission Line Department, has over 42 years of experience in the field of transmission lines design, with particular emphasis on the development of transmission line design programs, aerial survey; new tower design concepts and cost study techniques. He had served as an Engineering Specialist, Resident Manager and Project Manager. He has participated in the design of projects such as the 735-kV UHV lines at James Bay and Churchill Falls, 230-kV lines in the mountains of Ecuador, 400-kV EHV lines in Bolivia, and 400-kV lines in Iran, where he was Resident Manager.

Access Roads



C. P. Smith - Principal Engineer

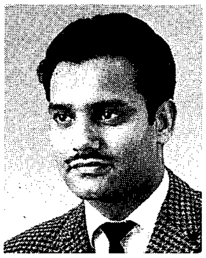
Mr. Smith has more than 16 years of professional experience in the design of transportation projects. He served with the Federal Highway Administration in Denver for 10 years where he was responsible for design and construction supervision of highways financed by federal funds. With IECO he has served as Project Manager for a feasibility study and environmental assessment for a proposed new highway in Idaho. Mr. Smith presently serves as Chief Transportation Engineer in IECO's Boise area office.

Construction, Planning and Scheduling

Tom Barber - Principal Engineer

Mr. Barber has more than 30 years of experience in heavy construction planning, scheduling, and management. Fifteen years of this experience was earned in the western U. S. and the Columbia Basin on USBR and Corps of Engineers dams and water resources projects. He has managed such complex construction projects as the San Francisco BART Montgomery Street Station, a computerized baggage handling system at the Dallas-Fort Worth airport, and underground construction projects.

Diversion, Spillways and Outlets



Prabhakar K. Mogera - Principal Engineer, Civil Design

Mr. Mogera has 17 years of professional experience in planning, construction, and design of concrete arch dams, earth and rockfill dams, river diversion works, spillways, powerhouses, intake structures, gates, penstocks and other project features related to water resources projects. Among the projects on which he has worked are: Itaipu, where he led the Diversion Gate Design Team; design of the Yuba Project Spillway, design of Ross Dam Intake, and design of a Diversion weir with 40 radial gates in Bangladesh. Mr. Mogera is Chief of the Hydraulic Structures Department.

Power Features

Oddvar Hougen - Principal Engineer

Mr. Hougen's 27 years of professional engineering experience encompasses the design and planning of hydroelectric projects, dams, and appurtenant structures, powerhouses, and basin development projects throughout the world. He has successively served as Engineer, Group Leader, Department Head, Chief Resident Engineer in the field, and Project Manager on projects located in the United States, Australia, Canada, El Salvador, Honduras, Colombia, Venezuela, Pakistan and Taiwan. He has been Project Manager of the Nicaragua Power Study, a study of 3 river basins and a 460 ft high rockfill dam, and the Brownlee expansion for a new 245 MW unit. Mr. Hougen is Chief of the Hydropower Plant Department.

Mechanical Facilities

James L. Carson - Principal Engineer

Mr. Carson has more than 20 years of experience in the field of hydraulic machinery, turbines, governors, pumps, and larger butterfly and spherical valves. He is completely familiar with all aspects of the selection and design of pumps and turbines. Mr. Carson has also worked extensively in the fields of hydraulic transients and stress analysis of hydroelectric mechanical equipment. He served as a consultant in Brazil for four years where he was responsible for the turbines of several hydroelectric projects. He assisted in the preparation of turbine specifications for such projects as the 700-MW units at Itaipu, and the 245-MW Brownlee Units. Mr. Carson is presently Chief of the Hydro-Mechanical Equipment Department.

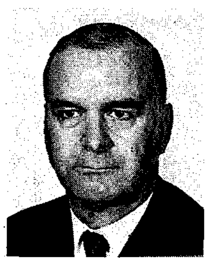
Plan Synthesis

Chief Planning Engineer

A. Ragnar Engebretsen - Principal Engineer

With over 31 years of experience, Mr. Engebretsen is thoroughly familiar with the development of water and power resources, including the preparation of basin and inter-basin Master Plans; the planning and design of hydroelectric projects, and reservoir operation studies. He has been involved in Master Planning Studies in Peru and Bangladesh, water resources feasibility studies in the western United States, and the planning and design of hydro projects in the United States, Australia, Taiwan, Iceland and Norway. Mr. Engebretsen is Chief Planning Engineer in the Water and Power Resources Planning Department.

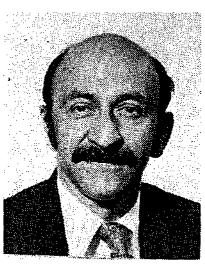
Economics and Finance



Adrien A. Duncan - Principal Economist

Mr. Duncan has extensive experience in the economic and financial assessment of major projects, such as power, flood control, transportation and related infrastructure. During his 30 years of experience he spent 8 years with the World Bank as Engineer/ Economist where he organized and supervised technical and economic preinvestment studies for various projects. He has provided technical assistance in modern engineering management, economic/ financial analysis, and infrastructure planning to Spain, Belgium and Pakistan, and has supervised engineering and economic staffs for consulting firms overseas.

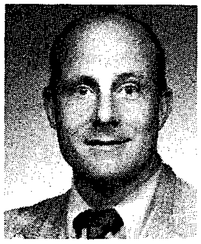
Project Layout Studies



Paul Collins - Principal Engineer

Mr. Collins has 20 years of experience in hydroelectric and water resources planning and project design. He has prepared a country-wide power survey and feasibility study in Panama, planning studies for the Itaipu Hydro Project in Brazil, Master Plans for Water Resources Development in Bangladesh and Turkey, and final designs for major hydro projects world-wide. Mr. Collins is currently Project Manager for the final design of a hydro power plant in Guatemala.

Power Studies and System Optimization



John Kerr - Senior Engineer

Mr. Kerr's experience covers the fields of water resources and energy studies, and hydropower engineering. During his 25 years of practice he has participated in nationwide water and energy Studies in Nicaragua, Brazil, Bolivia, Chile, and Canada which have included river basin planning, hydro and hydro thermal system analysis, and nuclear feasibility. Mr. Kerr has extensive experience in computer systems covering areas such as data banks, cost estimating, and simulation and economic annalysis of hydro and hydro thermal systems.

Power Market Study

Richard F. Ramirez - Senior Engineer

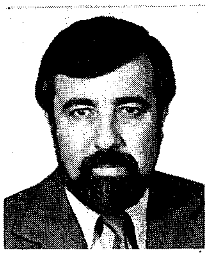
Mr. Ramirez has a broad background in the field of power system planning including power market surveys, demand and energy forcasts, rate studies, generation planning, system analysis for power flow, stability studies, and economic and reliability studies. He worked 5 years for a major utility as System Planning Engineer doing load forecasting, generation planning, and transmission and distribution planning. During his service with IECO, Mr. Ramirez has worked on the Nicaragua Master Plan for power generation and the Inga-Shaba EHVDC Transmission Line in Zaire.

