The Alaska Power Authority

SUSITNA HYDROELECTRIC PROJECT

A Detailed Plan of Study Task Descriptions

ARLIS

Alaska Resources Library & Information Services Anchorage; Alaska

September 1979



INTERNATIONAL ENGINEERING COMPANY, INC. A MORRISON-KNUDSEN COMPANY



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INTERNATIONAL ENGINEERING COMPANY, INC.

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Task Descriptions

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no. 4005

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Project Management

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SUSITNA HYDROELECTRIC PROJECT

PLAN OF STUDY

CATEGORY: A	PR	OJECT MAN	AGEMENT
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ASSIGNMENT: A-1 PROJECT MANAGER AND DEPUTY MANAGER

TASK TITLE: A-1-1 Management, Administration and Technical Supervision

1	LEVEL.	ÓF	EFFORT:	370	Man-days
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SCHEDULE:	30 Months - Over the Period of Plan of Study		
ESTIMATED COST:	\$175,000		-
RESPONSIBILITY:	E. B. Kollgaard (IECO)	· ·	
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PURPOSE:

To manage and administer both technical and non-technical activities associated with the project.

SCOPE:

Management and administration activities shall include the following:

- Provide project finance and staffing administration.
- Prepare project implementation schedules and procedures.
- Ensure project group organization and coordination.
- Maintain Client coordination, i.e., correspondence, consultations and meetings.
- Maintain outside agency coordination, i.e., correspondence, consultations and meetings.
- Prepare progress reports.
- Organize technical and quality control reviews.
- Resolve contractual and budgetary interfacing problems.
- Review and approve all work produced by the project group.
- Maintain project files.

CATEGORY:	A	PROJECT MANAGEMENT
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ASSIGNMENT: A-1 PROJECT MANAGER AND DEPUTY MANAGER

TASK TITLE: A-1-2 Coordination with <u>Client</u>

LEVEL OF EFFORT:	75	Man-days
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SCHEDULE:	30 Months - Over Period of Plan of Study
ESTIMATED COST:	\$50,000

RESPONSIBILITY: R. W. Retherford (IECO)

PURPOSE:

To continue communication with Alaska Power Authority that will be essential during the study to assure that the APA is kept informed of the progress of the work and also that IECO will be kept aware of actions affecting the scheduling or scope of the study.

SCOPE:

IECO is in a unique position for close coordination wih APA because of the location of the Arctic District office in Anchorage. IECO's District Manager and Vice President, R. W. Retherford, has been assigned as Deputy Project Manager. Mr. Retherford will meet with APA on a regularly scheduled basis, but will also be available at any time to discuss project matters.

ASSIGNMENT: A-2 PROJECT EXECUTIVE

TASK TITLE: A-2-1 Contractural Matters and Project Performance

LEVEL OF EFFORT:

SCHEDULE: <u>30 Months - Over the Period of Plan of Study</u>

ESTIMATED COST: (Cost Included in Overhead)

RESPONSIBILITY: R. B. Christensen (IECO)

PURPOSE:

To ensure compliance in implementation.

SCOPE:

The Project Executive exercise the following duties:

- Monitor overall implementation of the project to ensure both contract compliance and project performance within budgetary constraints.
- Resolve interfacing conflicts which cannot be solved by Project Manager.
- Appraise Client satisfaction in performance of project.
- Monitor cash flow activities, i.e. proper invoicing, contract price modifications, et. al.
- Liaison between Project Group and IECO management.

CATEGORY	Α	PROJECT MANAGEMENT	
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ASSIGNMENT: A-3 PUBLIC PARTICIPATION

TASK TITLE: A-3-1 Public Information and Participation Program

LEVEL OF EFFORT:	55 Man-days
SCHEDULE:	30 Months - Over the Period of Plan of Study
ESTIMATED COST:	\$35,000
RESPONSIBILITY:	R. W. Retherford (IECO)

PURPOSE:

To ensure an open planning process wherein all decisions have had the benefit of informed citizen input, an active aggressive public information and participation program is essential. The goal is to achieve a proposed plan of action satisfying public needs and sensitive to public values.

SCOPE:

The proposed program will encompass both public information and public participation.

From contract award to completion, the media will be extensively used to apprise the public of progress in the study. Newspaper articles and radio and television programs will present background material on energy needs, alternatives to the Susitna hydroelectric project, a description of the project itself and its impacts, and other subjects as deemed desirable. To supplement media coverage, a quarterly newsletter will be published and distributed to interested parties. All final reports and technical memoranda written during the course of study will be made available at appropriate centers in the Railbelt. An IECO staff person in Anchorage will answer public inquiries and disseminate information.

Public participation in planning is essential to give human and environmental values appropriate weight in balancing the engineering and purely economic aspects of resource development. Our program will provide an opportunity for the public to work with APA and IECO in identifying issues and objectives, in evaluating alternatives and impacts, and in determining mitigation measures. Citizen participants will be actively sought through personal contact and through the media.

Initial meetings in Fairbanks, Anchorage, and Susitna Valley will be held to introduce IECO and its Plan of Study. Citizen concerns will be heard, and workshops will be established to focus on these concerns. Additional meetings and workshops will be keyed to Phase I activities. At these forums, economic, social, environmental and political aspects of technical information will be analyzed. IECO staff members and consultants will be assigned to public events to ensure reliability of communications. Public agency representatives will also be present to complete the communications network. Where information must be gathered from the public for input to environmental or other studies, such inquiries will be incorporated in the public participation program in order to maximize efficiency and minimize costs.

Meetings will be well publicized, and pertinent material will be made available well in advance to ensure adequate preparation on the part of the public. During the exploration program, informal meetings will be held with residents of Susitna Valley.

Acting as the focal point for citizen input will be the Citizen's Advisory Panel. Its membership will represent a broad spectrum of Alaskan interests--including government, business, industry, labor, Alaska Native, environmental, recreational, and mining. The Panel will continue its active role during the definitive project study stage.

In cooperation with APA and Alaskan consultants, IECO will develop and schedule specific activities in the program. As the studies progress, the program will be continuously evaluated to determine its efficacy; modifications will be made as needed to ensure a sustained, thoughtful community debate.



SUSITNA HYDROELECTRIC PROJECT PLAN OF STUDY SHEET 1 of 2 CATEGORY: A PROJECT MANAGEMENT ASSIGNMENT: A-3 PUBLIC PARTICIPATION TASK TITLE: A-3-2 Public Agency Coordination

LEVEL OF EFFORT:_	30 Man-days
SCHEDULE:	30 months - During Period of Plan of Study
ESTIMATED COST:	\$15,000
RESPONSIBILITY:	R. W. Retherford (IECO)

PURPOSE:

To insure that all reasonable concerns are identified and addressed during the project planning process and that the APA and IECO team are being responsive to the agency concerns raised. A program will be established to provide the mechanism whereby appropriate local, State and Federal agencies can participate in the review of Phase I investigations.

SCOPE:

The program will be established in the following manner:

- Formulate Goals and Objectives of Agency Coordination Program. This is a critical first step. The IECO team will meet with APA staff early in the project and define specific goals and objectives of the coordination program.
- <u>Identify Agencies</u>: APA and IECO will jointly identify and characterize all local, State and Federal agencies to be involved in the program.
- <u>Identification of Agency Concerns and Issues</u>: The coordination program will include sessions with each of the agencies identified in the above step to determine the concerns and issues the agency may have relative to the Susitna project.
- Evaluate Alternative Coordination Techniques: The IECO team will identify and evaluate the various coordination techniques that could be used with the various government agencies. It may be that different methods should be used for the different agencies depending upon their involvement. After the various alternatives have been identified, the individual agencies will be contacted to discuss possible preference.
- Design Coordination Program: A flow chart will be prepared matching the project Plan of Study and schedule indicating key activities in the agency coordination program, their relationship to project decision points, and the steps to be taken to facilitate the coordination process.

Communication and coordination with the various agencies wil be a continuing process over the period of Phase I studies. It is expected that agency representatives will be appointed who will be the agency's contact with the study team and who will contribute their expertise at all public meetings, and will provide material for the public information program. At the same time IECO and APA will maintain contact with the agencies, following the agreed upon coordination technique, and will keep them supplied with current information relative to their area of concern. Periodic discussion sessions will be held as required to discuss the progress and direction the Phase I studies are experiencing and to receive the agencies' input and viewpoints.

PLAN OF ST	TUDY			SHEET 1 of 1
CATEGORY:	Α	PROJECT MANAGEMENT	,	·
ASSIGNMENT:	A-3	PUBLIC PARTICIPATION		
TASK TITLE:	A-3-3	Staff Support		
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LEVEL OF EF	FORT:_	260 Man-days	· · · · · · · · · · · · · · · · · · ·	
SCHEDULE:		30 Months - Over the Period of Plan of S	Study	

ESTIMATED COST: \$85,000 RESPONSIBILITY: R. Burg (IECO)

PURPOSE:

To execute the Tasks set forth under A-3, an IECO staff member assigned on a full time basis in the IECO Anchorage office will direct and coordinate A-3 Tasks. The individual assigned is Mr. Richard Burg, a resident of Anchorage with suitable experience and capabilities for this assignment.

SCOPE:

Mr. Burg will be responsible for:

- Coordination of the Public Information/Participation Programs.
- Colaboration with APA and IECO staff members in the preparation and dissemination of public information via the news media and APA newsletter.
- Scheduling and publicizing meetings and workshops, and arranging necessary accommodations.
- Coordinating and expediting the interchange of information between APA, the consultants and the various agencies.
- Obtaining answers and preparing replies to inquiries about the project plan and its progress.

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	CATEGORY:	Α	PROJECT MANAGEMENT			

ASSIGNMENT: A-3 PUBLIC PARTICIPATION

TASK TITLE: A-3-4 Environmental Input to Public Participation

LEVEL OF EFFORT:_	152 Man-days
SCHEDULE:	30 months - During Period of Plan of Study
ESTIMATED COST	\$81,000
RESPONSIBILITY:	D. H. Blau (EDAW)

PURPOSE:

The public participation in environmental concerns will be accomplished through Tasks A-3-1 and A-3-2. Environmental input for these two Tasks will be furnished primarily by the EDAW member of the IECO team. Additional input will stem from agencies involved in environmental matters, as well as concerned groups and individuals.

Portions of the public meetings and workshops will be devoted to evaluating the sum total of the data and arriving at conclusions that will be of assistance in the final environ-mental assessments.

CATEGORY:	А	PROJECT MANAGEMENT

ASSIGNMENT: A-4 IECO TECHNICAL REVIEW BOARD

TASK TITLE: A-4-1 Technical Review and Quality Assurance

LEVEL OF EFFORT: <u>16 Man-days</u>

SCHEDULE: Periodic

ESTIMATED COST: \$10,000

RESPONSIBILITY: E. B. Kollgaard (IECO)

PURPOSE:

To monitor the technical development of the project, and ensure that lessons learned on all of IECO's projects are applied to Susitna.

SCOPE:

The Technical Review Board is the project's principal mechanism for Quality Assurance. Consisting of high-level IECO technical executives, the board will be involved in each major step of project development, serving the two-fold purpose of monitoring the performance of the project team and advising the Project Manager in major decisions.

The board will be established at the outset of the project, its meetings 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 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 shall be especially thorough in examination of the manner in which the project team has reached its decisions, insisting on thorough studies of alternatives and well-documented conclusions.

The board members, as veteran engineers who have been responsible for many other projects over many years, are charged with bringing the entire company experience to the assistance of the Project Manager.

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Anchorage Support

B-1		PRINCIPAL-IN-CHARGE, ANCHORAGE SUPPORT
	B-1-1	Coordination of Support Operations
B-2		OFFICE SUPPORT
	B-2-1	Furnishing Support Services
B-3		FIELD CAMPS AND LOGISTICS
	B-3-1	IECO Coordination
	B-3-2	Plan and Establish Field Camps
	B-3-3	Furnish Field Personnel Housing and Subsistence
	B-3-4	Provide Field Logistic Support
B-4		PERMITS
	B-4-1	IECO Coordination
	B-4-2	Prepare and Process Permit Applications
B-5		SURVEY AND MAPPING
	B-5-1	IECO Coordination and Review
	B-5-2	Furnish Reservoir Mapping
	B-5-3	Furnish Access Road Preliminary Mapping
	B-5-4	Furnish Transmission Line Corridor Photo Mosaic
	B-5-5	Furnish Damsite Mapping
	B-5-6	Furnish River Cross Sections
	B-5-7	Furnish Access Road Detail Mapping
	B-5-8	Furnish Survey Support for Field Investigations
B-6		REAL ESTATE
	B-6-1	IECO Coordination
	B-6-2	Land Ownership Status
	B-6-3	Boundary Description
	B-6-4	Land Acquisition Costs

CATEGORY:	В	ANCHORAGE SUPPORT
ASSIGNMENT	B-1	PRINCIPAL-IN-CHARGE, ANCHORAGE SUPPORT
TASK TITLE:	B-1-1	Coordination of Support Operations

LEVEL OF EFFORT	30 Man-days
SCHEDULE:	Duration of Project
ESTIMATED COST:	\$22,000
RESPONSIBILITY:	R. S. Samuelson, Anchorage

PURPOSE:

To provide a single focal point for coordination of all Alaska support services to ensure that the activities are scheduled properly and executed in a timely manner so that the study can proceed on schedule.

SCOPE:

Mr. Samuelson will be responsible for overall coordination of support operations, including the following:

• Office Support

• Field Camps and Logistics

- Permit Applications
- Real Estate
- Surveys and Mapping
- Other Field Activities (University of Alaska personnel, USGS, etc.)

CATEGORY:	В	ANCHORAGE SUPPORT
ASSIGNMENT	B-2	OFFICE SUPPORT
TASK TITLE:	B-2-1	Furnishing Support Services
LEVEL OF EFI	FORT:	/5 Man-days
SCHEDULE:	FORI:	75 Man-days Duration of Project
SCHEDULE:	OST:	75 Man-days Duration of Project \$75,000

PURPOSE:

To furnish facilities and personnel of IECO's Anchorage office to expedite implementation of the project.

SCOPE:

Some of the support that will be available to the project team members in IECO's Arctic District office at Anchorage includes the following:

- Offices, furnishings, and supplies
- Support by technical personnel (engineers, draftspersons, technicians)
- Clerical assistance, including use of the IBM OS-6 word processor
- Use of a computer terminal that will communicate with the IECO San Francisco computer and others. Other desk computers will also be available.
- Use of telex, telephone, and telecopier equipment.

CATEGORY:	В	ANCHORAGE SUPPORT
ASSIGNMENT	B-3	FIELD CAMPS AND LOGISTICS
TASK TITLE:	B-3-1	IECO Coordination
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LEVEL OF EFF	ORT:_	30 Man-days
SCHEDULE:		Duration of Project
ESTIMATED CO	DST:	\$16,000

RESPONSIBILITY: IECO

PURPOSE:

To coordinate the activities of subcontractors supplying field camps and logistics support to ensure that the services are scheduled to meet the requirements of project work and that they are provided as scheduled.

SCOPE:

IECO Anchorage personnel will monitor the subcontractors' work and provide assistance where required.

SUSITNA HYDROELECTRIC PROJECT PLAN OF STUDY SHEET 1 of 2			
CATEGORY: B	ANCHORAGE SUPPORT		
ASSIGNMENT: B-3	FIELD CAMPS AND LOGISTICS	· · · · · · · · · · · · · · · · · · ·	
TASK TITLE: B-3-2	Plan and Establish Field Camps		
LEVEL OF EFFORT:_			
SCHEDULE:	January 1980 to April 1980		
ESTIMATED COST:	\$3,621,000	· · · · · · · · · · · · · · · · · · ·	
RESPONSIBILITY:	CIRI/H&N (Subcontract)		

PURPOSE:

To plan and establish field camps that will house personnel involved in the study (as well as support personnel and visitors) and serve as bases for logistic operations.

SCOPE:

A permanent base camp will be constructed near the Watana damsite in the Fog Lakes area. This 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 which can furnish an adequate supply of water for the camp as well as a landing area for amphibian planes in the summer and aircraft equipped with wheels or skis in the winter. The camp is also in an ideal location for expansion to a construction camp during the construction of the Watana Dam.