Coal and Gas Alternatives

Sam F. Fogleman - Principal Engineer

With over 27 years of engineering experience, Mr. Fogleman has an extensive background in the design of hydro power, thermal power, and alternative energy systems. He has participated in the design of hydro mechanical systems for such major hydro projects as Itaipu, Sao Simao, Paute, and Kings River, and most recently has been heavily committed to alternative energy sources. He has conducted studies utilizing biomass systems, geothermal, wind power, solar power, and combined cycle systems. Mr. Fogleman is Chief of the Thermal and Alternative Energy Systems Department.

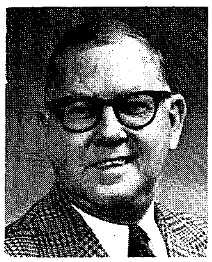
Other Alternative Energy Sources



Michael H. Wolfe - Principal Engineer

Mr. Wolfe has 24 years of experience in the field of power system analysis and economic studies for development planning. Among his recent assignments have been a study plan for hydro, thermal, and geothermal generation in Nicaragua, and a long-range planning study in the Philippines which included an analysis of generation plans covering pondage hydro, pumped storage, gas turbines and combine cycle plants, coal and oil fired thermal, geothermal, and nuclear sources.

Preparation of FERC License Application



Carter B. King - Principal Engineer

Mr. King, Chief of the Water Resources Planning Department, has 33 years of extensive experience in the field of water resources development, with special emphasis on engineering and environmental studies for water resources projects, including hydroelectric facilities, storage dams, diversion dams, and the master planning of river basins. As Department Head he is responsible for all water and power resources planning activities with the Water Resources Division, and for the preparation of all FERC license applications.

Associated Consultants - Key Personnel

Environmental Studies

Principal-in-Charge

D. Blau - (EDAW)

Mr. Blau is an experienced landscape architect and environmental planner with over 15 years of experience, principally in energy related projects. Projects under his direction include the Environmental Report, Recreation Plan, and Fish and Wildlife Resource Study for the 320-MW Stanislaus River Hydro Project, the Environmental Report for the Pine Flat Hydroelectric Project, and an environmental analysis of the long-range transmission plan, Master Plan for the Lake Tahoe Basin.

Environmental Aspects of Energy Alternatives and Demand

A. Massa - (EDAW)

Ms. Massa is an urban and regional planner with wide experience in general planning, policy development, and the evaluation of environmental and socioeconomic impacts of urban growth alternatives. She has been responsible for development and evaluation of economic, social, and environmental alternatives on a broad range of projects. Ms. Massa was formerly a planner for the City of Chicago, heading the industrial and commercial advance planning sections.

Environmental Report - Exhibit W

J.Everingham - (EDAW)

Mr. Everingham is a systems ecologist who has specialized experience in a wide range of rural and urban environmental analysis and planning programs including research-based environmental plans, environmental impact reports, comprehensive environmental data bases and data management systems. As Project Manager with EDAW, he is currently directing the preparation of Environmental Reports for three potential hydroelectric projects along the Snake River in Idaho, as well as a Fish and Wildlife Resource Study for the Wiley Hydroelectric Project on the Snake River.

Recreation Plan - Exhibit R

P. Miller - (EDAW)

Mr. Miller's extensive experience in landscape architecture includes environmental analysis, recreation and open space planning, and urban design. Projects which he has managed, include the Southfork American River Recreation and Village Protection Plans, the Wiley Hydro Project Recreation Plan, master plan for Nisqually National Wildlife Refuge, and the Nevada Statewide Trails Study. Additionally, he has been responsible for environmental studies for the Kings River Conservation District and the U. S. Fish and Wildlife Service.

Natural, Scenic, and Historic Resource Protection Plan

M. Bowie - (EDAW)

Mr. Bowie is a resource planner, landscape architect and architect with comprehensive experience in visual resource mapping and broad-scale environmental mapping. Recently, he directed land use studies for the plan to protect the wildlife values of Suisun Marsh, and an analysis of the visual sensitivity of river recreation for a power plant project in Minnesota. He also performed a visual resources inventory of Hells Canyon National Recreation Area.

Fish and Wildlife Resources Protection Plan - Exhibit S

J. Hemming - (Dames & Moore)

Mr. Hemming has over 17 years of experience in fish and wildlife evaluations. He has served on evaluations of caribou biology, commercial fisheries, subsistence surveys, wildlife management, and habitat classification and inventory. He identified and evaluated fish and wildlife stocks and their habitat between Valez Arm and Prudhoe Bay, Alaska, and was a federal coordinator and co-chairman on a joint Alaska State/Federal Fish and Wildlife Advisory Team. He is presently Principal-in-Charge of Dames & Moore Management of biological services in Alaska.

Hydrological Studies

Mathmatical Modeling and Simulation

Dr. Norman H. Crawford (Hydrocomp)

Dr. Crawford, Chairman of Hydrocomp, graduated from the University of Alberta in Canada and earned a Master of Science and Doctor of Philosophy degrees at Stanford University. Dr. Crawford's Ph.D. dissertation in 1962 was the Stanford Watershed Model which has become a widely used computer simulation method for the hydrologic cycle. From 1962 to 1968, he was an Assistant Professor of Civil Engineering at Stanford. In 1968 he joined Hydrocomp to further develop simulation methods and expand the use of simulation in Water Resources. He has supervised modeling studies for many large hydroelectric developments. His specialities are mathematical model development for natural resources, and advanced data management systems for computer use in management of water resource systems. He is author and co-author of many technical papers and reports on computer applications in Hydrology and Hydraulic Engineering, and has served as a modeling consultant for the United Nations and the U. S. Department of State.

Data Management

John L. Kittle, Jr. (Hydrocomp)

Mr. Kittle is Manager of Simulation Network Computer Services at Hydrocomp. Mr. Kittle graduated from the Georgia Institute of Technology and has five years of experience in hydrologic and water quality modeling. He was project manager for development of a data bank for climatological data in Northwestern Ohio, and worked on the development of the HSPF Comprehensive Watershed Model.

Special Consultants

Seismicity

Dr. Clarence R. Allen

Dr. Allen is Professor of Geology and Geophysics at the California Institute of Technology, where he has served since 1954. He is an internationally recognized authority on Engineering Seismology, and his primary research involves relationships between seismicity and geologic structures; tectonics of regional fault systems; earthquake mechanisms; earthquake predictions and geologic hazards. He was a member of many earthquake reconnaissance missions around the world, including Turkey and Pakistan.

Seismic Design

Dr. H. Bolton Seed

Dr. Seed has had more than 30 years experience in the academic and teaching fields. He served as Chairman of the Civil Engineering Department at the University of California, Berkeley from 1965 to 1971, and he is currently assigned as Professor, specializing in Geotechnical Engineering and Earthquake Engineering. In addition to his teaching duties, he has served as Consultant since 1950 on soil mechanics foundations and earthquake engineering problems. His services have been utilized by IECO on several projects having extensive earthquake engineering problems. He is the recipient of numerous honors and the author of more than 150 technical publications.

Geology and Rock Mechanics

Dr. George A. Kiersch

Dr. Kiersch has served as geologic consultant for over 80 major engineering projects in the U.S. and overseas since 1951. Projects include regional and site investigations for nuclear and fossil power plants and associated studies for disposal of nuclear and industrial waste; tunnels and underground construction; open-pit mines and large construction excavations; concrete and earth-fill dams; highways and railroads; assignments for large-scale geologic mapping and evaluation of area potential for mineral and industrial development; and associated technical presentations before review boards and in litigation and hearings. Responsibilities have also included direction of large geotechnical exploration teams.