All the design work and the procurement of modular units and attendant life support system (power plants, water plant, sewage treatment plant and communications system) will be done immediately after contract award. The Watana camp will be sized to accommodate a maximum of 60 people in modular living units.

The modular units and equipment for the Watana camp will be transported overland from Denali Highway to the Fog Lakes area. Construction of the Watana camp will begin in January 1980, and the 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. It will be operated through the remainder of 1980 and 1981, operating at a reduced scale or shut down in the winter months.

The Watana camp will be constructed from 10' x 24' modular units and will have complete water and sewage treatment systems. It will have warehouse, shop, recreational, office, food service, laundry, and fuel storage facilities. It will also have sheltered electrical generators and an incinerator. The dormitory, food service, and recreation buildings will be interconnected with Arctic walkways.

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In addition to the Watana camp, personnel may be housed at the Tsusena Lake Lodge near the Watana damsite, at the High Lake Camp near the Devil Canyon damsite, and in the town of Talkeetna. The impact on Talkeetna will be minimal because the personnel housed there will be a small number engaged in reconnaissance studies of the Anchorage-Fairbanks transmission line or in environmental studies in the lower Susitna region. A few individuals may be housed in Talkeetna while working on field investigations for the study during the winter months if the Watana camp is shut down.

CATEGORY:	В	ANCHORAGE SUPPORT	
ASSIGNMENT	B-3	FIELD CAMPS AND LOGISTICS	
TASK TITLE:	B-3-3	Furnish Field Personnel Housing and Subsistence	

LEVEL OF EFFORT:	_
SCHEDULE:	January 1980 to December 1981
ESTIMATED COST:	\$1,916,000
RESPONSIBILITY:	CIRI/H&N (Subcontract), IECO

PURPOSE:

The furnish housing and subsistence for study personnel while in the field camp.

SCOPE:

Study personnel while engaged in work in the Upper Susitna basin will be housed at the field camp to be established at Watana. Subsistence while at the Watana camp will be provided by CIRI/H&N by subcontract. When personnel are assumed to stay in Talkeetna, the cost of housing and subsistence is included under expenses for the particular Task that they are conducting.

CATEGORY:	В	ANCHORAGE SUPPORT	
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ASSIGNMENT: B-3 FIELD CAMPS AND LOGISTICS

TASK TITLE: B-3-4 Provide Field Logistic Support

LEVEL OF EFFORT: _____

SCHEDULE:	January 1980 to December 1981
ESTIMATED COST:	\$1,849,000
RESPONSIBILITY:	CIRI/H&N (Subcontract)

PURPOSE:

To provide field logistic support for the movement of supplies, equipment, personnel, and materiel needed to support the project activities.

SCOPE:

The camp units and all equipment will be transported overland to the field site by Cattrain in January 1980. This logistic item is included in the cost of establishing the camp. 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. The Twin Otter-type aircraft will be used to transport personnel and/ or camp resupply items. A 3,000' airstrip will be constructed to accommodate the Twin Otter-type aircraft during summer operations.

Helicopters will be provided to move field crews between the base camp and work sites. A heavy-lift helicopter will be provided to move drill rigs. Other modes of personnel transportation will include snow machines and boats.

Detailed transportation schedules will be developed prior to the start of field operations to ensure the maximum utilization of the transportation vehicles and to ensure maximum cost effectiveness.

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CATEGORY:	В	ANCHORAGE SUPPORT
ASSIGNMENT:	B-4	PERMITS
TASK TITLE:	B-4-1	IECO Coordination

LEVEL OF EFFORT:	6 Man-days
SCHEDULE:	January to March 1980
ESTIMATED COST:	\$2,000
RESPONSIBILITY:	IECO

PURPOSE:

To coordinate and expedite preparation and processing of permit applications by subcontractors.

SCOPE:

IECO Anchorage personnel will monitor the subcontractors' work and provide assistance as required.

INTERNATIONAL ENGINEERING COMPANY, INC.

SUSITNA HYDROELECTRIC PROJECT PLAN OF STUDY SHEET 1 of 2				
CATEGORY: B	ANCHORAGE SUPPORT			
ASSIGNMENT: B-4	PERMITS			
TASK TITLE: B-4-2	Prepare and Process Permit Applications			
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LEVEL OF EFFORT:		· · · · · · · · · · · · · · · · · · ·		
SCHEDULE:	January to March 1980			
ESTIMATED COST:	\$14,000			

RESPONSIBILITY: CIRI/H&N (Subcontract)

PURPOSE:

To ensure that 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 study teams.

SCOPE:

Permits required for entry and use of public or Native lands will be obtained in accordance with applicable stipulations. A Bureau of Land Management (BLM) temporary use permit (AK-017-9025) designating the Alaska Power Authority as permittee is presently being processed and will be the basis for study activities on BLM lands. Stipulations for the temporary use permit will be observed where BLM land is concerned. It is anticipated at this time that most of the land in the dam and reservoir area will be conveyed to the Cook Inlet Region, Inc., and associated villages before the study work commences. Even though most of the land is owned by Natives, it will be necessary to cross BLM lands for access to the Watana camp from the Denali Highway. Also, if some equipment is transported to the Devil Canyon damsite via the trail from the Alaska Railroad at Gold Creek, BLM land will be traversed. The requirements of Paragraph 3.2 of the Stipulations accompanying Temporary Use Permit AK-017-9025 will be followed for all land transportation across BLM lands. Stipulations for activities on BLM land will also be observed during reconnaissance studies of the access road and transmission line between the Parks Highway and Devil Canyon.

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

Permits from the State of Alaska for activities on State land 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 land owners in the dam and reservoir area. Private land will, however, be entered during reconnaissance of the transmission line route. The private lands to be entered will be determined and the appropriate land owners identified so that rights-of-entry can be obtained for study work.

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CATEGORY:	B	ANCHORAGE SUPPORT	

ASSIGNMENT: B-5 SURVEYING AND MAPPING

TASK TITLE: B-5-1 IECO Coordination and Review

LEVEL OF EFFORT: 50 Man-days

SCHEDULE:Intermittent, April 1980 to January 1982ESTIMATED COST:\$25,000RESPONSIBILITY:P. Clauzon (IECO)

PURPOSE:

To ensure that the project's technical requirements and schedules are met.

SCOPE:

IECO personnel will monitor the survey contractor's performance throughout the project and coordinate the various tasks with the survey contractor.

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CATEGORY:	В	ANCHORAGE_SUPPORT
ASSIGNMENT:	B-5	SURVEYING AND MAPPING
TASK TITLE:	B-5-2	Furnish Reservoir Mapping
LEVEL OF EFF	ORT:	-
SCHEDULE:		April 1981 to January 1982

ESTIMATED COST: \$128,000

RESPONSIBILITY: CIRI/H&N (Subcontract)

PURPOSE:

To permit capacity curves to be prepared.

SCOPE:

Photogrammetric mapping of the two reservoirs (Watana and Devil Canyon) at final scale of 1'' = 1000' with contour intervals of 20' (10' supplementals in flatter areas).

This task consists of the following phases:

- Photographic mission To take place in the early part of the summer as soon as the snow has melted down and before vegetation springs out. Negative scale should be 1" = 3333' with a 6" camera.
- Field control survey To be performed between April and October. Extensive photogrammetric bridging will be planned to limit the expensive and time-consuming field surveys.
- Aerotriangulation and photogrammetric restitution of the reservoir areas.

CATEGORY:	В	ANCHORAGE_SUPPORT
ASSIGNMENT:	B-5	SURVEYING AND MAPPING
TASK TITLE:	B-5-3	Furnish Access Road Preliminary Mapping
LEVEL OF EFF	ORT:	
SCHEDULE:		April 1980 to January 1981
ESTIMATED CC)ST·	\$48,000

RESPONSIBILITY: CIRI/H&N (Subcontract)

PURPOSE:

To obtain maps on which the preliminary alignment for the access road will be delineated.

SCOPE:

The existing 100' contour-interval USGS maps are not suitable for preliminary design of the access road. We plan to obtain maps at a scale of 1" - 1000' with 20' contour intervals on which the preliminary alignment for the access road will be delineated. We suggest use of the same technical requirement as for the reservoir map. In doing so, it will suffice to enlarge the restitution area south of the Devil Canyon Reservoir to cover the access route between Watana and Devil Canyon, and to extend the photographic flight westward of Devil Canyon to the gauging station at the railroad bridge and northward to the junction with Highway 3, linking Anchorage to Fairbanks.

We anticipate that an additional fifteen stereoscopic models with negative scale of 1'' = 3333' will cover the areas of interest.

Here again, this task will consist of three phases:

- Aerial Photography,
- Field control work, and
- Photogrammetric restitution.

Tasks B-5-2 and B-5-3 (reservoir mapping and access road mapping, respectively) will be combined into a single unit. Limitation of the actual areas of photogrammetric restitution will be defined as the work progresses.

If an access road toward Denali Highway #8 northwest of Watana is planned, the same methodology will apply.

CATEGORY	R	ANCHORAGE SUPPORT
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ASSIGNMENT: B-5 SURVEYING AND MAPPING

TASK TITLE: B-5-4 Furnish Transmission Line Corridor Photo Mosaic

LEVEL OF EFFORT:	-	
SCHEDULE:	April to November 1980	

ESTIMATED COST: \$16,000

RESPONSIBILITY: CIRI/H&N (Subcontract)

PURPOSE:

To facilitate selection of the transmission line alignment.

SCOPE:

General outlines of the transmission line corridors can be drafted on the existing USGS quadrangle maps, but to better define the alignments we propose to fly these corridors at a negative scale of 1" = 3333', which will give a ground coverage of some 30,000 feet, for the selection of the line route and its alternates. These photographs will also be used for geological mapping.

No further field work is anticipated during this season on this item, but a semicontrolled photo mosaic will be constructed based on blown up USGS quadrangle maps. This photo mosaic will cover the line between Anchorage and Fairbanks. Along the spur line from Watana to Devil Canyon to the junction with Highway #3, we assume that the transmission line corridor will be close to the access road previously mapped (Task B-5-3 above). Slight enlargement of the area of photogrammetric restitution for the access road will effectively and economically cover the transmission line alignment up to the main corridor between Anchorage and Fairbanks.

Special coordination to carefully define the areas of photogrammetric restitution for the reservoirs, the access road, and the transmission line will lead to substantial savings in the mapping program.



CATEGORY:	В	ANCHORAGE_SUPPORT

ASSIGNMENT: B-5 SURVEYING AND MAPPING

TASK TITLE: B-5-5 Furnish Damsite Mapping

LEVEL OF EFFORT:_	-
SCHEDULE:	April 1980 to January 1981
ESTIMATED COST:	\$28,000
RESPONSIBILITY:	CIRI/H&N (Subcontract)

PURPOSE:

To obtain a detail map for final design of Watana dam.

SCOPE:

A detail map of the Watana damsite is necessary for design purposes.

This map will be at a scale of 1'' = 200' with 10' contour intervals (with 5' supplemental intervals in the flat areas).

We suggest that this photogrammetric mapping be done with a negative scale of 1" = 1250'. Some six stereoscopic models should cover the entire area. Field editing may be necessary in the zones of dense vegetation along the river banks.

This task will consist of four phases:

- Aerial photography,
- Field control work,
- Photogrammetric restitution, and
- Field editing (if necessary).

Devil Canyon damsite has been mapped by the Corps of Engineers at 1" = 100' with 10' contour intervals.

	CATEGORY:	В	ANCHORAGE SUPPORT	
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ASSIGNMENT: B-5 SURVEYING AND MAPPING

TASK TITLE: B-5-6 Furnish <u>River Cross Sections</u>

LEVEL OF EFFORT: _____

SCHEDULE: April 1980 to January 1981

ESTIMATED COST: \$179,000

RESPONSIBILITY: CIRI/H&N (Subcontract)

PURPOSE:

To facilitate river channel studies.

SCOPE:

River cross sections will be surveyed at:

• One-quarter-mile intervals for the first 3 miles below Watana site (12 sections).

- One-quarter-mile intervals for the first 5 miles below Devil Canyon site (20 sections).
- One-mile intervals from there on downstream to the highway bridge above Talkeetna (35 sections).
- Upstream of Watana, between Vee and Denali damsites (20 sections).

At the damsites the sections will be taken from the safety of winter ice cover; elsewhere an electronic fathometer will be used during the summer months.

ASSIGNMENT: B-5 SURVEYING AND MAPPING

TASK TITLE: B-5-7 Furnish Access Road Detail Mapping

LEVEL OF EFFORT:_	-
SCHEDULE:	April 1981 to January 1982
ESTIMATED COST:	\$246,000
RESPONSIBILITY:	CIRI/H&N (Subcontract)

PURPOSE:

To obtain large scale maps for use in design of the access road.

SCOPE:

A preliminary alignment for the road will have been delineated on the 1'' = 1000' map (see Task B-5-3 above). Larger scale maps will be necessary for design of the access road. These new maps, at a scale of 1'' = 200' with 5' contour intervals will be prepared during the second year.

Here again, we suggest that this mapping be restituted from photographs at a negative scale of 1" = 1250'.

The flight map for this photographic mission will be designed onto the $1^{"}$ = 1000' base.

New photo control points (horizontal and vertical) will be necessary to support these new flight lines. They will be tied to the monuments surveyed the previous year.

This task will consist of the following phases:

- Photographic mission,
- Field control surveys, and
- Photogrammetric restitution.

As mentioned in Task B-5-4 above, the transmission line will most certainly be close to the access road; therefore, the area of photogrammetric restitution will include the probable transmission line alignment along this spur line.

CATEGORY:	В	ANCHORAGE	SUPPORT

ASSIGNMENT: B-5 SURVEYING AND MAPPING

TASK TITLE: B-5-8 Furnish Survey Support for Field Investigations

LEVEL OF EFFORT: _____

SCHEDULE: May to October 1980, May to October 1981

ESTIMATED COST: \$95,000

RESPONSIBILITY: CIRI/H&N (Subcontract)

PURPOSE:

To provide support for geotechnical studies.

SCOPE:

This task comprises staking out in the terrain the various field investigations needed by the Geotechnical Group.

CATEGORY:	В	ANCHORAGE SUPPORT
ASSIGNMENT:	B-6	REAL ESTATE
TASK TITLE:	<u>B-6-1</u>	IECO Coordination
LEVEL OF EFF	ORT:	6 Man-days

SCHEDULE:	January to November 1980, November 1981 to February 1982
ESTIMATED COST:	\$2,000
RESPONSIBILITY:	IECO

PURPOSE:

To coordinate the activities of the subcontractor involved in land ownership status, boundary description, and land acquisition cost determination activities, to ensure that the work proceeds as expeditiously as possible.

SCOPE:

IECO Anchorage personnel will monitor the subcontractor's work and provide assistance where required.

SUSITNA HYDROELECTRIC PROJECT PLAN OF STUDY			SHEET 1 of 1
	R		
ASSIGNMENT:	B-6	REAL ESTATE	
TASK TITLE:	B-6-2	Land Ownership Status	
	_		
LEVEL OF EFF	ORT:		
SCHEDULE:		January to June 1980	
ESTIMATED CO	DST:	\$55,000	

PURPOSE:

RESPONSIBILITY:

To identify ownership and other interests in the project area, as well as adjoining areas and associated transmission corridors, to provide information needed for power project planning and land acquisition analysis, and to facilitate obtaining rights-of-entry to conduct field studies.

SCOPE:

Onwership information will be gathered from the tax assessor and land recorder, the BLM, the State Division of Lands, and Native Corporations. Lands will be categorized by general ownership category (private land, State land, U.S. 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.

CIRI has already collected a substantial portion of the information required.

CIRI/H&N (Subcontract)

SUSITNA HYDROELECTRIC PROJECT PLAN OF STUDY			SHEET _ 1 of 1
CATEGORY:	В	ANCHORAGE SUPPORT	
ASSIGNMENT:	B-6	REAL ESTATE	
TASK TITLE:	B-6-3	Boundary Description	
LEVEL OF EFI	FORT:	_	

ESTIMATED COST: \$20,000

SCHEDULE:

RESPONSIBILITY: CIRI/H&N (Subcontract)

April to June 1980

PURPOSE:

To provide precise descriptions and maps of lands that will be affected by construction of the project, either in the reservoir areas or along the routes of access roads and transmission lines. The property descriptions and maps will be used in subsequent negotiations for purchase of land and as the basis for exhibits in the Federal Energy Regulatory Commission (FERC) License Applications.

SCOPE:

The maps will cover the land that will be affected by the dams, reservoirs, and appurtenant facilities, as well as the transmission line and access road cooridors.
CATEGORY:	<u></u> B	ANCHORAGE SUPPORT
ASSIGNMENT:	B <u>-6</u>	REAL ESTATE
TASK TITLE:	B-6-4	Land Acquisition Costs
LEVEL OF EFF	ORT:	_
SCHEDULE:		July to November 1980, November 1981 to February 1982
ESTIMATED CC	ST:	\$35,000

RESPONSIBILITY: CIRI/H&N (Subcontract)

PURPOSE:

To estimate the costs of required land and right-of-way acquisition, as part of the estimate of the cost of the project.

SCOPE:

Each private land owner will be identified and the amount and market value of land to be acquired by either easement or purchase will be estimated. The amount of public land required will be broken down by agency land holder, and an estimate of the cost of rightof-way permits will be made. Evidence of title will be secured as needed. All third party rights will be identified and evaluated in terms of impact on acquisition costs.

CIRI has already collected a substantial portion of the information required.

Environmental Studies

C-1		PRINCIPAL-IN-CHARGE - ENVIRONMENTAL
	C-1-1	Management and Technical Supervision
	C-1-2	Project Orientation
C-2		COORDINATION WITH ENGINEERING STUDIES
	C-2-1	Coordination of Environmental Study Input to Design
-	C-2-2	Coordination of Engineering Study Input to Environmental Report
C-3		ENVIRONMENTAL ASPECTS OF ENERGY ALTERNATIVES AND DEMAND
	C-3-1	Socioeconomic Aspects of Energy Demand Forecasts
	C-3-2	Comparative Environmental Evaluation of Alternatives
C-4		EXHIBIT "W" ENVIRONMENTAL REPORT
	C-4-1	Climatology
	C-4-2	Hydrology
	C-4-3	Geology
	C-4-4	Seismology
	C-4-5	Soils and Sedimentation
	C-4-6	Water Quality
	C-4-7	Aquatic Resources - Anadromous Fisheries
	C-4-8	Aquatic Resources - Resident Fisheries
	C-4-9	Aquatic Resources - Upper Cook Inlet Estuary
	C-4-10	Vegetation
	C-4-11	Wildlife Resources - Large Mammals
	C-4-12	Wildlife Resources - Bird and Small Mammals
	C-4-13	Land Use
	C-4-14	Land Ownership
	C-4-15	Recreation
	C-4-16	Transportation
	C-4-17	Air Quality and Noise
	C-4-18	Population and Demography
	C-4-19	Economics

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- C-4-20 Cultural Resources
- C-4-21 Public Safetv

C-4-22 Visual Resources

- C-4-23 Transmission Routing Environmental Aspects
- C-4-24 Prepare Final Report

C-5

EXHIBIT "R" RECREATION PLAN C-5-1 Formulate Goals and Operational Objectives C-5-2 Determine Recreational Land Use Suitability C - 5 - 3Assess Recreation Demand C-5-4 Develop Conceptual Recreation Schemes C-5-5 Review Alternative Plans with APA and Appropriate Agencies C-5-6 Select and Refine Preferred Recreational Use Plan

Formulate Goals and Objectives

Transmission Line Corridor Analysis

Describe Pre-Project Biological Setting

Coordination with Natural Resources Agencies

Assess Impacts to Fish and Wildlife

EXHIBIT "V" NATURAL, SCENIC AND HISTORIC RESOURCE

Analysis of Federal, State and Local Guidelines

Cultural Resource Identification, Impact and Mitigation

Visual Resource Identification, Impact and Mitigation

EXHIBIT "S" FISH AND WILDLIFE RESOURCES PROTECTION PLAN

Prepare Final Report

Prepare Final Report

Prepare Mitigation Plan

Prepare Final Report

PROTECTION PLAN

C-6

C-5-7

C-6-1

C - 6 - 2

C-6-3

C - 6 - 4

C-6-5

C-6-6

C-7-1

C-7-2

C-7-3

C-7-4

C-7-5

C-7

CATEGORY:	С	ENVIRONMENTAL	STUDIES
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ASSIGNMENT: C-1 PRINCIPAL-IN-CHARGE, ENVIRONMENTAL STUDIES

TASK TITLE C-1-1 Management and Technical Supervision

LEVEL OF EFFORT:	Included within Tasks C-4-24, C-5-7, C-6-6 and C-7-5
SCHEDULE:	Throughout Study Period - January 1980 to July 1982
ESTIMATED COST:	Costs included within Task Assignments C-4, C-5, C-6, and C-7
RESPONSIBILITY:	D. H. Blau (EDAW)

PURPOSE:

To provide direction and technical guidance to the Environmental Group so that the Environmental Studies will be carried out in an efficient and orderly manner.

SCOPE:

The responsibility of the Principal-in-Charge will include the following:

- Provide close coordination with other groups to ensure that information and data will be available when needed.
- Monitor progress and plan ahead to ensure efficient execution of the work.
- Review results of studies performed by group to ensure high quality performance.

CATEGORY:	ENVIRONMENTAL	STUDIES
CATEGORY:C	ENVIRONMENTAL	STUDIES

ASSIGNMENT C-1 PRINCIPAL-IN-CHARGE

TASK TITLE: <u>C-1-2 Project Orientation</u>

LEVEL OF EFFORT:	45 Man-days	·	
SCHEDULE:	January 1980		
ESTIMATED COST:	\$14,000		
RESPONSIBILITY:	D. H. Blau (EDAW)	·····	

PURPOSE:

To ensure that all environmental team members have a clear understanding of project study approach and objectives, task responsibility, and time requirements to ensure timely and cost-effective performance of the entire project.

SCOPE:

Initiate Studies

- Meetings with Alaska Power Authority to review proposed work scope and budgets.
- Detailed refinement of work tasks, assignments and schedule and preparation of detailed project network (or flow chart) for Environmental Studies.
- Meetings with task leaders to discuss and confirm assignments and schedule.
- Coordination meetings with Engineering Design Group and Plan Synthesis Group to obtain the necessary parameters of a Susitna hydroelectric project and non-Susitna alternatives to permit initiation of environmental studies (see Task C-2-2).

Document Review

- Preparation and circulation of brief project summary and information package including project history, previous project-related studies, and reference list of data and studies with reference to the project.
- Determination of additional environmental data requirements and intiation of data assembly from available sources.

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ASSIGNMENT: C-2 COORDINATION WITH ENGINEERING STUDIES

TASK TITLE: C-2-1 Coordination of Environmental Study Input to Design

LEVEL OF EFFORT:	40 Man-days
SCHEDULE:	January 1980 to April 1982
ESTIMATED COST:	\$14,000
RESPONSIBILITY:	D. Sanders (IECO)

PURPOSE:

- To ensure that environmental considerations are recognized and included in all phases of alternative assessments and project design.
- To ensure that potential adverse environmental effects are avoided or minimized by appropriate planning and design.
- To avoid costly delays in project design through the early planning and incorporation of mitigation measures.
- To ensure that costs of environmental impact and mitigation are considered in the economic evaluation of Susitna and non-Susitna alternatives.

SCOPE:

Coordination meetings will be held at the beginning of the project study and on a monthly basis thereafter, to ensure that the Design and Plan Synthesis Groups are kept informed of the environmental constraints associated with the following project aspects:

- Location of access roads, transmission lines, construction camps, borrow and spoil areas.
- Design and operation of outlet works and spillways.
- Restoration of areas affected by earthmoving.

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ASSIGNMENT: C-2 COORDINATION WITH ENGINEERING STUDIES

TASK TITLE C-2-2 Coordination of Engineering Study Input to Environmental Reports

LEVEL OF EFFORT:	40 Man-days
SCHEDULE:	January 1980 to April 1982
ESTIMATED COST:	\$14,000
RESPONSIBILITY:	D. Sanders (IECO)

PURPOSE:

To provide liaison between the Environmental Studies Group and the engineering studies groups to ensure that the Environmental Studies Group receives up-to-date project data so that a thorough and efficient environmental assessment is accomplished.

SCOPE:

Monthly meetings will be held between representatives of the Environmental Studies Group and the various engineering studies groups, including Plan Synthesis, Design, Geotechnical, Hydrologic, and Anchorage Operations, in order to describe and update the following aspects of the project:

- Identification of Susitna and non-Susitna alternatives to be studied and as much site-specific and design data that is possible for each alternative.
- Estimates of construction schedules, number of construction workers, type and number of construction equipment, amount of construction payroll, and size of construction camps.
- Location and extent of all project features associated with a Susitna alternative, including construction areas, camp areas, access road corridors, transmission line corridors, and reservoir areas.
- Reservoir operational data including reservoir depth, maximum daily and yearly level fluctuations, alterations in seasonal streamflow patterns, and effects on downriver hydraulics.

CATEGORY:	С	ENVIRONMENTAL STUDIES
	C-3	ENVIRONMENTAL ASPECTS OF ENERGY ALTERNATIVES AND DEMAND

TASK TITLE C-3-1 Socioeconomic Aspects of Energy Demand Forecasts

LEVEL OF EFFORT:	55 Man-days
SCHEDULE:	August to December 1980
ESTIMATED COST:	\$18,000
RESPONSIBILITY:	A. Massa (EDAW)

PURPOSE:

To provide the social and economic input to Task Assignment on Energy Demand Forecast.

SCOPE:

The scope will include a description of the existing, and anticipated changes in demographic, social and economic conditions in the State and the Railbelt Region affecting unit measures of energy consumption and overall projections of energy demand. The information will form the basis for the discussion of project need in Exhibit W of the FERC License Application.

CATEGORY:	<u>C</u>	ENVIRONMENTAL STUDIES
ASSIGNMENT:	C-3	ENVIRONMENTAL ASPECTS OF ENERGY ALTERNATIVES AND DEMAND
TASK TITLE:	C-3-2	Comparative Environmental Evaluation of Alternatives

LEVEL OF EFFORT:	160 Man-days
SCHEDULE:	September 1980 to January 1981
ESTIMATED COST:	\$51,000
RESPONSIBILITY:	A. Massa (EDAW)

PURPOSE:

To compare the environmental effects and costs of development and power generation of alternative energy sources. Development and power generation assumptions and scenarios to be evaluated will be prepared under Assignments G-5 and G-6. These environmental costs will be used in the evaluation of alternate energy sources as performed under Task Category G, Plan Synthesis.

The approach will involve development of a comparable base for evaluating environmental costs through the use of a list of weighted environmental factors against which each energy source scenario will be measured.

SCOPE:

Identification of lists of appropriate evaluation factors (one for resource use or extraction and one for power generation) will require review and input by the Alaska Power Authority, relevant state agencies, and project review boards. Assignment of weights, representing the relative importance or value placed on each factor, will be accomplished with participation of selected representatives of APA, state agencies, the project team and the Boards of Review.

Activities will include:

- 1. Identification of evaluation factors. These are likely to include the following:
 - a. Resource use/extraction
 - land requirements
 - displacement or disruption of settlements

- disruption or preemption of other land uses (which may be subdivided into categories of use such as recreation, wilderness, commercial forest, agriculture and grazing)
- vegetation and wildlife destruction or disruption
- erosion and alteration of landform
- water resources (streamflow, water supply and water quality) alteration
- loss or reduction of visual quality
- loss or alteration of cultural resources
- community and fiscal changes due to workforce requirements.
- b. Power generation -
 - land requirements
 - water supply
 - water quality
 - air quality
 - visual quality
 - land use
 - community and fiscal conditions
 - vegetation and wildlife
- 2. The probable level of impacts, including disruption, displacement of existing use, preemption of other uses or loss of resource quantity and quality, will be assessed.

High, moderate or low impacts on each factor will be combined with the importance weight assigned to each factor in each scenario to give a general overall ranking of the environmental costs of each scenario. Data to support application of the process will be drawn largely from existing published documents and readily available data sources. They will be assembled at a level of detail comparable to that developed for the alternative energy use scenarios.

- 3. Results of the environmental-cost evaluation will be compared with those of the technological feasibility/risk assessment and cost-effectiveness analyses in Task Assignments G-5 and G-6.
- 4. If results of the combined analysis of energy source alternatives point to the desirability of hydropower development, a further evaluation iteration will be performed to identify the most appropriate Susitna River alternative.

CATEGORY: C ENVIRONMENTAL STUDIES

ASSIGNMENT C-4 EXHIBIT "W" ENVIRONMENTAL REPORT

TASK TITLE C-4-1 Climatology

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LEVEL OF EFFORT:	781 Man-days	
SCHEDULE:	February 1980 to March 1982	
ESTIMATED COST:	\$545,000	
RESPONSIBILITY:	C. B. Fahl (Dames & Moore)	n na standarda da serie da se Transferie da serie d

PURPOSE:

- Provide a climatological/meteorological data base of the Upper Susitna basin upon which environmental, hydrologic, and dam and transmission line design parameters of a Susitna hydroelectric project will be determined.
- Assess relative impacts on climatology and meteorology for various Susitna and non-Susitna energy alternatives.
- Assess in detail the potential impacts on climatology and meteorology that could result from a Sustina hydroelectric project and recommend appropriate mitigation measures.

SCOPE:

Initial Reconnaissance for Planning Studies

The objective of this Task is to provide an early overview of regional climatological and meteorological conditions as input to Stage 1 - Plan Formulation Studies. Activities will include:

- Identification and review of existing data.
- Identification of climatologic and meteorologic conditions that are likely to be of concern in the assessment of energy source alternatives.
- Preliminary assessment of the relative potential impact to climate and meteorology for each energy source alternative.

Baseline Data Collection

A climatological and meteorological data gathering network will be established to measure and/or calculate the following parameters:

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- Precipitation
- Wind Speed
- Wind Direction
- Temperature
- Relative Humidity
- Snow Depth
- Solar Radiation
- Evaporation

1. Develop Need, Criteria, and Constraints for Data Gathering Program:

A data gathering field program will be essential for two reasons: (1) there are few existing climatological data for the project area; and (2) existing state and regional climatologies are not representative of specific locations due to the rugged, complex terrain.

The climatological data that will be gathered will be put to three major uses: (1) environmental -- baseline and impact assessments; (2) hydrologic -- computer model studies; and (3) engineering -- dam and transmission line design calculations.

The data gathering field program will consist of a multistation network, since the representativeness of the data provided by a single monitoring station will be necessarily small because of the rugged and complex terrain. F;or example, wind speed and direction data collected near Gold Creek could not be expected to represent the wind patterns at the Devil Canyon damsite, and neither of those two sites would have wind records that represented the Watana damsite. Also, a "basin" wind rose would be far different from a wind rose on top of a high exposed ridge such as those found along the transmission line corridor.

Monitor siting, accuracy, and data recovery are very important and have been given higher priority in the development of a data collection program than numbers of stations. The conceptual data collection program described below exhibits reliability and accuracy without escalating costs. The monitoring system aspect of the program is the best combination of instrumentation, available at this time, suited for this project.

Because of the rugged, complex terrain station representativeness will be more important on this project than it would be in the case of less rugged and complex terrain. Monitor siting will be a significant task with significant costs, so fewer stations will be installed for the same amount of money than would be in the case of less rugged, complex terrain.

Because of these two factors, representativeness and siting costs, the chosen system must be reliable -- it must have a high design rate of data recovery. For example, a 6-station system where each station has a design data recovery rate of 90 percent, would have in the worst case, a system data recovery of 53 percent. However, an 8-station system where each station has a design data recovery rate of 80 percent, would have in the worst case, a system data recovery of 17 percent.



TASK: C-4-1 Climatology

Data accuracy will be important in the cases of hydrologic and design parameters. These parameters must be more accurately determined than environmental parameters as they will have more economic effect on the project. Overdesigned dams and/or transmission lines imply profligate use of public money, while under-designed dams and/or transmission lines imply unacceptable threats to the public's commonwealth.