High Embankment Dams

Stanley D. Wilson

Mr. Wilson is a recognized authority in the soil and rock mechanics and foundations fields. His extensive experience as engineer, consultant and author is indicated by the many honors and awards he has received as a result of his efforts. His soils and foundation assignments have covered projects in the dam, pumped storage, highway, railroad, and mining fields, and he has done considerable work in the investigation of landslides. He has been active as a lecturer and educator, and as a member of many advisory and consulting boards for government agencies and industrial firms. He is a visiting lecturer in soil mechanics at the University of California and Harvard University. He has conducted short courses on instrumentation for the Army Corps of Engineers, and has served on consulting boards for major hydroelectric projects.

Hydrometeorologist

Joseph L. H. Paulhus

Mr. Paulhus retired from the U. S. Weather Bureau in 1969 and since has been active as an independent consultant. He has been retained by the National Weather Service to analyze major U. S. Floods, such as the major snowmelt floods of 1969 in the upper and midwest states. He served as consultant to the Organization of American States to analyze depth-duration-area relationships of major storms and to make statistical estimates of probable maximum precipitation in Uruguay. He has participated in the hydrometeorological studies for the Itaipu and Sao Simao projects in Brazil, and has prepared estimates for probable maximum precipitation for river basins in Algeria, Iran, Dominican Republic, Indonesia and Salvador. He was editor and chief author of a manual on the estimation of probable maximum precipitation for the World Meteorological Organization in Geneva, and has served on the ASCE Task Committee on the Re-evaluation of the Adequacy of Spillways of Existing Dams.

Risk Analysis

Dr. Haresh C. Shah

Dr. Shah is Professor of Structural Engineering at Stanford University, a Director of the John A. Blume Earthquake Engineering Center and a recognized authority on seismic risk analysis, and risk analysis in general. His experience includes seismic risk analysis for projects in California, Nicaragua, Guatemala, Costa Rica and Algeria; seismic hazard prediction; and seismic design criteria. Dr. Shah is Chairman of the EERI Committee on Seismic Risk in the USA, Chairman of the ASCE Technical Council on Lifeline Earthquake Engineering Committee on Seismic Criteria and Risk, and Chairman of the ACI Subcommittee on Probabalistic Methods for Safety Evaluation.

Arctic Engineering for Power Plant Design

J. A. Thomas - Shawinigan

Mr. Thomas is presently Senior Company Consultant and Vice-President of the Shawinigan Engineering Group. His experience in power plant design in severe winter conditions includes such aspects as: ice loading criteria, gate and penstock design, winter protection, and de-icing equipment. Mr. Thomas has participated in the civil, hydraulic and mechanical design for such projects as the Churchill Falls Hydro Project and the Bay d'Espoir Power Development in Labrador, and the Carrillon Power Development and Beaumont Power Development in Quebec.

Arctic Engineering for Switchyards and Power Transmission Lines

G. B. Furst - Shawinigan

Mr. Furst has 30 years of experience as an electrical engineer in the design of power transmission systems. He has been involved in studying transmission alternatives from hydro developments on the Yukon and Liard Rivers to Southern British Columbia, long range development plans for transmission system load flow for the Greater Vancouver Area, and transmission alternatives from the Maritime Provinces to New England and Quebec. Mr. Furst's special experience includes problems in: grounding in discontinuous permafrost zones, transmission line conductor icing and the dangers of surging and galloping, switchyard reliability in extreme winter conditions, and insulator arching problems associated with severe icing. He is presently head of the system planning group in Shawinigan.

Section 2 - Organizational Structure of the Study Team

The Study Team, which is composed of a project management unit, a support group, five study groups, and a number of special consultants, has a simple hierarchic organizational structure. The support group and study groups are divided into task groups responsible for specific assignment or task areas, and each of these task areas is further divided into individual tasks, as described in Part A, Section 5. Exhibit B-2-1 shows the general organization of the Study Team, and Exhibit B-2-2 shows a more detailed organizational breakdown of the Environmental Study Group.

Although the Study Team comprises several diverse organizations, it will function as an integrated unit, with the prime consultant, IECO, in the role of team leader and general coordinator. The interface between environmental and engineering studies will be coordinated through one person, assigned by IECO to that position. The hydrologic work performed by Hydrocomp, as an associated consultant, will be integrated into the overall study program by the Principal-in-Charge of that assignment area. In each task area where the work is under the jurisdiction of a supporting subcontractor, IECO will assign one of its personnel to facilitate overall coordination.

The responsibilities of the Study Team members (IECO and the associated consultants) and those of other entities and individuals that will contribute to the study effort (supporting subcontractors, special consultants, and governmental agencies) are discussed below.

2.1 IECO

As prime consultant, IECO will be responsible for project management, the project executive function, public participation and information, technical review of the progress of the work, and study groups, as discussed below.

A. Project Management

IECO will provide overall direction to each study group and coordinate overlapping study areas between study groups. The Project Manager will be responsible for keeping the APA informed of the progress of the study, and he will be the focal point for the dissemination of information and instructions between the APA and the Study Team. The Project Manager will organize project-related meetings for the APA Board of Consultants, provide the necessary briefing materials for the Board, and answer all questions raised by the Board.

B. Project Executive Function

The IECO Project Executive will be responsible for contract administration from the nontechnical point of view. He will also provide a second communication link between the APA and IECO management, if such is ever needed.

C. Public Participation and Information

This very important area will be entrusted to a Senior Vice President with in-depth knowledge of the local issues and sensitivities. His responsibilities will be to work with the APA in organizing public forums to air the issues, respond to questions from the public concerning the project, provide accurate information about the project to the news media, and serve as liaison between the project group and the general public.

D. Technical Review Board

The IECO Technical Review Board will be made up of Principal Engineers within the IECO organization who will not be participating in the project on a continuing basis. The Board's function will be to review the progress of the work on a regular schedule and act as a staff consultant to ensure that a standard of excellence is maintained throughout the project development. The Board will report to the Project Manager.

E. Study Groups

With the exception of the Environmental Study Group, IECO will designate the Principal-in-Charge of each of the study groups and the support group. Each of these Principal Engineers will be responsible for the technical development of the work under his charge and will report directly to the Project Manager.

2.2 ASSOCIATED CONSULTANTS

The associated consultants are those consultants contracted by and working directly with IECO. They include EDAW, Inc., Dames and Moore, and Hydrocomp. Each of these consultants has been assigned responsibility for or in a specific task area, and each has planned the work within its assignment area, including the preparation of the detailed activity descriptions, schedules, and estimates of work presented in the Plan of Study.

A. EDAW, Inc.

EDAW will conduct the Environmental Study Program in its entirety as a subcontractor. IECO will coordinate the program on a hands-off basis, except where the environmental studies are directly linked to the engineering studies. IECO will be concerned primarily with maintaining schedules and coordinating the physical preparation of the final reports. EDAW will be fully responsible for the scope and content of the Environmental Study Program and the program objectives.