The statistics of extreme values are also important parameters in hydrologic modeling and in dam design and will influence project feasibility and costs. Therefore, the climatological study will be designed so that extreme values as well as averages can be obtained. Data collected will lend themselves to use, such as modeling Spillway Design Floods and predicting maximum probable precipitation rates.

2. Data Acquisition and Transmission Equipment

Climatological and meteorological data will be collected by means of LaBarge remote platforms. The LaBarge Remote Climatological Station (RCS) uses the same platform as the LaBarge Remote Meteorological Station (RMS) but contains only precipitation and temperature sensors.

The LaBarge remote platform is uniquely suited to the demands of this project. Data are collected and stored on each platform for transmission every 3 hours to the geostationary environmental satellite (GOES). The GOES then retransmits with high reliability to a central ground station for ultimate delivery to the Alaska office of Dames & Moore. Data recoveries are higher and recovery costs are lower than any other known method of retrieval from remote stations. Current recovery rates on a similar station operated by Dames & Moore in the Brooks Range of Alaska are exceeding 95 percent.

We believe the initial cost of the data platform is more than recouped by the low service and maintenance requirements and the high data recovery. Further, if instrument (sensor) failures are experienced, status checks transmitted with the data alert the appropriate personnel within a day or two and decisions can be made to minimize losses.

3. Planning and Siting Studies

An initial planning study will be conducted to determine the number and locations of monitoring sites. This study will be coordinated with the project hydrological, glaciological, and water quality requirements to the extent needed for efficiency in field data collection. For example, a climatic monitoring station could be located at the same place as a water monitoring location if the location were mutually acceptable to both discipline investigators. Such an arrangement would allow one LaBarge data platform to transmit meteorological/climatological data and water quality data to the GOES statellite and maximize utilization of the platform.

An aerial site reconnaissance will be conducted along the Upper Susitna basin to select acceptable climatic and meteorological monitoring sites. Site acceptance will be based on the principles of good meteorological practice and the acceptance standards for probe siting set forth by EPA. The reconnaissance will be conducted by Dames & Moore senior meteorologists in a one- or two-day trip by Cessna 185 or helicopter.

Potential sites will be marked on maps and notes will be taken to indicate areas of general orographic similarity where climatic factors could be expected to be similar. This information will be used in siting decisions and in minimizing the number of monitoring stations. Ten man-days will be allotted for this task.

TASK: C-4-1 Climatology

At this time, we believe that the network should consist of three to four Remote Meteorological Stations (RMS) and six to nine Remote Climatological Stations (RCS) based on cursory examination of maps. Figure 1 shows the preliminary siting of four RMS's and seven RCS's. This network was used in determining schedules and levels of effort. The stations will consist of the following:

<u>Meteorological Monitoring Stations</u> (4)	Watana	Devil Canyon	High <u>Point</u>	Gold <u>Creek</u>
LaBarge Data Collection Platform	x	x	x	x
GOES Transmission Antenna	x	x	x	×
Wind Speed & Direction Sensors	x	X .	x	x
Peak Wind Gust			x	
Heated Precipitation Gage (tipping bucket)		x	x	
Air Temperature	x	x	x	x
Relative Humidity	x	x	x	×
Net Radiation Pyranometer	x	x		
Water Temperature	x	x		
Evaporation	x	X		

Climatological Monitoring Stations (7)

LaBarge Data Collection Platform

GOES Transmission Antenna

Air Temperature

Heated Precip. Gage (tipping bucket)

Relative Humidity (optional)

Soil or Water Temperature (optional)

The Transmission Line High Point station will be located along the transmission line corridor about half way between Watana and Devil Canyon at a place where the line would reach its highest altitude and be exposed to strong winds. At this station, special effort will be made to monitor short-term peak winds and to quantify those peaks and their durations. Such information can be extremely useful in tower design and tower separation planning.

Precipitation sensors will be located at the dam stations as well as the RCS's. The number of RCS's will be minimized, based on the initial reconnaissance and the siting analysis. Obviously, one or two rain gages cannot adequately represent the rainfall patterns in a mountainous area. The objective will be to minimize number of stations and





maximize accuracy, and we expect this can be done with 8 to 11 precipitation stations. During the winter of 1979-80, snow courses will be laid out and representative snow depths will be measured by manual staff gaging. The results of these snow course surveys will be considered in siting climatological stations for spring/summer installation. Additional snow course surveys will be made during the second winter season. All snow course survey analyses will be integrated with snow course survey data from the U.S. Soil Conservation Service network stations that are located in and adjacent to the project watershed.

4. Work Plan

Dames & Moore, after completing the site selection, will develop for APA a complete Work Plan for meteorology and climatology, which will describe the details of further work, site locations, network design and installation, instrument specifications, and data formats. Computer software will be outlined and report formats will be prepared. The Work Plan will also describe interaction with other disciplines in optimizing manpower and equipment.

5. Installation of First Two Meteorological Monitoring Stations

After APA approval of the Work Plan, Dames & Moore will move rapidly to attempt to complete installation of the first two meteorological monitoring stations before onset of winter weather. We recommend that the first two sites installed should be:

- Watana Dam Site
- Transmission Line High Point

The Watana site is representative of basin canyon winds; the High Point needs to be monitored for as long as possible prior to final design decisions on the transmission line.

The instrumentation for all these sites will be ordered as soon as written authorization is received from APA. Tentative arrangements and reservations have already been made with manufacturers for the longest lead time items. Applications for transmitting permits from the National Environmental Satellite Service have already been submitted. Instrumentation will be shipped to the Denver office of Dames & Moore for preinstallation inspection and testing.

A suitable location on the chosen site will be leveled and prepared for instrument installation. No permannet anchors or concrete pads will be needed. In an attempt to discourage moose and/or bear site visits, an 8-foot barbed wire fence will be placed around the installation, fencing approximately 400 square feet of land area. The site will be located in a clearing at least 200 feet from the nearest obstruction in any direction that would interfere with data collection.

The LaBarge Data Platform (described in Appendix A) will be set on the site on its tripod tundra pads. The meteorological sensors will be mounted on a horizontal boom atop the 20-foot mast. The LaBarge mast will be guyed for stability, using screw anchors. Temperature and relative humidity will be recorded at about 10 to 15 feet above ground level on the mast.



TASK: C-4-1 Climatology

6. <u>Status Report</u>

A report will be prepared after the first two meteorological stations are installed. This report will contain a status of the project, photos of the installed sites, technical details of the system and communications networks, initial data, calibrations, tests, and an operating procedures manual.

7. Installation of Remaining Meteorological and Climatological Monitoring Stations

This phase will begin in the spring of 1980 and be completed in approximately 5 to 6 weeks. Two teams of two technicians each will be dispatched. Instruments will be flown to the selected sites by Cessna 185 and/or helicopter.

Each site will be contained within a barbed wire compound about 20 x 20 feet and each will be marked by a 20-foot flagpole.

All rain gages will be mounted on platforms to elevate them above the nominal winter snow depth. The platform will be tubular aluminum painter's scaffold. It will be erected on site and guyed in place using screw anchors. The platform will enable precipitation readings to be taken throughout most or all of the year. Rain gages will be propane heated. Wind skirts will be installed on the platform to improve precipitation accuracy.

The LaBarge remote data platforms will be mounted on their tripod tundra pods alongside the rain gage platforms. Batteries will be buried or placed on the ground surface and insulated. Each platform will include solar panels to aid the batteries in retaining their charge. Solar panels, of course, will be of only marginal use throughout the winter, but will help the batteries enter the dark season at full charge, and to recuperate quickly in the spring.

Air temperature will be recorded 10 to 15 feet above ground level, by means of a wind aspirated, solar shielded thermistor probe. At one or two of these nine sites, relative humidity (optional) will be monitored by thin film polymer capacitor.

These monitoring stations will be installed to recover, with very little maintenance, 80 percent of the data points or greater. A 90 percent data recovery is a prime objective, and the system described is fully capable of such excellent recoveries. However, 90 percent recovery is a very difficult task in remote areas. We should also point out that Dames & Moore is presently recovering greater than 95 percent of the data from their LaBarge station in the Brooks Range.

Recovery rates are perhaps as important to meteorological and climatological monitoring as accuracy and validity, because the data bases are used in computer modeling and in generating broad annual descriptions of probable future events. Losing data usually will affect the conclusions drawn, especially in regard to extreme values.

The total network described in this scope of work will collect, at a 90 percent recovery rate, on the order of 2.8 million hourly data points from 11 stations.

8. Data Collection and Reduction Procedures

Data will be collected automatically by each LaBarge data platform until, once every 3 hours, the platform is activated to transmit its data load to the geostationary environmental satellite (GOES). The data are transmitted in hexadecimal format.

The GOES satellite receives, amplifies, and retransmits this data, multiplexed, to a central receiving station located at Wallops Island, Virginia. From that receiving station, Dames & Moore obtains data via teletype or teleprinter and converts it by computer programs into engineering units, calibrated and tabulated as hourly values.

The information is then stored on computer tape files. These files will be summarized on a monthly update. Hard copy is always retained by Dames & Moore in case or computer failure. Another copy of the data will be transferred to the Hydrological Studies, Data Management Assignment D-3, for their use.

Data will be collected for at least 1 week before data reduction begins, but data will be inspected daily by Dames & Moore data technicians for potential problems or voids, which would be given immediate attention by the Principal Investigators.

Our proposal assumes at this time that monitoring would be continued for 12 months, starting at the time the whole network becomes operational. This will provide as much as 18-20 months at the early Phase I stations.

9. Maintenance and Service

The data received by Dames & Moore includes a status check of each parameter to indicate Whether each station is performing properly. If not, the Principal Investigator will decide whether to dispatch a technician to the site for repairs.

The decision will be based on many factors, including accessibility, degree of severity of problem, criticality of data if lost, magnitude of repairs, etc. If a technician is dispatched, he will fly into the site and repair or replace the defect. Our cost estimates include two service trips in addition to the regular quarterly visits (to half the sites each quarter).

Dames & Moore will design quality control into this program as an integral part of the assessment and monitoring. Data will be "followed" and registered as it is handled. Calibration records will be cross checked and data records will be verified. Quality control procedures will be written into the Work Plan.

10. Data Reports

As the data are received, Dames & Moore will prepare quarterly summaries which will include tables of the hourly values as well as monthly and quarterly summaries.

Winds will be reported as joint distributions of frequency of occurrrence by direction and speed. Peak winds will be reported only from the High Point meteorological stations, and will consist of highest and second highest gusts of a specified duration such as 3 or 4 seconds.



TASK: C-4-1 Climatology

We propose that all stations be operated to obtain a concurrent 12-month data record, then some stations be removed from the network if data from these stations is found unnecessary or redundant (and if such action would result in lower costs or higher efficiencies).

Our proposal, throughout, assumes that we receive written authorization to proceed in time to complete the initial siting studies and install the first two remote meteorological stations prior to freezing.

LEVEL OF EFFORT DESCRIPTION:

Labor

The above scope of work will require an estimated 781 man-days of labor including the administrative and technical support efforts at a cost of \$231,000. Approximately 20 percent of the effort will be concentrated in the first 2 months of the project after authorization to proceed.

Equipment

Dames & Moore will provide all necessary instrumentation for the monitoring efforts, including spare instruments and parts, construction materials and supplies, and consumable materials. We estimate the total cost for equipment to be \$270,000.

Expenses

Dames & Moore expenses for 28 months of field and office labor amount to \$44,000. This includes travel by air and surface vehicles, subsistence costs of food and lodging for field personnel, and computer lease costs for data manipulation.

The total cost estimate for Meteorological/Climatological studies is \$545,000.

PERSONNEL ASSIGNED:

Dames & Moore has designated the following specific professional and technical personnel to serve in performing the climatological monitoring program:

Dr. Charles B. Fahl - Principal-in-Charge

John L. Gordon - Technical Advisor and Quality Control Supervisor

Rodger G. Steen - Principal Investigator for Monitoring

Fred Rosenblum - Principal Investigator for Data Management and Report Preparation Gary L. Wentz - Technician

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Hourly temperature, relative humidity, and precipitation data will be tabulated and summarized showing monthly means, maxima, and intensities (duration).

In addition, the summaries will report the percent data recoveries and any problems and solutions.

Impact Assessment and Mitigation

The National Environmental Policy Act (NEPA) specifically requires that climatic baseline information be presented and impacts of the proposed action predicted in EIS's. Climatic data usually requested by lead agencies in environmental impact assessments include winds, precipitation, and temperature as a minimum baseline, plus other parameters that might be affected. Although the environmental impacts on climate of the Susitna hydro-electric project are expected to be slight and localized, the parameters that may exhibit changes include, in addition to the above, dew point, humidity, and snowfall. Therefore, the proposed monitoring network includes these measurements -- for environmental reasons.

An assessment will be performed to define potential impacts of the project, if any, on baseline climatology and meteorology. The imapct review will begin in parallel with Phase I work so that changes can be made in the monitoring programs if needed to assess baseline impacts.

Potential impacts to be evaluted include:

- Local changes in climate due to creation of a small lake (reservoir) where no lake exists.
- Changes in surface wind patterns due to the damming and due to the broadening of the water surface.

Positive and negative impacts will be included, and their effects will be quantitatively balanced, along with any quantitative mitigations, wherever possible. Discussions will be held with State and federal EPA agencies on the extent and importance of the various impacts and on the value of mitigation.

DOCUMENTATION:

A written discussion of the baseline setting data, impacts and mitigation measures will be prepared in a format appropriate for the environmental report (Exhibit W) of the FERC License Application.

SCHEDULE DESCRIPTION:

Dames & Moore proposes to monitor meteorology and climatology and to perform impact assessments over a period spanning approximately 28 months. This schedule will result in 24 months of field data from the earliest installed meteorological stations at Watana and High Point and 12 to 18 months of data from the remaining stations.



CATECORY ·	C	ENVIDONMENTAL	STUDIES
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ASSIGNMENT: C-4 EXHIBIT "W" ENVIRONMENTAL REPORT

TASK TITLE: C-4-2 Hydrology

LEVEL OF EFFORT:	40 Man-days
SCHEDULE:	February 1980 to December 1981
ESTIMATED COST:	\$14,000
RESPONSIBILITY:	W. C. Peterson (IECO), C. Watson (EDAW)

PURPOSE:

To describe the hydrologic setting and the existing hydrologic features of surface waters in areas affected by the project in sufficient detail to make an assessment of the effects of the project on stream flow.

SCOPE:

Hydrologic conditions will be described as part of Category D - HYDROLOGICAL STUDIES. Therefore, the scope of hydrologic studies for Exhibit W will be limited to summarizing Category D studies and results, supplementing this input with additional studies if required and in order to assess the potential effects of the project on the hydrologic environmental and recommend measures to avoid or minimize these effects.

Initial Reconnaissance for Planning Studies

The objective of this portion of the task is to provide an early overview of regional and site-specific hydrologic conditions and potential constraints and impacts as input to Stage 1 - Plan Formulation Studies. Most of the activities would be performed in the Hydrological Studies Task Category. These include:

- Identification and preliminary review of existing data sources including files of the U.S. Geological Survey and previous project reports.
- Preliminary identification of hydrologic conditions and phenomena likely to be of concern in the assessment of energy source alternatives.

Baseline Data Collection

This portion of the Task will be carried out throughout the course of the study. All hydrologic data will be entered into a central computer bank (HYDROLOGICAL STUDIES Assignment D-3 Data Management) and through data management and updating of information, these data will be readily available for use by any Task Group.

TASK: C-4-2 Hydrology

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- Describe the physical characteristics of the Susitna Basin and a description of the seasonal streamflow characteristics of streams within the basin.
- Describe the existing ice conditions of streams in the Susitna Basin, concentrating on the Sutitna River at the project sites and downstream.

Impact Assessment and Mitigation

The objective of this aspect of the task will be to describe and assess the effects of the project on stream flows during various operational modes of the project. The detailed studies in the Hydrological Studies Task Category will present the pre-project and post-project conditions. Activities will include a description of the following:

- The fluctuations in downstream flows and reservoir levels.
- The effects on the frequency and magnitude of downstream flooding.
- The effects on ice conditions downstream and in the reservoirs, including an assessment of the potential for frazil ice production downstream.
- The effects on downstream river hydraulics under normal mode of project operation.
- The effects on downstream conditions during probable maximum floods or in the event of catastrophic action.
- Measures to eliminate or minimize potential adverse hydrologic effects; and identification of those adverse effects that cannot be mitigated.

DOCUMENTATION:

The analysis of the hydrologic conditions, potential impacts, and mitigation measures will be assembled in text and map form for inclusion in Exhibit W of the FERC License Application.



CATEGORY:	C.	ENVIRONMENTAL STUDIES	
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ASSIGNMENT: C-4 EXHIBIT "W" ENVIRONMENTAL REPORT

TASK TITLE: C-4-3 Geology

LEVEL OF EFFORT:	80 Man-days
SCHEDULE:	February 1980 to December 1981
ESTIMATED COST:	\$26,000
RESPONSIBILITY:	D. Sanders (IECO), C. Watson (EDAW)

PURPOSE:

To describe the existing topographic, physiographic, and nonseismic geologic conditions within the area to be affected by the project in order to assess the constraints of the geologic environment and the potential effects of the project on the geologic environment.

SCOPE:

Topographic, physiographic and geologic conditions will be described as part of Task E - GEOTECHNICAL STUDIES; therefore, the scope of geologic studies for Exhibit W will be limited to supplementing input from Category E tasks concentrating on such non-engineer-ing issues as the identification of mineral resources and unique geologic resources, and evaluating the potential impact of the project on the geologic environment.

Initial Reconnaissance for Planning Studies

The objective of this Task is provide an early overview of regional and site-specific geologic conditions and potential constraints and impacts as input to Stage I - Plan Formulation Studies.

Activities will include:

- Identification of data sources including agencies, previous reports, aerial photos, etc.
- Preliminary identification of geologic conditions and phenomena likely to be of concern in the assessment of energy source alternatives.

TASK: C-4-3 Geology

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Baseline Data Collection

Activities will include:

- Data collected as part of the ENGINEERING GEOLOGY Task E-2 will be reviewed and summarized in order to provide a description of the existing geotechnical conditions and constraints in the project area. Emphasis of the description will be on foundation characteristics, permafrost conditions; and slope stability at potential damsites, along access routes and transmission line corridors. Regional and site-specific geologic maps will be prepared.
- Mineral resources within protential project areas will be described from existing reports and agency files. Location of known mineral resources and mining claims in the prject area will be shown on a map.
- Any unique geologic or topographic features wihtin the study area will be described.

Impact Assessment & Mitigation

- Geologic constraints and mitigation measures for all project elements will be summarzied from the engineering geology report that will be developed as part of Assignment E-2.
- Potential changes in existing geologic conditions will be assessed for each of the project elements to be constructed. The assessment of potential effects on the existing geologic environment will focus on effects on slope stability and permafrost. Environmental changes that are related to construction activities and are temporary in nature will be distinguished from long-term or permanent changes.
- Measures to avoid or minimize adverse impacts will be identified and incorporated into project designs wherever possible. Unavoidable impacts will be identified.

DOCUMENTATION:

The analysis of nonseismic geologic conditions and potential impacts will be assembled in text and map form for includsion in Exhibit W of the FERC License Application.

CATEGORY: C	ENVIRONMENTAL STUDIES		
ASSIGNMENT: C-4	EXHIBIT "W" ENVIRONMENTAL REPORT	e	
TASK TITLE: C-4-4	Seismology		· · ·
LEVEL OF EFFORT:	38 Man-days	· · · · · · · · · · · · · · · · · · ·	······································
SCHEDULE:	February 1980 to December 1981	1	/ ×
ESTIMATED COST:	\$13,000		e di tanàna dia 1979. Ang kaominina dia kaominina
RESPONSIBILITY:	D. Sanders (IECO), C. Watson (EDAW)		

PURPOSE:

To describe the seismic setting of the area to be affected by the project in order to assess earthquake and fault movement hazards to project facilities as well as to assess the potential for reservoir-induced seismicity.

SCOPE:

The scope of seismologic studies for Exhibit W will be limited to summarizing the results of studies performed under Task E-4, SEISMOLOGY.

Initial Reconnaissance for Planning Studies

The objective of this aspect of the Task is to provide an overview of regional and sitespecific seismic conditions, and preliminary identification of potential constraints and impacts as input to Stage I - PLAN FORMULATION STUDIES.

Activities will include:

- Identification and preliminary review of data sources including previous studies.
- Preliminary identification of the relative seismic hazards that are likely to be of concern in the assessment of energy source alternatives.

Baseline Data Collection

Activities will include:

• Review and summarize data collected as part of Task E-4, Seismology, including a discussion of the regional tectonic setting, the regional earthquake history, the location of active faults, earthquake-related phenomena such as liquefaction, differential settlement, lurching, and landsliding.

• Earthquake epicenters, active faults, and regional tectonic features will be depicted on maps. These data will be obtained from existing publications, the Earthquake Data File maintained by the National Atmospheric and Oceanic Administration, and project geologic mapping and seismic monitoring performed as part of Task Category E - GEOTECHNICAL STUDIES.

Impact Assessment and Mitigation

This discussion also will be a summary of Task Assignment E-4, SEISMOLOGY, and will include an assessment of the seismic hazards at all project element sites but focusing on the damsites. Potential hazards that will be assessed include fault rupture, ground shaking, liquefaction, slope failure, seiches, and reservoir-induced seismicity.

Measures to avoid or minimize seismic hazards will be identified and incorporated into project design.

DOCUMENTATION:

The analysis of seismic conditions and potential impacts will be assembled in text and map form for inclusion in Exhibit W of the FERC License Application.



SUSITNA HYDROELECTRIC PROJECT

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CATEGORY: <u>c</u> ENV	IRONMENTAL STUDIES
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ASSIGNMENT: C-4 EXHIBIT "W" ENVIRONMENTAL REPORT

TASK TITLE <u>C-4-5 Soils and Sedimentation</u>

LEVEL	OF	EFEORT.	11 Man dave		
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SCHEDULE: February 1980 to December 1981

ESTIMATED COST: \$26,000

RESPONSIBILITY: D. Sanders (IECO), C. Watson (EDAW)

PURPOSE:

To describe the existing soil conditions within the area to be affected by the project in order to assess the erosion potential at construction sites and the erosion and sedimentation potential within reservoir and downstream areas.

SCOPE:

Initial Reconnaissance for Planning <u>Stu</u>dies

The objective of this portion of the task is to provide an early overview of regional and site-specific soil conditions, potential constraints and impacts as input to Stage I - PLAN FORMULATION STUDIES.

Activities will include:

- Identification of data sources including federal and state agencies, previous reports, aerial photos, etc.
- Preliminary assessment of relative potential for erosion, sedimentation and loss of agricultural soils associated with the various energy source alternatives.

Baseline Data Collection

Soils data in the vicinity of all project elements will be developed from existing reports and files as well as data obtained from studies performed for Task E-GEOTECHNICAL STUDIES. The focus of the soils data collection will be on erosion potential at project construction sites and downstream along the Susitna River, the physical and chemical characteristics of the soils, and the agricultural capability of the soils. Engineering characteristics of soils at construction sites will be assessed as part of the GEOTECH-NICAL STUDIES (CATEGORY E).

Impact Assessment and Mitigation

- Areas with a high potential for erosion will be described.
- A Hydrocomp model will be used to predict sedimentation rates within the reservoirs and downstream.
- 3. Specific measures for minimizing the loss of soil by erosion at construction sites will be described, such as scheduling, revegetation, slope protection, runoff diversion, and use of settling ponds.

DOCUMENTATION:

The analysis of soil conditions relating to erosion, sedimentation, and agricultural capability will be assembled in text and map form for inclusion in Exhibit W of the FERC License Application.

INTERNATIONAL ENGINEERING COMPANY, INC.

CATEGORY:	С	ENVIRONMENTAL STUDIES	
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ASSIGNMENT: C-4 EXHIBIT "W" ENVIRONMENTAL REPORT

TASK TITLE: C-4-6 Water Quality

LEVEL OF EFFORT:_	44 Man-days
SCHEDULE:	February 1980 to December 1981
ESTIMATED COST:	\$23,000
RESPONSIBILITY:	W. Wrobel (Dame <u>s & Moore)</u>

PURPOSE:

- To describe the water quality of the Upper Susitna River before the proposed project.
- To describe water use requirements during construction and operation of the project.
- To describe potential changes in water quality of the Susitna River resulting from construction and operation of the project.

SCOPE:

- Supplemental information on water velocity, temperature, dissolved oxygen, and turbidity will be gathered in conjunction with other tasks (see Anadromous and Resident Fisheries, Tasks C-4-7 and C-4-8 respectively).
- Review published and unpublished water quality data of the U.S. Geological Survey and Alaska Department of Fish and Game.
- Obtain additional sediment and water quality at the 11 stream gage sites from the Hydrologic Studies Group.

DOCUMENTATION:

The analysis of water quality, conducted as part of this Task, and Anadromous and Resident Fisheries, Tasks C-4-7 and C-4-8, will be assembled in text form and provided as one of a series of Environmental Studies for direct incorporation into the FERC License Application, Exhibit W.

CATEGORY: <u>C</u><u>ENVIRONMENTAL STUDIES</u>

ASSIGNMENT: C-4 EXHIBIT "W" ENVIRONMENTAL REPORT

TASK TITLE: C-4-7 Aquatic Resources - Anadromous Fisheries

LEVEL OF EFFORT:Total 4046 Man-days, POS Phase 2971 M/D, Follow-on 1075 M/DSCHEDULE:February 1980 to July 1982, Follow-on work to April 1983ESTIMATED COST:Total \$1,341,000; POS Phase \$1,018,000; Follow-on \$323,000RESPONSIBILITY:J. P. Houghton (Dames and Moore)

PURPOSE:

- To define the distribution, abundance, and timing of adult anadromous fish usage of the main stem Susitna River and the lower reaches of tributaries and sloughs most likely to be affected by altered stream flows.
- To study the rate of development and survival of eggs deposited in sloughs near the main stem as a function of temperature and percent fines in the gravel (i.e. in areas that could be affected by increased winter temperature or sediment load).
- To define the distribution, abundance, and timing of juvenile salmon usage of the main stem Susitna River and lower reaches of tributaries and sloughs most likely to be affected by altered stream flows. Emphasize fall and spring migration patterns, areas of overwintering, and winter food habits.
- To assess the seasonal abundance and character of benthic, planktonic, and drift invertebrates comprising the food resource of juvenile anadromous species in main stem Susitna River and lower tributaries and sloughs most likely to be affected by altered stream flows.
- To evaluate potential impacts of the project on the aquatic habitat and anadromous fisheries resources of the Susitna River system.
- To investigate the suitability and effectiveness of alternative measures to mitigate predicted project-related impacts on anadromous fisheries.
- To assess the impacts of alternatives to the project on this resource group and rank them in relation to this project.

INTRODUCTION:

In recent years, the fisheries resources of the Susitna River system have received considerable study by the Alaska Department of Fish and Game (ADF&G). Between 1974 and 1977 investigations partially funded by the U.S. Fish and Wildlife Service (USFWS) were directed largely at obtaining basic information on distribution, abundance, and life history information of commercially important anadromous species (Pacific salmon) between Devil Canyon and Montana Creek. Some additional effort was directed at overall system escapement of the five species of salmon indigenous to the system, as well as to resident fish populations in the waters in and upstream of the area of the proposed impoundments. Results of these studies have been reported by several sources (e.g. Riis 1977, Barrett 1974, Friese 1975) and summarized by ADF&G.(1978). This information provides a framework on which to build the data base required for analysis of project impacts on the Susitna system's highly valuable salmonid resources. Two basic sampling strategies will be employed. The first involves qualitative surveys of large areas of the river system and is designed to further define distributional patterns of important species and different age classes at key times of the year. The second is comprised of intensive sampling year round at a number of sampling stations considered "typical" of important aquatic habitats (e.g. spawning areas, rearing areas, overwintering areas, mouths of tributaries) that may be impacted. Important characteristics that will be examined include water quality and quantity, flow patterns, sediment load, streambed characteristics, benthos and plankton, and anadromous and resident fish.

SCOPE:

Review of Available Information

Review available literature and other information regarding anadromous fisheries resources (including habitat characteristics) of the Susitna River system and the potential impacts of project construction and operation on these or similar resources. Review project specifications and expected alterations to the physical characteristics of anadromous fish habitat. This will provide historical background information and a basis for finalizing details of the field studies. This Task will begin immediately upon authorization and will be largely complete within the first quarter. However, limited effort will be continued throughout the study as additional information becomes available.

Initial Reconnaissance for Planning Studies

The objective of this Task is to provide an early overview of regional anadromous fisheries conditions as input to Stage 1 - Plan Formulation Studies. Activities will include:

- Identification of anadromous fisheries conditions that are likely to be of concern in the assessment of energy source alternatives.
- Preliminary assessment of the relative potential impact to anadromous fisheries for each energy source alternative.

Initial Reconnaissance of the Study Area

Conduct low altitude aerial reconnaissance of the study area during the first quarter of the study to orient principal researchers with the local geography. Ideally this would be

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done before before freezeup in 1979. If this is not possible the aerial reconnaissance will be conducted during the winter and repeated after breakup. Researchers will note key features on detailed maps or aerial photographs. They will be particularly alert for potential sites for further study and for clearwater tributaries and sloughs that may represent overwintering areas. Only lower reaches of tributaries likely to be affected by higher winter flows will be surveyed.

During the winter of 1980 ground reconnaissance will also be conducted along the river below Devil Canyon. The survey party will move by snow machine or aircraft and use ice augers to determine ice thickness and water depth. Feasibility of various through-theice techniques for sampling fish and bottom gravels will be evaluated. Particular emphasis will be placed on sloughs in the Gold Creek to Talkeetna area that have been previously studied by ADF&G (Barrett 1974).

Baseline Data Collection

Distribution and Abundance

In order to further refine existing information (e.g. Barrett 1974, Friese 1975, Riis 1977, ADF&G 1978) on the relative use of various areas (primarily the main stem and the lower reaches of tributaries below Devil Canyon) qualitative sampling will be conducted using a variety of techniques such as electrofishing, beach seining, fish wheels, and fish traps. Streams to be crossed by transmission line and road corridor will also be examined. This effort will start in tributaries in the lower part of the drainage soon after breakup and work upstream through the spring. Main stem studies will depend on the progression of breakup. This approach should provide sampling of most areas near the time of maximum likelihood of usage by downstream migrants.

Near the end of the open-water period many of the same areas will be surveyed again to determine the degree of usage by late spawning salmon (coho and chum). Fish traps and wheels in the main river will be operated during the midsummer to fall period of adult upstream migrations. Sonar techniques under development by ADF&G and other groups will be used if deemed feasible for assessing adult escapement and migration timing. Tagging and electripheorsis of tissue samples (using techniques of F. Utter, NMFS, Seattle) will be used to identify fish stocks and investigate the degree of "milling" in the vicinity of Talkeetna (see ADF&G 1978). During the summer and fall salmon spawning period, stream surveys will be conducted on foot, by boat, and by plane to map the distribution of redds in clear water areas of the system within 1 to 2 km of the main stem (depending on the gradient). Surveys will concentrate on areas where spawning has not previously been documented (e.g. in the main stem and in tributaries in and above Devil Canyon) but will also reassess spawning levels in sloughs and tributaries below Devil Canyon where historical data exist. Attempts will be made to determine the extent of under-ice spawning, perhaps in the main stem after it clears, a recently discovered phenomenon in many Alaskan streams.

Distribution and abundance studies will be concentrated during the first year of the program but will be continued in subsequent years in key locations during adult migration and spawning, and in areas where data are incomplete.

These studies will be concentrated below Devil Canyon. Resident fish taken in various sampling programs will be recorded and measured and the data turned over to the resident fish study group.