B. Dames and Moore

Dames and Moore has been selected by EDAW to assist in the Environmental Studies in the areas of fish, wildlife, and the biological sciences.

Dames and Moore personnel will be responsible to the EDAW Principal-in-Charge of the Environmental Studies.

C. Hydrocomp, Inc.

Hydrocomp personnel will work under IECO's direction, in the Hydrological Study Group, providing their specialized expertise in computer-based hydrologic analysis using mathematical modeling and simulation, and data management.

2.3 SUPPORTING SUBCONTRACTORS

The supporting subcontractors are those organizations selected by IECO or the associated consultants to assist in the prosecution of the work. These groups may be assigned special studies within a task area and will be responsible to a task leader. Drilling, special geological tests, and other similar activities requiring specialized equipment will also be performed by supporting subcontractors. All the supporting subcontractors have not been selected at this time; however, as the project develops and schedules are finalized, these groups will be selected to assist the Study Team. The responsibilities of the organizations that have been selected to date are discussed in the following paragraphs:

A. CIRI/H&N

The joint venture of Cook Inlet Region, Inc./Holmes and Narver, Inc., as a subcontractor, will provide camp and logistic support to the Study Team in the field, surveying and mapping services, and support services in procuring permits, obtaining real estate information, and planning construction infrastructure. The various team leaders working on specific task areas will be directly responsible to the Principal-in-Charge of the Anchorage Support Operations.

B. University of Alaska Geophysical Institute

The Geophysical Institute will be responsible for special arctic studies related to the project site. They will be responsible directly to the Principal-in-Charge of Geotechnical Studies.

C. University of Alaska Museum

The Museum will be responsible for the cultural resources survey, as part of the Environmental Studies Program. Museum personnel will report to the Principal-in-Charge of the Environmental Studies.

D. University of Alaska Institute of Social and Economic Research

The Institute will assist in the preparation of forecasts of socioeconomic growth for use in power market studies. Institute personnel will report to the task leader for the power market studies.

E. Shannon and Wilson, Inc.

Shannon and Wilson, through their Fairbanks office, will be responsible for conducting laboratory tests on soil and rock samples. They may also provide additional support to the field work, if needed, in materials sampling, in situ testing, and logging of test pits or auger holes.

2.4 SPECIAL CONSULTANTS

Individual special consultants will be utilized during the project to assist the Study Team in an advisory capacity. They will work directly with the leaders of study groups, such as the Geotechnical Studies Group, and task areas, such as embankment dam design. However, they will be directly responsible to the Project Manager. The Project Manager will call upon the consultants for their services, as required, and assign them to specific study groups. Upon completion of their assignments, the consultants will prepare final reports addressed to the Project Manager.

Some special consultants will be retained to serve for the duration of the project. They will be called upon periodically to provide advice or to review and comment upon the work progress and designs completed to date.

One consultant that deserves special mention is Shawinigan Engineering Company Limited, which has agreed to work with IECO on an as-required basis as a contributing subconsultant, providing specialized expertise in relation to design and construction in arctic environments. With over 50 years of experience, Shawinigan has developed engineering methods and techniques for successfully dealing with severe winter conditions for safe and reliable operation of hydroelectric power plants in northern climates.

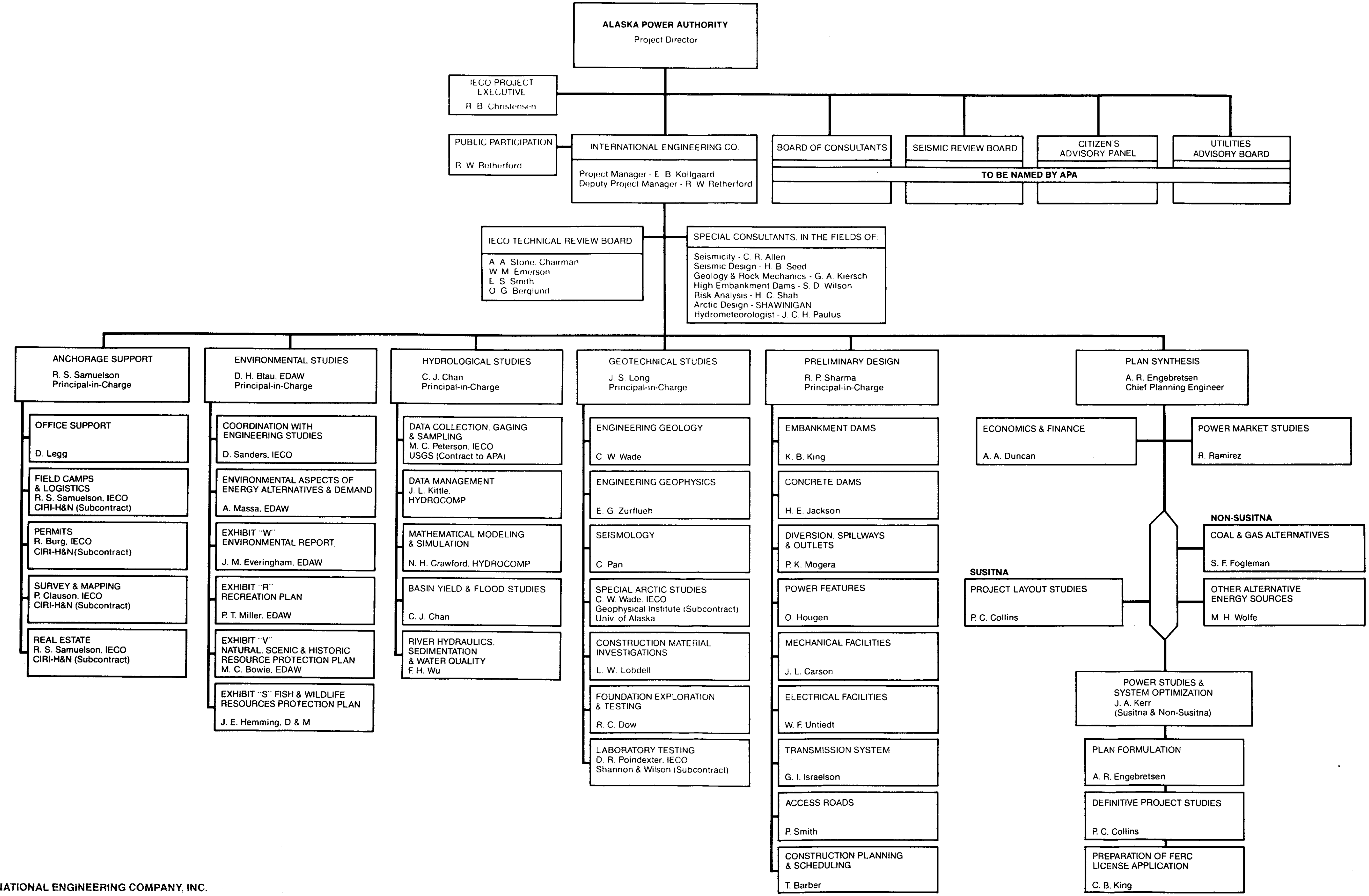
The special consultants that have already agreed to participate in the Susitna project studies are listed on the Table of Organization (Exhibit B-2-1). Others may be selected at a later date as specific problems arise.