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• Egg-to-Fry Development and Survival

The effect of temperature on the rate of development of salmon spawn in the gravel will be measured in selected slough areas in the Gold Creek to Talkeetna area. Redds, where species and spawning data are known, will be marked with stakes, buoys, or above water survey marks before freezeup. Artificially fertilized eggs will also be placed in the same area in bottom-anchored incubation boxes using the methods of Graybill et al. (1978). Continuous recording thermistors will be placed in the gravel to monitor temperature through the intragravel development period. Egg samples will be recovered periodically to check stage of development after 200 temperature units (T.U.) have been accumulated. These experiments will be carried out in one of the "warm water" sloughs identified by Barrett (1974) as well as in sloughs without warmer ground water seeps to examine the effect of temperature on the total number of T.U.s required for peak emergence. These studies should allow estimation of the acceleration of emergence timing that can be expected due to the project in spawning areas that are influenced by project-induced temperature changes.

Attempts will be made to use standard hydraulic sampling techniques through or under the ice (using divers) to determine egg-to-fry survival rates in natural redds in various areas. Grain size analysis of redd materials both in the fall and after emergence will be performed and related to survival rates.

Techniques for this study will be refined with a pilot study during the first winter and will be employed in more extensive studies over the second winter.

• Juvenile Life History Studies

In addition to the general distributional surveys described above, more concentrated and quantitative studies will be conducted during the first year of the study at sites where ADF&G has previously carried out similar studies (e.g. Montana, Rabideaux Creeks; ADF&G 1978). This work will serve to build on the existing data base for these areas and to field test methods to be used in the second year of the project.

The general goal of these studies will be to examine in detail aspects of the life history of species that may be affected by the altered flow regime that will result from project construction and operation. Methods used will be similar to those described by ADF&G (1978) and will include electrofishing, seining, and trapping to obtain population indices, density estimates and fish for tagging, scale, and otolith (age) analysis, and stomach analysis. Emphasis will be placed on spring and fall migration patterns of juveniles and the delineation of wintering habitat requirements. Of primary concern is the extent of fall migrations from the tributaries into overwintering areas in the main stem Susitna or adjacent clearwater sloughs. Recapture of marked fish and relative capture rate in upstream- and downstream-directed traps will aid in this determination. Abundance of juveniles in the main stem will be indexed by frequent (biweekly or monthly) beach seining during the open-water period. Various techniques including use of baited traps, fyke nets, gill nets, and electrofishing will be used to attempt to capture fish through and under the ice.

General condition of the fish (length-weight ratio, degree of "smoltification") degree of stomach fullness, and nature of stomach contents will be closely followed in all areas sampled.

• Invertebrates

The effects of the project on availability of invertebrates comprising the food base for rearing juvenile anadromous fish is of major importance in evaluation of overall project impacts. During the ice-free period, standard methods such as Surber-type samplers, drift nets, and artificial substrates (multiple plate samplers and gravel-filled baskets) will be used to collect quantitative or semiquantitative samples in the main stem, sloughs off the main stem, and in lower reaches of tributaries. During the winter, this gear will be set through the ice to document abundance of food organisms, especially in the main stem.

Aquatic Habitat Assessment

Water quantity and quality are important aspects of the aquatic habitat of the Susitna system. Baseline information will be collected to provide data on the interrelationship between the flowing water and biological components of the system. Emphasis will be placed on evaluating the nature and extent of mutual changes in water flow, suspended sediment load, temperature, and the dissolved oxygen. Data also will be collected to assess the relative contributions from the discharges of the Chulitna and Talkeetna Rivers to the Susitna system.

The quantity and quality of water within the main stem Susitna River and in the Chulitna and Talkeetna Rivers will be monitored year round. Data will be obtained at existing U.S.G.S. gaging stations and at additional sites to be established conjunction with the hydrology study team. Information to be obtained at each site will include discharge, temperature, dissolved oxygen, pH, and specific conductance. The U.S.G.S. will be contracted to install and operate the gaging stations.

As part of the biological field studies, the principal investigators will concurrently collect aquatic habitat data. Streambed characteristics will be documented and water samples will be collected and analyzed for temperature, turbidity, and total suspended sediment. In addition, staff gages will be installed near the field camps to identify important flow conditions for biological sampling at near-shore areas, sloughs, and mouths of tributaries. Sampling and flow conditions will be correlated to document conditions (e.g. access to sloughs, depth in spawning and rearing areas) under flow regimes similar to those expected during project operation.

Impact Assessment and Mitigation

A detailed review will be conducted of literature, both published and unpublished, relating to the environmental tolerances of Pacific salmon and the effects of potential project-related alterations to the physical habitat of these fish. This review will begin early in the study so that information gained can be used to improve the utility of field sampling programs for impact analysis.

Direct information on effects of dams on salmon in the Alaskan environments is lacking. Therefore, extrapolation from research done elsewhere (Canada, Pacific Northwest) will be required based on the knowledge of the present life history requirements, timing, and distributional patterns as determined by on-site studies described above. Results and impact projections from a similar study of downstream impacts of dam contruction on Pacific salmon in the Skagit River, a glacially-fed stream in Washington State (Graybill et al. 1978) will be of particular interest. Major potential impacts that must be evaluated include:

- Effects of lowered summer stream flow, suspended sediment levels, and temperatures on migration patterns, access to spawning areas, success of spawning, and success of rearing (increased predation, increased food availability). These effects are expected largely above the confluence of the Chulitna and Talkeetna Rivers.
- Effects of increased winter stream flow, suspended sediment levels, and temperatures on late fall or under-ice spawning (if it exists), egg development and survival in the main stem (if there is main stem spawning) and in the clearwater sloughs and mouths of tributaries, and on the availability and suitability of overwintering areas (including availability of food resources) for juvenile salmon.

Impacts expected to be relatively minor depending on the outcome of on-site studies include:

- Blockage of all upstream migration, if any now exists.
- Gradual purging of fines from streambed gravels between the lower dam and the mouths of the Chulitna and Talkeetna Rivers. Over the years this results in a very coarse or "shielded" streambed unsuited to spawning by salmon.

In the course of these evaluations balanced attention will be given to both positive and negative impacts of the project. Several potentially very significant positive impacts that have received little attention in discussion to date include:

- The likelihood of establishing conditions suitable for salmon spawning in a large stretch of river from Devil Canyon to Talkeetna due to the reduced suspended sediment load and the stabilized flow regime.
- The likely increase in summer productivity of benthic invertebrates in the main stem from Devil Canyon to Talkeetna due to the same factors. (This will be offset to some degree by the lowered summer temperatures.)
- The potential for a greatly increased overwintering area in the main stem and connecting sloughs due to the much greater winter flow rates. (This will be offset to a degree by the increased suspended sediment load the water will carry.)
- Reduction in the adverse effects of floods and large flow fluctuation on benthic productivity and the success of intragravel egg development (dependent on the present level of benthic productivity during periods of natural floods and the extent of spawning in the main stem).

Positive and negative impacts will be placed in perspective and quantified to the extent possible. Impacts that are directly related to construction activities and are of a short-term nature will be distinguished from long-term impacts. Overall net losses (or gains) of salmon runs attributable to the project will be difficult to precisely predict and numbers derived can only be considered as estimates.



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TASK: C-4-7 Aquatic Resources - Anadromous Fisheries

Late in the second year of study, a workshop will be set up, bringing together a number of experts from Alaska, British Columbia, and Washington in salmonid life history and effects of hydropower development. These will include representatives from ADF&G, U.S. Fish and Wildlife Instream Flow Technical Group, the National Marine Fisheries Service, and area universities. Project scientists and engineers will provide descriptions of existing conditions in the Susitna system and the expected design of the project including anticipated downstream flow, total suspended sediment, and temperature regimes.

Round table discussions will ensue regarding anticipated impacts on indigenous species and the potential for development of "exotic" populations (e.g. a new run of fish spawning in the main stem).

In this manner the best available expertise will be brought to bear on the questions of:

- Adequacy of studies to date and redirection of future efforts.
- Degree of expected positive and negative impacts and validity of impact analyses conducted to date.
- Measures to mitigate negative impacts and augment positive impacts.

Results of workshop discussions will be incorporated into the preliminary feasibility analysis to be prepared at the end of the second year of study.

Potential mitigation measures that will be evaluated include:

- Establishing guaranteed minimum flows at various times of the year.
- Establishing guaranteed minimum rates of change of flow at various times of the year.
- Requiring discharge from reservoir stratum to most closely match upstream temperature.
- Improving fish accessibility to sloughs and tributaries by removing present barriers (e.g. beaver dams, cascades, or barriers created by altered flow regimes such as sills) that limit access to otherwise suitable spawning and/or rearing areas.
- Construction of hatcheries, spawning channels, etc.

The latter two types of mitigation above could be applied elsewhere in the Susitna system or in other systems not affected by the project. Stream channel improvements often are highly successful at increasing fish production at a reasonable cost. Because of technical problems and the extreme cost of operating a hatchery in the cold climate of the study area, this approach may well be classed as the "last resort" among alternative mitigative measures. Construction of spawning channels for pink and chum salmon, taking advantage of the regulated flow from the project and the minimal freshwater rearing requirements of these species, would be a far more attractive option.
DOCUMENTATION:

All quantitative field and laboratory data will be recorded on standard computer forms for automated processing using existing programs. Field notes, distribution, and spawning bed mass and other qualitative data will be compiled in a scientifically appropriate manner and checked for accuracy and completeness by the principal investigator. Water quality and stream flow data also will be provided to the hydrology study team for integration into that data base.

Quarterly reports will be prepared outlining activities and significant results, analyses, and problems encountered during the preceding quarter.

An annual report will be prepared each year describing in detail:

- Methods used in field sampling and laboratory analysis.
- Results of studies conducted during the year and their relation to the previous data base. Results will be amplified by appropriate graphic and tabular presentations of information.
- Discussion of the potential impacts of the project, as currently conceived, on the anadromous fish resources of the system.
- Discussion of the apparent suitability of various mitigation alternatives.
- Description of studies to be performed in the coming year.

The first annual report will also include a discussion of the results of the review of available information both on existing conditions and populations in the drainage and on potential impacts of hydroelectric projects.

The second annual report will also include the results of the impact and mitigation workshop. This report will be the basis for an interim report discussion of the existing conditions, potential impacts and mitigation measures required for Exhibits S and W in order that the FERC License Application can be submitted at the earliest possible date.

The final report will contain the elements listed above but encompassing the entire feasibility programs. It will be fully integrated with other tasks in the program and will contain recommendations for construction and operational monitoring programs to assess actual impacts of the project. This document will be suitable for inclusion as a supplement to Exhibits W and S of the Federal Energy Regulatory Commission License Application.

SCHEDULE DESCRIPTION:

Anadromous fisheries studies will extend over 3 full biological years (1980-1982) with an additional period (1983) for final data analysis and reporting. The timing of effort within any given year is described under the Scope section above. Some activities such as spawners distribution will be repeated at roughly equivalent efforts in all 3 years while others such as the egg-to-fry survival studies will be concentrated in 1 or 2 years. A 3-year study period is required to include the high and low points on the cycles (up to 5 years) of the various anadromous species.



LEVEL OF EFFORT DESCRIPTION:

A total effort of 4,046 man-days is anticipated at a labor cost of approximately \$1.22 million (1979 dollars). Equipment, travel, subsistence (except while in field camps), and subcontracted analyses are estimated at \$120,000 for a total task cost of \$1.34 million. Costs of establishing and supporting field camps, gaging stations, and subsistence in field camps are not included, nor is the cost of boats, aircraft, vehicles, and snow machines.

PERSONNEL ASSIGNED:

Dames & Moore will be responsible for all work in this task. However, it is anticipated that major portions of the field and laboratory analyses will be performed by ADF&G and the U.S.G.S. (for discharge and water quality) through arrangements to be negotiated.

REFERENCES:

- Alaska Department of Fish and Game, 1978. Preliminary environmental assessment of hydroelectric development on the Susitna River. Ms. prepared for USFWS.
- Barrett, B.M., 1974. An assessment study of the anadromous fish population in the upper Susitna River watershed between Devil Canyon and the Chulitna River. Cook Inlet Data Report No. 74-2. Alaska Department of Fish and Game. Division of Commercial Fisheries, 56 pp.
- Friese, N.V., 1975. Preauthorization assessment of anadromous fish populations of the upper Susitna River watershed in the vicinity of the proposed Devil Canyon hydroelectric project. Cook Inlet Data Report No. 75-2. Alaska Department of Fish and Game. Division of Commercial Fisheries, 121 pp.
- Graybill, J.P. et al. (co-authors), 1978. Assessment of the reservoir-related effects of the Skagit River Project on downstream fishery resources of the Skagit River, Washington. Interim report for the City of Seattle, Department of Lighting, FRI-UW-7822, Seattle, Washington.
- Riis, J.C., 1977. Pre-authorization assessment of the proposed Susitna River hydroelectric projects: preliminary investigations of water quality and aquatic species composition. Alaska Department of Fish and Game. Division of Sport Fish, 91 pp.

CATEGORY <u>C</u>ENVIRONMENTAL STUDIES

ASSIGNMENT: C-4 EXHIBIT "W" ENVIRONMENTAL REPORT

TASK TITLE: C-4-8 Aquatic Resources - Resident Fisheries

LEVEL OF EFFORT:_	1468 Man-days
SCHEDULE:	February 1980 to July 1982
ESTIMATED COST:	\$517,000
RESPONSIBILITY:	J. Morsell (Dames & Moore)

PURPOSE:

- To define the seasonal distribution and abundance of resident fish species in the main stem Susitna River and the lower reaches of tributaries and sloughs most likely to be affected by reservoirs on the Upper Susitna River.
- To determine seasonal habitat requirements necessary to sustain the species present, stressing the extent of use of the main stem of the Susitna River and lower reaches of tributaries for overwintering by resident species.
- To assess the seasonal abudance and character of benthic, planktonic, and drift invertebrates comprising the food resource of resident species in main stem Susitna River and tributaries that will be affected by a Susitna hydroelectric project.
- To evaluate potential impact of a Susitna hydroelectric project on the resident fisheries resources of the Susitna River system.
- To investigate the suitability and effectiveness of alternative measures to mitigate predicted project-related impacts on resident fisheries.
- To assess and rank the relative impacts of alternatives to a Susitna hydroelectric project on this resource group.

SCOPE:

Review of Available Information

The limited available information on the resident fisheries and freshwater habitat characteristics of the Susitna River system and on the proposed project design and associated physical impacts will be assembled and reviewed. This will provide historical and background information and a basis for finalizing details of the field studies. This Task

will begin immediately upon authorization and will be largely complete within the first quarter. However, limited effort will be continued throughout the study as additional information becomes available.

Initial Reconnaissance for Planning Studies

The objective of this Task is to provide an early overview of regional resident fisherier conditions as input to Stage I - PLAN FORMULATION STUDIES.

Activities will include:

- Identification of resident fisheries conditions that are likely to be of concern in the assessment of energy source alternatives.
- Preliminary assessment of the relative potential impacts to resident fisheriers for each energy source alternative.

Initial Reconnaissance of the Study Area

Low altitude aerial reconnaissance of the study area will be conducted during the first quarter of the study to orient principal researchers with the local geography. Ideally this would be done before freezeup in 1979. If this is not possible the aerial reconnaissance will be conducted during the winter and repeated after ice breakup. Researchers will note key features on detailed maps or aerial photographs. They will be particularly alert for potential sites for further study and for clearwater tributaries, lakes, and sloughs that are the primary habitat of resident species. Only lower reaches of tributaries likely to be affected by the reservoirs will be surveyed.

During the winter of 1980 ground reconnaissance will also be conducted along the riever and its tributaries in and above Devil Canyon. The survey party will move by snow machine or aircraft and use ice augers to determine ice thickness and water depth at various locations. Feasibility of various through-the-ice techniques for sampling fish and bottom gravels will be evaluated. Particular emphasis will be placed on lower portions of tributaries in areas that will be inundated by project reservoirs.

Baseline Data Collection

Distribution and Abundance

In order to further refine existing information (e.g. ADF&G 1978) on the relative use of various areas (primarily the main stem and the lower reaches of tributaries in and above Devil Canyon and along transmission and road corridors) qualitative sampling of resident fish species will be conducted using a variety of techniques such as electrofishing, beach seining, and fish traps. This effort will begin in tributaries soon after ice breakup in order to coincide with grayling spawning migrations. Main stem studies will depend on the progression of ice breakup. Data on resident fish below Devil Canyon will be obtained from sampling conducted under the anadromous fish task and will be analyzed within this task.