2.5 GOVERNMENTAL AGENCIES

In some instances the assistance of certain governmental agencies will be required. The United States Geological Survey is one such agency whose special expertise would make a valuable contribution to the development of the project. Also, some of the work described in the Environmental Studies Program will probably be assigned to governmental agencies. In those instances where an agency will provide service to the project, the APA will be the contracting party. IECO will provide the APA with all the necessary input for outlining the task requirements, including schedules, and will work directly with the agency during the development of the task. The agency, however, will be responsible to the APA.

EXHIBIT B-2-1
Table of Organization

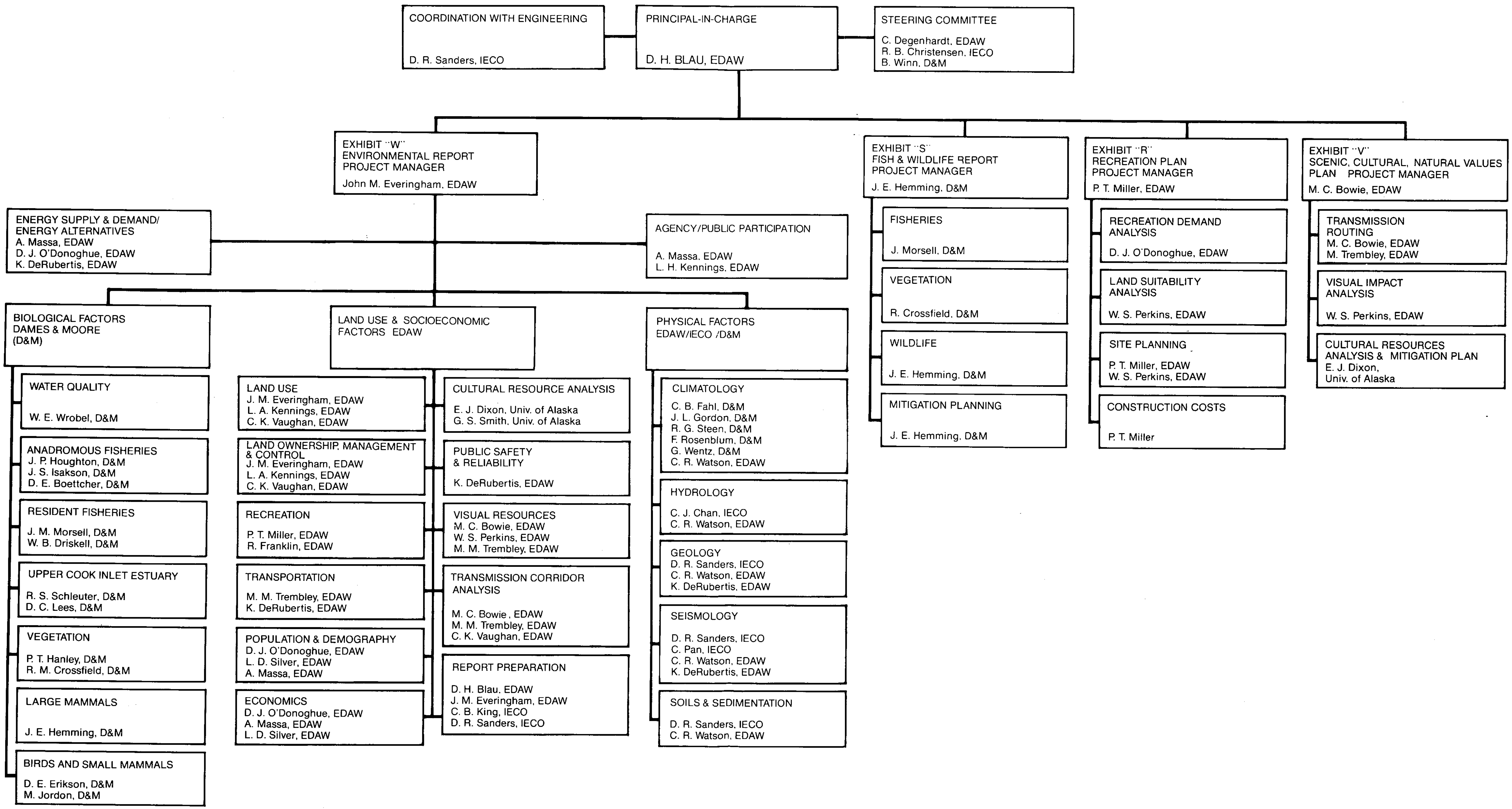
Susitna Hydroelectric Project
Plan of Study
Table of Organization



Susitna Hydroelectric Project
Plan of Study

Environmental Program Organizational Chart

EXHIBIT B-2-2
Environmental Program
Organizational Chart



Section 3 - Coordination Procedures

An involved matrix of relationships between the APA, the engineer, various subcontractors, advisory boards, and public entities must be identified, monitored, and cultivated to ensure effective execution of the Plan of Study and the follow-on work.

The consulting engineer becomes the basic clearinghouse and catalyst for this coordination. Fundamental to effectively filling this role is the existence of a strong project management system within the engineer's in-house operations. Experience has clearly shown that detailed attention to the management and prosecution of the engineer's planning, analysis, and design work is prerequisite to successful relationships with others interested in the project.

Another major element of coordination is effective communication. Under IECO's system of project management and control, the Project Manager bears prime responsibility for ensuring effective communication with all involved groups. He has broad authority to delegate and negotiate specific assignments, but must personally see to the overall adequacy of communications. The detailed descriptions of the specific tasks (Part A, Section 5) make reference to the external relationships important to the particular tasks.

The following description of IECO's project management procedures and controls sets forth the core program from which total coordination of the Susitna project activities will be developed.

3.1 PROJECT MANAGEMENT

IECO's philosphy of project management places full responsibility, and total accountability for results--technical, financial, and schedule--on the Project Manager. As opposed to systems that view the Project Manager as coordinator, IECO requires him to be the project's leader and primary driving force, and IECO provides him with the status, the tools, the power, and the executive support to achieve planned results. This somewhat authoritarian approach requires that the Project Manager have the strength and professional understanding to command the respect of his professional peers. It has served IECO well.

3.2 PROCEDURES MANUAL

Coordination procedures will be defined in detail in a Susitna Development Procedures Manual, which will be prepared immediately after the contract is awarded. This manual will include specific procedures addressing the following areas:

Correspondence

- Numbering system to classify and provide an identifying number for each item of correspondence.
- Identification of a single person in each entity (office, company, agency, etc.) to send and receive correspondence.

Document Development

- Master document list, identifying all documents to be developed for the project, and by what entity.
- Numbering system to be used by all entities originating documents.
- Classification of documents by discipline and type.
- Stages at which documents are to be reviewed and approved.
- Review and approval procedures.

- Procedure to expedite continuation of work in the event of failure of timely response by approval entity.

- Resonsibility for preparing and distributing telephone notes, meeting minutes, and design memos.

Document Distribution - A chart in matrix format that identifies and classifies all documents to be generated, identifying for each classification the originator, recipient of original, recipient of copies, and those whose approval or other response is required.