During midsummer many of the same areas will be resurveyed to determine the summer habitat requirements and carrying capacity for resident fish. Tagging of fish will be used to identify fish stocks and investigate the degree of interchange of fish between the tributaries and the main stem.

Distribution and abundance studies will be concentrated during the first year of the program but will be continued in the second year in key locations and in areas where data are incomplete.

• Detailed Life History Studies

In addition to the general distributional surveys described above, more concentrated and quantitative studies will be conducted during the second year of the study on two or more of the major creeks (e.g. Watana, Kosina, Jay Creeks). The general goal of these studies will be to examine in detail aspects of the life history of species that may be affected by the fluctuating water levels in impoundements that will result from the construction and operation of a Susitna hydroelectric project. Sampling methods employed will include electrofishing, seining, and trapping. Sampling will be used to obtain population indices, density estimates and fish for tagging, scale, and otolith (age) analysis, and stomach analysis. Emphasis will be placed on spring and fall migration patterns and the delineation of wintering habitat requirements. Recapture of marked fish and relative capture rate in upstream- and downstream-directed traps will aid in this determination.

Abundance of fish in the main stem will be indexed by frequent (monthly or bimonthly) beach seining during the open-water period. Various techniques including use of baited traps, fyke nets, gill nets, and electrofishing will be used to attempt to capture fish through and under the ice.

General condition of the fish (length-weight ratio), degree of stomach fullness, and nature of stomach contents will be closely followed in all areas sampled.

• Invertebrates

During the ice-free period, standard methods such as Surbertype samplers, drift nets, and artificial substrates (multiple plate samplers and gravel-filled baskets) will be used to collect quantitative or semiquantitative samples of invertebrates that comprise the food base for resident fish in the main stem, sloughs off the main stem, and in lower reaches of tributaries. During the winter, this gear will be set through the ice to document abundance of food organisms, especially in the main stem.

Aquatic Habitat Assessment

Water quantity and quality are important aspects of the aquatic habitat of the Susitna River system. Baseline information will be collected to provide data on the interrelationships between the flowing water and biological components of the system. Emphasis will be placed on evaluating the nature and extent of natural changes in water flow, suspended sediment load, temperature, and dissolved oxygen.

TASK: C-4-8 Aquatic Resources - Resident Fisheries

The quantity and quality of water within the upper main stem Susitna River will be monitored year round. Data will be obtained at existing U.S.G.S. gaging stations and at additional sites to be established in conjunction with the Hydrology Study Team. Information to be obtained at each site will include discharge, temperature, dissolved oxygen, pH, and specific conductance. The U.S.G.S. will be contracted to install and operate the gaging stations.

As part of the Biological Field Studies, the principal investigators will concurrently collect aquatic habitat data. Streambed characteristics, and water depths and velocities will be documented. Water samples will be collected and analyzed for temperature, turbidity, and total suspended sediment.

Impact Assessment and Mitigation

A detailed review will be conducted of literature, both published and unpublished, relating to the life history and environmental tolerances of resident fish and the effects of potential project-related alterations to the physical habitat of these fish. This review will begin early in the study so that information gained can be used to improve the utility of field sampling programs for impact analysis.

The major potential impact to resident fish that must be evaluated is the effects of reservoir inundations on streams tributary to the reservoirs. The two major aspects of reservoir inundation affecting resident fish include the habitat in the portions of tributaries and, possibly, the opening up of fish access to streams previously blocked by falls or cascades. The effects of the impoundments on resident species will be largely a function of direct loss or gain of habitat and the extent of usage of that habitat.

The workshop process (described in the anadromous fisheries task) to evaluate impacts of the project and potential mitigative measures also will be applied to resident species.

Mitigation of impacts to resident species in the impoundment area can perhaps best be achieved by improving fish accessibility to sloughs and tributaries by removing natural barriers (e.g. beaver dams, cascades) that limit access to otherwise suitable spawning and/or rearing areas. Mitigation of effects on resident species below Devil Canyon can be achieved by methods described in the anadromous fish task.

DOCUMENTATION:

All quantitative field and laboratory data will be recorded on standard computer forms for automated processing using existing programs. Field notes, distribution, and spawning bed maps and other qualitative data will be compiled in a scientifically appropraiate manner and checked for accuracy and completeness by the principal investigator. Water quality and streamflow data also will be provided to the hydrology study team for integration into that data base.

Quarterly reports will be prepared outlining activities and significant results, analyses, and problems encountered during the preceding quarter.



TASK: C-4-8 Aquatic Resources - Resident Fisheries

An annual report (1980) and a final report (1981) will be prepared, describing in detail:

- Methods used in field sampling and laboratory analysis.
- Results of studies conducted during the year and their relation to the previous data base. Results will be amplified by appropriate graphic and tabular presentations of information.
- Discussion of the potential impacts of the project, as currently conceived, on the resident fish resources of the system.
- Discussion of the apparent suitability of various mitigation alternatives.
- Description of studies to be performed in the coming year.

The annual report for 1980 also will include a discussion of the results of the review of available information, both on existing conditions and populations in the drainage and on potential impacts of hydroelectric projects.

The final report will be fully integrated with other tasks in the program and will contain recommendations for construction and operational monitoring programs to assess actual impacts of the project. This document will be suitable for inclusion as a part of Exhibits W & S of the Federal Energy Regulatory Commission application. The final report also will include the results of the impact and mitigation workshop.

SCHEDULE DESCRIPTION:

Resident fisheries studies will last over 2 full biological years (1980-1981) with an additional winter sampling and 6-month period for final data analysis and report during 1982. Two years are considered adequate to define populations of resident fisheries because of their more stable and less dynamic nature (as compared with anadromous species). Resident populations, especially above Devil Canyon, are largely unexploited and are expected to be governed largely by the carrying capacity of their environment, a feature unaffected by events outside of the drainage area. The timing of effort within any given year is described under the Scope section above. Abundance studies will be concentrated in the first year and more detailed life history studies in selected areas will be concentrated in the second year.

LEVEL OF EFFORT DESCRIPTION:

A total effort of 1,468 man-days is anticipated at a labor cost of approximately \$442,000. Equipment, travel, subsistence (except while in field camps) and subcontracted analyses are estimated at \$75,000 for a total task cost of \$517,000. Costs of establishing and supporting field camps, gaging stations, and subsistence in field camps are not included, nor is the cost of boats, aircraft, vehicles, and snow machines.



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PERSONNEL ASSIGNED:

Dames & Moore will be responsible for all work in this Task. However, it is anticipated that major portions of the field and laboratory analyses will be performed by ADF&G and the U.S.G.S. (for discharge and water quality) through arrangements to be negotiated.

REFERENCES:

Alaska Department of Fish and Game, 1978, Preliminary environmental assessment of hydroelectric development on the Susitna River. Ms. prepared for USF & WS.



CATEGORY:		ENVIRONMENTAL	STUDIES	· · ·	
ASSIGNMENT	<u>C-4</u>	EXHIBIT "W" -	ENVIRONMENTAL	REPORT	

TASK TITLE: C-4-9 Aquatic Resources - Upper Cook Inlet Estuary

LEVEL OF EFFORT:_	80 Man-days
SCHEDULE:	February 1980 to April 1981
ESTIMATED COST:	\$40,000
RESPONSIBILITY:	R. Schleuter (Dames & Moore)

PURPOSE:

- To identify critical deficiencies in the existing data base with respect to predicting project impacts in the estuary and design studies to gather required information.
- To perform limited field investigations to correct critical deficiencies in the data base and/or to refine the model.
- To derive a preliminary physical and chemical model, based on available data, to describe the present conditions in the upper inlet (net nutrient, freshwater and sediment input, current, salinity, and temperature patterns, etc.).
- Using the model, to evaluate the impact on the estuary of the altered flow regime of the Susitna River that will result from project operation.

SCOPE:

Review of Available Information

There are a moderate number of studies of the existing oceanographic conditions in Upper Cook Inlet (e.g. Britch 1974, Dames & Moore 1974, Kinney 1970, Rosenburg et. al. 1967), and the inputs of various freshwater tributaries (e.g. Rosenburg et. al. 1967, U.S.G.S annual water resources reports). This body of information will be compiled and reviewed in detail from data relevant to the modeling effort. Data on expected project-related changes to the contribution of fresh water, nutrients, and sediments in the upper inlet also will be assembled. Areas where data are insufficient or lacking will be identified.

Initial Reconnaissance for Planning Studies

The objective of this Task is to provide an early overview of the Upper Cook Inlet Estuary aquatic resources as input to Stage 1 - Plan Formulation Studies. Activities will include:

- Identification of aquatic resources in the Upper Cook Inlet Estuary that are likely to be of concern in the assessment of energy source alternatives.
- Preliminary assessment of the relative potential impacts to the aquatic resources of the Upper Cook Inlet Estuary for each energy source alternative.

Field Studies (Optional)

Limited field studies may be deemed advisable to correct critical deficiencies in the existing data base and/or to refine the predictive capabilities of the model. These studies may include one-time flow, suspended sediment, or nutrient measurements of major streams to supply data for correlation with existing data on nearby watersheds. Profiles of sediment and nutrient levels in the upper inlet at certain times of the year (e.g. winter) may also require limited study. Biological importance of the upper inlet (e.g. for feeding of juvenile salmonids) may also require additional investigation if results of physical and chemical model analyses indicate the potential for significant project-related changes.

Model Formulation

Existing data or projections extrapolated from existing data (e.g. in the case of significant river systems lacking U.S.G.S. records) are expected to be adequate to permit formulation of a first-order mass balance model of the upper inlet. This model will balance net inputs of relatively nutrient- and sediment-poor water northward along the east side into the upper inlet (Gatto 1976) and inputs of sediment-laden and relatively nutrient-rich waters entering the inlet from its northern tributaries, with the net outflow of sediment-laden nutrient-rich water southward down the west side of the inlet. The relative importance of the contribution from various freshwater tributaries will be summarized under existing conditions.

Model Refinement

The model, as formulated based on existing data, will be evaluated and any shortcomings will be identified. Studies to supply inputs, which when refined could have a major influence on the outcome of model predictions, will be defined. These studies, if required, would be performed to improve the data base. Study results will be evaluated and factored into the model, thereby improving its predictive sensitivity.

Impact Assessment

The effect of altered Susitna River flows and nutrient and sediment contributions on the upper inlet will be evaluated utilizing the model. The biological effects of these changes on the already low level of biological activity in the upper inlet will be assessed.

Documentation

Data extracted from available literature will be compiled on standard forms to increase ease of retrieval and use in the model.

Quarterly reports will be prepared outlining the status of work on the various Tasks and the prognosis for successful modeling based on available data or steps that are planned to gather required data.



A final report will be prepared describing in detail:

- The status of oceanographic knowledge of Upper Cook Inlet identifying general gaps in existing data.
- The form and function of model developed.
- Studies (if any) required to supply missing data and/or to improve predictive capability.
- Results of modeling project impacts on the estuary.
- Recommendations for additional research (if needed) to provide more detailed evaluation of project effects on the estuary.

Results of the study will be summarized and incorporated into the FERC Application, Exhibits W and S.

SCHEDULE DESCRIPTION:

The literature review and model formulation will be completed within the first two quarters of the project so that limited field efforts under open-water conditions can be performed, if deemed necessary, during the summer of 1980. If winter observations are needed they would take place during the winter of 1980-1981 with task completion in the second quarter of 1981. Otherwise the entire Task should be completed by the end of 1980.

LEVEL OF EFFORT DESCRIPTION:

80 Man-days; \$40,000 (Assumes no field work is required to support the model.)

PERSONNEL ASSIGNED:

Dames & Moore will have responsibility for this Task but will require inputs from the Hydrology Study Team.

REFERENCES:

- Britch, R. P., 1976. Tidal currents in Knik Arm Cook Inlet, Alaska--A Masters Thesis prepared at University of Alaska, Institute of Water Resources.
- Dames & Moore, 1974. Detailed environmental analysis concerning a proposed liquified natural gas project for Pacific Alaska LNG Company. Docket No. CP75-Exhibit Z-1V.
- Gatto, L. W., 1976. Baseline data on the oceanography of Cook Inlet, Alaska. Report prepared at U.S. Army, Cold Regions Research and Engineering Laboratory for National Aeronautics and Space Administration as CRREL Report 76-25.

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- Kinney, P. J., 1970. Cook Inlet environmental data, R/V Acona Cruise 065--May 21-28, 1968. Institute of Marine Science Report R70-2, University of Alaska, Fairbanks, Alaska.
- Rosenberg, D. H., Burrell, D. C., Natarajan, K. V., and Hood, D. W., 1967. Oceanography of Cook Inlet wih special reference to the effluent from the Collier Carbon and Chemical Plant. Institute of Marine Science Report No. R67-5, University of Alaska, Fairbanks, Alaska.

CATEGORY	С	ENVIRONMENTAL STUDIES	

ASSIGNMENT C-4 EXHIBIT "W" ENVIRONMENTAL REPORT

TASK TITLE: C-4-10 Vegetation

LEVEL OF EFFORT	280 Man-days
SCHEDULE:	February to December 1980
ESTIMATED COST:	\$95,000
RESPONSIBILITY:	P. Hanley (Dames & Moore)

PURPOSE:

- To produce large-scale (1:24,000 or 1 inch 2,000 feet) vegetation maps of the project area. This area will include impoundment areas, the downstream flood-plain as far as the confluence with the Chulitna River, the upstream floodplain as far as the confluence with the Tyone River, and transportation and transmission line corridors.
- A major purpose of the vegetation maps is to provide a baseline investigative tool for the other biologic tasks including the habitat evaluations of birds, small and large mammals, and fish. In addition the maps will provide the necessary baseline description required in the assessment of vegetation and habitat loss and related impacts resulting from the project.
- To perform vegetation mapping to establish seasonal variations in vegetation types, which will provide input to the wildlife habitat assessment, Tasks C-4-11 and C-4-12.

SCOPE:

The vegetation maps will delimit the forest and nonforest vegetation of the project area according to the classification development by Dryness and Viereck (1978) suitably modified for the biogeographic characteristics of the project area.

The vegetation mapping program will be an essentially straight-forward evaluation comprising three sequential tasks: (1) preliminary interpretation of remote sensing data, review of available literature on project area vegetation, and vegetation classification systems; (2) field checking and verification of preliminary vegetation maps; and (3) final interpretation and compilation of final vegetation maps. The scheduling of this analysis will be structured to provide preliminary vegetation maps to the biological researchers in time for the beginning of summer field seasons (see "Schedule" below). The photo intepretation and field verification tasks will be conducted in consultation

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and close coordination with the recipients and users of vegetation maps in order that specific needs can be addressed.

A brief description of the component tasks is given below:

Initial Reconnaissance for Planning Studies

The objective of this Task is to provide an early overview of regional vegetation conditions as input to Stage 1 - Plan Formulation Studies. Activities will include:

- Identification of vegetation condition that are likely to be concern in the assessment of energy source alternatives.
- Preliminary assessment of the relative potential impacts to vegetation for each energy source alternative.

Interpret Remote Sensing Data, Review Available Literature and Applicable Vegetation Classifications

The availability of remote sensing data and the requirements of the habitat investigations indicate that the most appropriate mapping scale will be 1:24,000 or 1 inch = 2,000 feet.

The following remote sensing data are known to be available for the project area:

- ERTS-1 and LANDSAT-1 and -2 multispectral satellite imgery
- High altitude U-2 photography
- Conventional black-and-white and infrared aerial photography at scales of 1:24,000 and 1:12,000
- LANDSAT Vegetation Classification mapping of Denali; mapping unit 10 acres.

Each of these imagery types have advantages and disadvantages, both in general terms and with respect to this study. ERTS and LANDSAT imagery, for example, provide multi spectral capabilities and can be interpreted and reduced using automatic data processing techniques which enable rapid, economical mapping of large areas. Generally, interpretation and mapping from this imagery are more suited to regional or subregional mapping up to 1:250,000 scale although successful vegetation mapping to a scale of 1:18,000 has been reported by the University of Alaska. ERTS/LANDSAT imagery does have the advantage of temporal coverage enabling seasonal variations in vegetation types and conditions to be assessed.