Schedule

- Procedure for preparing and updating master schedule.

- Method by which individual entities will provide subschedules compatible with the master schedule.

- Provision for regular distribution of schedule information, as defined in the Document Distribution Chart.

Contract and Purchase Orders

- Procedure for approval and issue of subcontracts and purchase orders.

- Control summary identifying scope of services, materials, or equipment to be provided under each subcontract and purchase order.

- Identification of interfaces with other subcontracts.

- Status reports for distribution, as defined in the Document Distribution Chart.

Expenditures

- Procedure for preparation and approval of detailed control budget for project.

- Procedure for review of budget provisions prior to award of each purchase order and subcontract.

- Provision for regular distribution of cost reports, as defined in the Document Distribution Chart. (Cost reports will include means of emphasizing exceptional situations.)

- Procedure for periodic updating of the project cash flow estimate.

Organization Chart

- Functional charts identifying entities responsible for particular aspects of the work and establishing lines of communication and approval.

Contract and Task Managers

- Roles of managers assigned to administer particular tasks and contracts.

3.3 THE PLANNING/FEEDBACK PROCESS (SCHEDULE AND COST CONTROL)

All work done internally by IECO is subject to the EMPAC (Engineering Manpower Planning and Control) system. The Plan of Study work program presented in Part A is compatible with the EMPAC system. This simple, computer-based system provides that:

- Every project is subdivided into discrete tasks.

- Every task is simply but formally documented, establishing:

  -Scope, detailed content, defined end product,
  -Schedule, including intermediate milestones,
  -Cost (in man-hours), and
  -Task Leader.

- The Project Manager and a task leader sign each task order, mutually committing themselves to its provision.

- Each task leader receives feedback every pay period on all charges to his task, by employee, compared to plan.

- The Project Manager receives feedback every pay period in the form of a project status report showing manpower charges to all project tasks, compared to plan.

The result of using the EMPAC system is that everyone who works on any IECO project is working within the framework of a formally defined, budgeted, scheduled task under an identified leader.

This system of management by objectives is simple, flexible, and non-bureaucratic. Moreover, it has become second nature to IECO personnel, who find it easier, and far more economical, to work within a well-documented plan with timely feedback than to "fly blind".

For the Susitna Project, the EMPAC philosophy, though not the computerized system itself, will be extended to all outside contributors--subcontractors, consultants, and cooperating agencies.

As in the preliminary framework established in the Plan of Study, the project will be divided into tasks, each the responsibility of an entity and of a designated task leader. Task documentation will be developed establishing the content, schedule, and cost of each task, negotiated as necessary to secure commitment to the task's achievement as planned. The resulting document will be formalized and become a part of the Project Plan.

A. Scheduling

It is not IECO's intention to use computerized network techniques (PERT, CPM, etc.) in scheduling and progress control for the Susitna project. These tools, which IECO uses routinely for control of procurement and construction, are unnecessary in planning and design work of the Susitna type. Instead, schedules will be prepared using time-scaled bar charts, which will show intertask constraints graphically or by note where they exist. The unit of scheduling will be the task, with intratask milestones identified as applicable.

B. Project Progress Reports

On the first working day of every month, the the Project Manager or his staff will secure from task leaders status reports of progress on all active tasks. These brief statements will be immediately consolidated into a project progress report for review, comparison to plan, and remedial action where required. The progress report will be separate from the cost report because it can be developed much earlier, and it will be crucial to direction of the work.

C. Progress Cost Report

Later in the month detailed cost data will be compiled through normal accounting channels. The project cost report will be assembled, again on a task-by-task basis, and compared to plan, taking reported task progress into consideration.

3.4 QUALITY ASSURANCE

In IECO quality assurance is exerted through the mechanism of the Technical Review Board, established for every major project. Consisting of high-level IECO technical executives, the Board is involved in each major step of project development, serving the twofold purpose of monitoring the performance of the Study Team and advising the Project Manager in major decisions.

The Board will be established at the outset of the Susitna project, and its meetings will be scheduled to coincide with important milestones and decision points. Every effort will be exerted to input the Board's advice constructively, at early stages when changes can be adopted without loss of completed work. In addition to scheduled meetings, the Project Manager will be free to convene the Board whenever special problems arise or policy decisions are needed.

The Board will review and approve all matters of basic project approach and technical policy and all major technical decisions. It will be especially thorough in examining the manner in which the Study Team has reached its decisions, insisting on thorough studies of alternatives and well-documented conclusions.

Since the Board members will be senior executives who have been responsible for many other projects, over many years, they will bring the entire company experience to the assistance of the Project Manager.

Section 4 - Proposed Contractual Language

Execution of the engineering, scientific, and technical support services required for the Susitna Hydroelectric Project Plan of Study can best be accomplished under an agreement that:

- Fixes a single point of responsibility for the performance of all services.
- Clearly ties the scope of services to the desired Plan of Study.
- Provides sufficient flexibility to encourage innovation and allow optimization of operations, while retaining effective control of the project budget and schedule.
- Includes an incentive to the contractor for quality performance within established budget and schedule constraints.

The "Services Agreement" presented on the following pages embodies these basic concepts, along with other necessary provisions ensuring the rights and obligations of each party.

SERVICES AGREEMENT

SUSITNA HYDROELECTRIC PROJECT

THIS AGREEMENT, entered into this _____ day of _______________, 1979, between:

State of Alaska
Alaska Power Authority
333 West 4th Avenue, Suite 31
Anchorage, Alaska 95501,

hereinafter called "AUTHORITY", and

International Engineering Company, Inc.
180 Howard Street
San Francisco, California 94105
and
6927 Old Seward Highway
Anchorage, Alaska 99502,

hereinafter called "CONTRACTOR", provides:

ARTICLE I SCOPE OF SERVICES

CONTRACTOR agrees to perform for AUTHORITY the services described in Exhibit A, which is incorporated herein and made a part hereof, providing for engineering, scientific, and technical support services to study the environmental, engineering, and economic feasibility of the proposed SUSITNA HYDROELECTRIC PROJECT and to prepare an application for licensing by the Federal Energy Regulatory Commission.

ARTICLE II COMPENSATION AND PAYMENT

For the performance of its services, CONTRACTOR shall be paid by AUTHORITY, in the manner and at the times hereinafter specified, its Recoverable Costs and a Fee as follows:

A. Recoverable Costs - AUTHORITY shall pay CONTRACTOR for all costs and expenses expended by CONTRACTOR in the performance of the services. Such costs and expenses shall include:

1. Payroll Costs - Costs and related expenses incurred by CONTRACTOR in accordance with its established personnel policies, including all salaries and wages of personnel engaged directly in the performance of the services and all social and retirement benefits and allowances for these personnel, all payroll taxes, workman's compensation, employer's liability insurance, and other contributions and benefits imposed by any applicable law or regulation, and all insurance premiums measured by payroll costs. In the event that CONTRACTOR's officers perform direct professional services (nonmanagerial), such services shall be charged at the rate of Professional Specialist. For the purpose of this subarticle, payroll cost shall be computed at 115% of the annual salary, divided by 1800 usual working hours per year, billed on an hourly rate basis for all hours expended on the project.

2. Other Direct Costs, including but not limited to:

a. The cost of all equipment, materials, and supplies used or consumed in the performance of the services or to be incorporated in the work, including the cost of transportation, freight, storage, and handling.

b. Costs of communications, data processing computer services, word processing, and computer-assisted drafting services, including costs for the use of computer programs, at CONTRACTOR's established rates.

c. All costs associated with preparation of models, reproduction of plans, and preparation of specifications and reports and all costs associated with record management, including costs for preparation of material for filming, equipment, and microreproduction.

d. Cost of all federal, state, and local taxes, assessments, levies, imposts, duties, excises, and licenses, excepting taxes levied solely on CONTRACTOR's real estate and net income.

e. All costs associated with outside consultants, subcontractors, and other outside services and facilities, including costs for field camps, offices, special transportation, and outside-agency personnel.

f. Costs incurred for travel, subsistence, relocation, and return of personnel engaged in the performance of the services.

g. The cost of any special insurance required by AUTHORITY.

h. Any other costs not described above which are proper charges to the project and are approved by AUTHORITY.

3. Indirect Costs - An amount equal to 90% of the costs described in paragraph 1 above to cover such indirect costs to CONTRACTOR as maintaining and operating established offices, which indirect costs are not charged to the services as direct costs and shall not duplicate such direct costs. In the case of payroll cost for temporary, locally hired, hourly field support personnel, an amount equal to 65% of the costs described in paragraph 1 above to cover indirect costs.

B. Fee - In addition to the Recoverable Costs set forth in Section A above, CONTRACTOR shall be paid by AUTHORITY a Fixed Fee in the amount of ________________ dollars.

C. Manner of Payment - On or as soon as practicable after the first day of each month, CONTRACTOR shall prepare and submit to AUTHORITY an invoice covering Recoverable Costs incurred during the previous month, and the Fee applicable to such costs. AUTHORITY shall pay to CONTRACTOR within fifteen days after receipt of the invoice the amount shown to be due.

D. Estimated Cost - CONTRACTOR's estimate for performance of the services, based on its best judgment as to the work required, is outlined in Appendix A. This estimate is for AUTHORITY's budget purposes only and is not guaranteed. Services beyond the total cost set forth in Appendix A shall not be undertaken by CONTRACTOR without prior authorization by AUTHORITY.

ARTICLE III ACCOUNTING OF COSTS

During the period of this Agreement, CONTRACTOR shall maintain books and accounts of its Recoverable Costs in accordance with generally accepted accounting principles and practices. AUTHORITY shall have access to these books and accounts during normal business hours to the extent required to verify all Recoverable Costs for a period of one year after completion of CONTRACTOR's services.

ARTICLE IV SUBCONTRACTOR APPROVAL

AUTHORITY reserves the right to review and approve any subcontractor proposed to perform services covered by this Agreement. Any subcontract agreement entered into by CONTRACTOR, or a subcontractor, shall incorporate the requirements of Articles III, IV, VI, IX, and X. CONTRACTOR shall be responsible to AUTHORITY for all work performed under this Agreement, including that performed by subcontractors.

ARTICLE V RESPONSIBILITY OF CONTRACTOR

CONTRACTOR shall perform its services as an independent contractor in accordance with its own methods, this Agreement, and applicable laws and regulations.

CONTRACTOR agrees to correct any deficiencies resulting from its negligent performance of its services which are discovered and reported to CONTRACTOR within one year from the date of completion of its services hereunder. CONTRACTOR shall be liable to AUTHORITY only for any loss or damage arising out of, or in connection with, CONTRACTOR's negligent performance of this Agreement. Such liability shall not exceed the Fee received by CONTRACTOR hereto, and AUTHORITY hereby agrees to hold CONTRACTOR harmless from any other liability. Under no circumstances shall CONTRACTOR, or its subcontractors and suppliers, be liable to AUTHORITY for any consequential damages, including loss of use or loss of profit.

ARTICLE VI OWNERSHIP OF DOCUMENTS

All documents, including original drawings, estimates, specifications, field notes, and data, shall be supplied to, and be the property of, AUTHORITY.

ARTICLE VII RESPONSIBILITY OF AUTHORITY

AUTHORITY will designate a representative to review and approve documents submitted by CONTRACTOR. The representative shall be empowered to render decisions and provide information in a timely manner that will not delay the orderly progress of the work. CONTRACTOR is entitled to rely upon the information, decisions, and approvals furnished by AUTHORITY's representative.

ARTICLE VIII DELAYS

Neither party hereto shall be considered in default in the performance of its obligations hereunder to the extent that the performance of any such obligation is prevented or delayed by any cause, existing or future, which is beyond the reasonable control of such party.

ARTICLE IX NONDISCRIMINATION AGREEMENT AND CERTIFICATE

The attached form entitled "Nondiscrimination Agreement and Certificate", set forth in Exhibit B, is hereby made a part of this Agreement. CONTRACTOR shall certify compliance by appropriate execution hereof and agrees to continue such compliance during the life of this Agreement.

ARTICLE X INSURANCE AGREEMENT AND CERTIFICATE

CONTRACTOR shall procure and maintain, during the entire term of this Agreement, the following types of insurance with limits as specified:

A. Workman's Compensation and Employer Liability coverage with statutory limits in accordance with the law of the state in which the work is being performed.

B. Automobile Bodily Injury and Property Damage Liability Insurance covering all automobiles used in connection with the work, with limits of not less than $1,000,000 each occurrence, combined single limit for Bodily Injury Liability and Property Damage Liability. Such insurance shall include an endorsement stating that such insurance applies to the liability assumed by CONTRACTOR under Article V, Responsiblity of Contractor.

C. Comprehensive General Liability Insurance, with limits of not less than $1,000,000 each occurrence, combined single limit for Bodily Injury Liability and Property Damage Liability. Such insurance shall include provisions or endorsements as follows: Blanket Contractual Liability, including the liability assumed by CONTRACTOR under Article V, Responsibility of Contractor.

D. Excess Liability Insurance in an amount not to exceed $5,000,000.

E. Any of CONTRACTOR's subcontractors of any tier shall be required by CONTRACTOR under the terms of any subcontract to obtain like insurance coverage to that specified and to provide a certificate evidencing such insurance.

F. Insurance coverage described in paragraphs A, B, C, and D above shall be carried with insurance companies satisfactory to AUTHORITY, and CONTRACTOR shall provide to AUTHORITY a Certificate of Insurance evidencing such insurance coverage prior to commencing any work under this Agreement.

ARTICLE XI TERMINATION AND ASSIGNMENT

AUTHORITY may terminate this Agreement at any time upon payment to CONTRACTOR of all of the Recoverable Costs incurred in the performance of its service, plus all costs incurred as a result of such termination, plus related Fee.

CONTRACTOR may terminate this Agreement in the event of nonpayment of costs and fees as specified herein.

This Agreement shall not be assigned by either party without prior written approval of the other, except that CONTRACTOR may utilize in the performance of this Agreement, without prior approval of AUTHORITY, personnel or services of its related entities and affiliated companies as if they were an integral part of CONTRACTOR.

IN WITNESS WHEREOF, the parties hereto have entered into this Agreement effective as of the day and year first hereinabove written.

	STATE OF ALASKA, ALASKA POWER AUTHORITY
ATTEST OR WITNESS	By ______________________
______________________	INTERNATIONAL ENGINEERING COMPANY, INC.
ATTEST OR WITNESS	By ______________________
______________________	Title ______________________

EXHIBIT A

TO

SERVICES AGREEMENT

SUSITNA HYDROELECTRIC PROJECT

(Note: This exhibit will set forth--either in full detail or by reference to an accepted Plan of Study--the entire scope of work required to complete the feasiblity study and prepare the Federal Energy Regulatory Commission license application. It will include the detailed cost estimate and the contract schedule. It will also provide for submittal of monthly progress reports.

EXHIBIT B

TO

SERVICES AGREEMENT

SUSITNA HYDROELECTRIC PROJECT

NONDISCRIMINATION AGREEMENT AND CERTIFICATE

THIS AGREEMENT AND CERTIFICATE shall form a part of the SUSITNA HYDROELECTRIC PROJECT SERVICES AGREEMENT and shall be attached to all subcontracts.

1. EQUAL OPPORTUNITY CLAUSE

CONTRACTOR agrees that the following provisions are hereby made a part of the Agreement mentioned above between it and AUTHORITY.

During the performance of this Agreement, CONTRACTOR agrees as follows:

(1) CONTRACTOR will not discriminate against any employee or applicant for employment because of race, religion, color, sex, or national origin. CONTRACTOR will take affirmative action to ensure that applicants are employed and that employees are treated during employment without regard to their race, religion, color, sex, or national origin. Such action shall include, but not be limited to, the following: employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. CONTRACTOR agrees to post in conspicuous places, available to employees and applicants for employment, notices setting forth the provision of this nondiscrimination clause.

(2) CONTRACTOR will, in all solicitations or advertisements for employees placed by or on behalf of CONTRACTOR, state that all qualified applicants will receive consideration for employment without regard to race, religion, color, sex, or national origin.

(3) CONTRACTOR, or any subcontractor, will send to each labor union or representative of workers with which it has a collective bargaining agreement or other contract or understanding, a notice, to be provided by the agency contracting officer, advising the labor union or workers' representative of CONTRACTOR's commitments under Section 202 of Executive Order Number 11246 of September 24, 1965, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

(4) CONTRACTOR will comply with all provisions of Executive Order Number 11246 of September 24, 1965, and the rules, regulations, and relevant orders of the Secretary of Labor.

(5) CONTRACTOR will furnish all information and reports required by Executive Order Number 11246 of September 24, 1965, and by the rules, regulations, and orders of the Secretary of Labor, or pursuant thereto, and will permit access to its books, records, and accounts by the contracting agency and the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations, and orders.

(6) In the event of CONTRACTOR's noncompliance with the nondiscrimination clauses of this contract or with any of such rules, regulations, or orders, this Agreement may be cancelled, terminated, or suspended in whole or in part, and CONTRACTOR may be declared ineligible for further contracts, in accordance with procedures authorized in Executive Order Number 11246 of September 24, 1965, and such other sanctions may be imposed and remedies invoked as provided in Executive Order Number 11246 of September 24, 1965, or by rules, regulations, or orders of the Secretary of Labor, or as otherwise provided by law.

(7) CONTRACTOR will include the provisions of paragraphs (1) through (7) in every subcontract or purchase order unless exempted by rules, regulations, or orders of the Secretary of Labor, issued pursuant to Section 204 of Executive Order Number 11246 of September 24, 1965, so that such provisions will be binding upon each subcontractor or vendor.

2. NONSEGREGATED FACILITIES CERTIFICATE

CONTRACTOR certifies that it does not maintain or provide for its employees any segregated facilities at any of its establishments, and that it does not permit its employees to perform their services at any location, under its control, where segregated facilities are maintained. CONTRACTOR certifies further that it will not maintain or provide for its employees any segregated facilities at any of its establishments, and that it will not permit its employees to perform their services at any location, under its control, where segregated facilities are maintained. CONTRACTOR agrees that a breach of this certificate is a violation of the Equal Opportunity clause in this Agreement. As used in this certificate, the term "segregated facilities" means any waiting rooms, work areas, rest rooms and wash rooms, restaurants and other eating areas, time clocks, locker rooms and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation, and housing facilities provided for employees which are segregated by explicit directive or are in fact segregated on the basis of race, creed, color, or national origin, because of habit, local custom, or otherwise. CONTRACTOR further agrees that (except where it has obtained identical certifications from proposed subcontractors for specific time periods) it will obtain identical certifications from proposed subcontractors prior to the award of subcontracts exceeding $10,000 which are not exempt from the provisions of the Equal Opportunity clause; that it will retain such certifications in its files; and that it will forward the following notice to such proposed subcontractors (except where the proposed subcontractors have submitted identical certifications for specific time periods): "NOTICE TO PROSPEC-

TIVE SUBCONTRACTORS OF REQUIREMENT FOR CERTIFICATE OF NONSEGREGATED FACILITIES"

"A Certificate of Nonsegregated Facilities", as required by the May 9, 1967, order on Elimination of Segregated Facilities, by the Secretary of Labor (32 Fed Reg 7439, May 19, 1967), must be submitted prior to the award of a subcontract exceeding $10,000 which is not exempt from the provisions of the Equal Opportunity clause. The certification may be submitted either for each subcontract or for all subcontracts during a period (i.e., quarterly, semiannually, or annually)."

3. WRITTEN AFFIRMATIVE ACTION COMPLIANCE PROGRAM

If CONTRACTOR, or a subcontractor, has 50 or more employees and the contracts are in an amount of $50,000 or more, CONTRACTOR or a subcontractor may be required under Section 60-1.40 of Title 41 of the Code of Federal Regulations to develop a written Affirmative Action Compliance Program for each of its establishments. If CONTRACTOR or a subcontractor is so required, it agrees to do so no later than 120 days after the effectiveness of the first of the contracts of sale and maintain such program until such time as it is no longer required by law or regulation.

4. EMPLOYMENT OF HANDICAPPED (Applies to all contract amounts over $25,000)

CONTRACTOR hereby pledges to take affirmative action to employ eligible handicapped individuals, in accordance with Public Law 93-112, Section 503 (the Rehabilitation Act of 1973), together with applicable orders promulgated thereunder.

By ______________________________

Date ______________________________

Supplemental Information

Supplemental Information

Qualifications of the associated consultants and supporting contractors, which were not previously submitted with IECO's qualification document, dated June 1979, are presented in an Appendix, furnished to the Alaska Power Authority as a separate volume. Detailed experience resumes of IECO personnel and special consultants are also included in the Appendix. The complete contents of the Appendix is given below:

EDAW, Inc. Qualifications
Dames & Moore Qualifications
Hydrocomp, Inc. Qualifications
CIRI/H&N Qualifications
University of Alaska Qualifications

- University of Alaska Geophysical Institute
- University of Alaska Institute for Social and Economic Research
- University of Alaska Museum

Shannan & Wilson Qualifications
Biodata - IECO Personnel
Biodata - Special Consultants