For detailed vegetation mapping and wildlife habitat evaluation, however, we believe that conventional and infrared black-and-white photography at a scale of 1:24,000 should be the primary interpretation and mapping tool. We propose to conduct a preliminary interpretation of ERTS/LANDSAT at the outset of this task as an adjunct and comparative base to the conventional photography as well as providing information on seasonal vegetation changes.



TASK: C-4-10 Vegetation

Interpreted data from the aerial photographs will be transferred to photomasaics and then to topographic base maps at the same scale for field verification and use by biological field personnel. Published data on the vegetation of the project area will be reviewed to assist in the photo interpretation. At the the same time, the vegetation classification system of Dryness and Viereck (1978) will be refined for the project area and adopted in the photo interpretation.

It is anticipated that the resolution of the photography and the requirements of the requirements of the biology team will result in map resolution to Level IV of this classification system.

Field Checking and Verification of Preliminary Vegetation Maps

The specific details of the field program to check and verify the preliminary vegetation maps will depend upon the results of the preliminary interpretation. The field program will involve helicopter, boat, and foot traverse to systematically resolve the following interpretation verification requirements:

- Delimitation of vegetative boundaries.
- Checking or sampling of representative vegetation units.
- Identification of units whose interpretation is uncertain.
- Correlation of geomorphic, hydrologic, climatologic, and geologic factors affecting vegetation distribution.

The field program will involve both annotation of aerial photos and preliminary maps during overflight and site sampling stops. These traverses and site sampling stations will be planned to maximize coverage while at the same time minimizing flying time.

Compilation of Final Vegetation Maps

A final photo interpretation will be conducted utilizing the results of the field program. Data obtained from other biologic researchers will also be utilized to assist in the final interpretation. A short fall field program will be conducted to provide additional data on seasonal vegetative changes.

DOCUMENTATION:

All data sources, interpretation notes and techniques, and field notes will be compiled in a scientifically appropriate manner and summarized in quarterly reports along with activities and problems encountered during the preceding quarter.

In addition to the vegetation maps and annotated key, the final (1981) report* will incorporate the results of this task in narrative describing:

* This Task will be completed prior to the annual (1980) report so that only one vegetation mapping report will have to be completed.

TASK: C-4-10 Vegetation

and and

- Methods and analytical techniques employed in compilation of the maps.
- Discussion of the vegetation classification system utilized.
- Description of vegetation types and distribution and their relationships to geomorphic, hydrologic, climatologic, and geologic controls.
- The significance of the vegetation types and distribution to wildlife habitat.
- The potential loss of vegetation (species type, area, etc.) resulting from the project and its significance to wildlife habitat.
- The analysis of vegetation, potential impacts and mitigation opportunities will be assemble in text and map form for direct incorporation into the FERC License Application Exhibit W.

SCHEDULE DESCRIPTION:

Assuming a February 1, 1980 authorization, this task can be completed in 10-1/2 months, i.e. mid-December 1980. Preliminary photo interpretation, data review, and preliminary map compilation can be completed in time for the first summer field season (by June 1, 1980) and used by other biologists in the project. Field checking will be completed by the end of July and final maps prepared by the end of August. A second field visit in the fall would be conducted to assess seasonal vegetation changes. The vegetation analysis schedule proposed as follows:

- February 1 May 1: Preliminary photo interpretation and review of available data.
- June 1 : Completion of preliminary vegetation maps.
- July 1 Sept. 31 : Field program.
- Aug. 15 Sept. 31: Compilation of final vegetation maps.
- Oct. 30 Nov. 15 : Fall field program.
- Nov. 15 Dec. 15 : Final report preparation.

LEVEL OF EFFORT DESCRIPTION:

A total effort of 280 man-days is estimated at a labor cost of \$84,000. Acquisition of remote sensing data (satellite imagery, aerial photos, etc.) photo data processing, travel and subsistence (except while in field camps), and map printing is estimated at \$11,000 for a total cost of \$95,000.

REFERENCES:

Dyrness, C. R. and Viereck, L. A., 1978. A suggested classification for Alaskan vegetation. University of Alaska (unpublished report).

CATEGORY:	C	ENVIRONMENTAL	STUDIES

ASSIGNMENT: C-4 EXHIBIT "W" ENVIRONMENTAL REPORT

TASK TITLE: C-4-11 Wildlife Resources - Large Mammals

LEVEL OF EFFORT: <u>648 Man-days</u> SCHEDULE: February 1980 to July 1982

ESTIMATED COST: \$244,000

RESPONSIBILITY: J. Hemming (Dames & Moore)

PURPOSE:

• To review available literature and raw data from ongoing studies of the Alaska Department of Fish and Game regarding moose, caribou, Dall sheep, grizzly bear, black bear, and wolves of the Upper Susitna River.

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- To identify areas of potential impact on wildlife resources from an evaluation of designs and project siting plans for hydroelectric dams, transmission/transportation corridors, and related facilities.
- To delineate sensitive wildlife habitate such as calving, lambing, and denning areas, migration routes, winter ranges, etc.
- To describe short- and long-term impacts of the project on large mammals and to provide methods of mitigating wildlife impacts.

INTRODUCTION:

A considerable volume of information exists in the literature and in unpublished reports of the Alaska Department of Fish and Game (ADF&G) regarding large mammals in the Upper Susitna Basin (upstream from Talkeetna River Junction). Records of the occurrence and abundance of caribou have been collected since the early 1940's (Skoog, 1968, Hemming 1971, 1975) and similar information has been collected for moose since 1952 (Rausch 1968, 1969; Taylor and Ballard 1978). Periodic aerial surveys of Dall sheep have been conducted since 1949 (Scott 1951, Nichols and Erickson 1968).

As a result of the various studies by ADF&G, major migration routes across the proposed reservoir area, calving areas, lambing areas, and winter ranges have been identifed. This information provides a framework that can be used to quantify habitat impacts of the proposed project and to develop a mitigation plan. Some additional field confirmation of sensitive areas for large mammals will be necessary for mapping purposes. Also, details of seasonal use patterns of moose on the south side of the Susitna River, particularly

the Oshetna River drainage will require considerable aerial survey. Grizzly bears are abundant throughout the area, but only limited information exists on denning areas and seasonal movements (especially on the south side from Fog Creek to Oshetna River) and additional study is required (Karl Schneider, ADF&G, personal communication).

Data on birds, and small mammals is extremely limited. Furbearer harvests have been monitored by ADF&G since statehood, but within the proposed project area only a small amount of information on the distribution, abundance, and productivity of wolves, wolverine, and lynx is available. There is essentially no data on small mammals and birds.

The approach to wildlife studies will be to summarize existing information and conduct supplementary field surveys on the south side of the Susitna for large mammals. Seasonal distribution patterns of small mammals and birds will be accomplished by intensive sampling at a number of stations within and immediately adjacent to the proposed reservoir areas.

SCOPE:

Review of Available Information

Available information on large mammals and their habitat characteristics along the Upper Susitna River will be assembled and reviewed. This will provide background information and identify site-specific data gaps requiring additional field study. This Task will begin immediately upon authorization and will be mostly complete within the first quarter. However, limited effort will be continued throughout the study as additional information becomes available.

Initial Reconnaissance for Planning Studies

The objective of this Task is to provide an early overview of regional large mammal wildlife resource conditions as input to Stage 1 - Plan Formulation Studies. Activities will include:

- Identification of large mammal wildlife resource conditions that are likely to be of concern in the assessment of energy source alternatives.
- Preliminary assessment of the relative potential impacts to large mammal wildlife resources for each energy source alternative.

Baseline Data Collection

Seasonal Distribution - In areas where information on the location or boundaries of sensitive habitat is lacking, aerial surveys by large mammal specialists will be conducted beginning in the winter of 1979-1980. Initially the south side of the Susitna between Devil Canyon and Tyone River and the entire Susitna River floodplain from Talkeetna to Devil Canyon will be surveyed. Special emphasis will be placed on the distribution and seasonal movements of grizzly bears, because of limited existing data and the fact that problems of bear/human interaction are to be expected on most remote construction projects in Alaska. Additional aerial survey will be conducted as required. Travel will be conducted by Cessna 185 equipped with ski-wheels in winter and floats in the summer.



• Delineation of Sensitive Areas - Information from field studies and the literature will provide the framework for identification of habitat that is critical for the continued survival of the species or population under study. Within the zone of impact for the project the sensitive areas will be carefully plotted on aerial photo mosaics at a scale of 1:24,000 (1" = 2,000').

Impact Assessment and Mitigation

A detailed review will be conducted of published and unpublished literature relating to behavior and environmental tolerances of large mammals such as Milke (1969), Price (1972), or Cameron (1975). Once the behavioral and habitat tolerances of the various large mammal species are understood, final quantification of impacts can be completed and mitigation plans can be developed.

One of the major potential impacts that must be evaluated is the potential loss of moose winter range in the Susitna River floodplain. Downstream areas may be affected by stabilization of seasonal flow and impacts within the proposed reservoir will be largely a function of direct loss of habitat.

An evaluation of ongoing studies by the U.S. Forest Service, the U.S. Fish and Wildlife Service, and the Alaska Department of Fish and Game on the Kenai Peninsula where various techniques of moose habitat improvement, such as controlled burning or crushing are being tested, will provide the primary guidelines for moose habitat mitigation.

Documentation

Field notes, distribution maps and other qualitative data will be compiled by standard scientific methods and incorporated into quarterly project reports.

An annual report (1980) and a final report (1981) will be prepared including:

- Methods used in field sampling and data analysis.
- Results of studies and conducted during the year and their relation to the previous data base. Results will be amplified by appropriate graphic and tabular presentations of information.
- Discussion of the potential impacts of the project on large mammals.
- Discussion of the apparent suitability of various mitigation alternatives.

The annual report for 1980 will also include a discussion of the results of the review of available information both on existing conditions and large mammal populations in the drainage and on potential impacts of hydroelectric projects.

The final report will be fully integrated with other tasks in the program and will contain recommendations for construction and operational monitoring programs to assess actual impacts of the project. This document will be suitable for inclusion as a part of Exhibits W and S of the FERC License Application.

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SCHEDULE DESCRIPTION:

Large mammals studies will be conducted for approximately 2 years (1980 and 1981) with an additional 6 months for final data analysis and reporting (1982). Two years of field study is considered adequate because of the large amount of data already available.

LEVEL OF EFFORT DESCRIPTION:

A total effort of 648 man-days is anticipated at a labor cost of approximately \$194,000. Equipment, travel, subsistence (except while in field camps) and subcontracted analyses are estimated at \$50,000 for a total task cost of \$244,000. Costs of establishing and supporting field camps and subsistence in field camps are not included nor is the cost of boats, aircraft, vehicles, and snow machines.

PERSONNEL ASSIGNED:

Dames & Moore will be responsible for all work in this task. However, it is anticipated that portions of the field study will be performed by ADF&G through arrangements to be negotiated.

REFERENCES:

- Cameron, R. D. and Whittier, K. R., 1975. Effects of the Trans Alaska pipeline on caribou movements. Alaska Department of Fish and Game, Fed. Aid in Wildlife Restoration, W-17-8.
- Chatelain, E. F., 1951. Winter range problems of moose in the Susitna Valley. Proc. Alaska Scientific Conference. Vol 2, pp. 233-347.
- Hemming, J. E., 1971. The distribution and movement patterns of caribou in Alaska. Department of Fish & Game. Technical Bull. No. 1, 60 pp.
- Hemming, J. E., 1975. Population growth and movement patterns of the Nelchina caribou herd. In Proc. 1st International Reindeer and Caribou Symposium, Biol. Papers Univ. Alaska, Special Report No. 1.
- Milke, G. C., 1969. Some moose-willow relationships in the interior of Alaska.
- Nichols, L., and Erickson, J. 1968. Sheep studies, Alaska. Alaska Department of Fish and Game, Fed. Aid in Wildlife Restoration, W-15-R2 and 3.
- Price, R., 1972. Effect of human disturbance on Dall sheep. Alaska Coop. Wildlife Res. Unit. Quarterly Prog. Rpt. Vol. 23, No. 3, pp. 23-28.
- Rausch, R. A., 1968. Dynamics of the Railbelt moose populations. Alaska Dept. of Fish and Game, Fed. Aid in Wildlife Restoration, W3R.
- Rausch, R. A., 1969. A summary of wolf studies in South-central Alaska, 1957-1968. Trans. Thirty-Fourth N. Am. Wildlife Conf., Washington, D.C.
- Raush, R. A., 1971, Moose report. Alaska Dept. of Fish and Game, Fed. Aid in Wildlife Restoration, W-17-1.

- Scott, R. G., 1951. Mountain sheep studies. U.S. Fish and Wildlife Service, Fed. Aid in Wildlife Restoration W-3-4-6-R-6.
- Skoog, V., 1968. Ecology of caribou in Alaska. Unpubl. Ph.D. Thesis. Univ. California, Berkeley, 699 pp.
- Taylor, K. P. and Ballard, W. B. 1978. Moose Movements and habitat use along the Upper Susitna River--A preliminary study of potential impacts of the Devil Cayon Hydroelectric Project. Alaska Department of Fish and Game, 91 pp.

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CATEGORY: C ENVIRONMENTAL STUDIES

ASSIGNMENT: C-4 EXHIBIT "W" ENVIRONMENTAL REPORT

TASK TITLE: C-4-12 Wildlife Resources - Birds and Small Mammals

LEVEL OF EFFORT: 249 Man-days

SCHEDULE: February 1980 to June 1982

ESTIMATED COST: \$110,000

RESPONSIBILITY: D. Erikson (Dames & Moore)

PURPOSE:

• To review available literature for all bird and small mammal species within the proposed reservoir areas.

- To identify areas of potential impact from an evaluation of designs and project siting plans for hydroelectric dams, transmission/transportation corridors, and related facilities.
- To delineate sensitive bird and small mammal habitat.
- To describe short- and long-term impacts of the project on bird and small mammal species and provide methods for mitigation impacts.

SCOPE:

Review of Available Information

Published and unpublished data pertinent to the proposed reservoir area and transportation/transmission corridors will be reviewed and assembled.

Initial Reconnaissance for Planning Studies

The objective of this Task is to provide an early overview of regional bird and small mammal wildlife resource conditions as input to Stage 1 - Plan Fomulation Studies. Activities will include:

- Identification of bird and small mammal wildlife resource conditions that are likely to be of concern in the assessment of energy source alternatives.
- Preliminary assessment of the relative potential impacts to bird and small mammal wildlife resource for each energy source alternative.

Baseline Data Collection

- <u>Seasonal Distribution</u> Surveys will be conducted by experienced arctic biologists. Boat and foot travel in each of the representative habitats (ecotypes) within the proposed reservoir areas with the aid of binoculars and spotting scopes will allow the occurrence and seasonal status of birds to be delineated. In June and July 1980 snap trap surveys incorporating 200-meter transects with trap stations at 10-meter intervals at various locations within the area to be flooded by the proposed reservoirs. Larger species such as mink, ground squirrels, marmots, and pikas will be inventoried from direct observation, tracks, droppings, and from information gained during interviews with local fur trappers. Field activities will begin during the winter of 1979-1980 and continue until the end of spring bird migration in 1981.
- <u>Delineation of Sensitive Areas</u> Special attention will be given to confirming the presence of absence of the peregrine falcon, the only endangered species that may occur seasonally within the project area. Nesting areas, denning areas, winter feeding areas, and migration staging areas will be plotted on 1:24,000-scale aerial photo mosaics.

Impact Assessment and Mitigation

The relative loss of habitat for the various species within the zone of primary impact will be assessed and mitigation plans will be developed.

DOCUMENTATION:

Field notes, distribution maps, and other qualitative data will be compiled by standard scientific methods.

An annual report (1980) and a final report (1981) will be prepared including:

- An annotated list of species within the study area.
- Distribution by habitat type in narrative form.
- Maps of critical or sensitive avian habitat
- Discussion of potential impact.
- Discussion of the suitability of various mitigation alternatives.

The final report will be fully integrated with other tasks in the program and will be suitable for inclusion as part of Exhibits W and S of the FERC Application.

SCHEDULE DESCRIPTON:

Birds and small mammal studies will be conducted for approximately 2 years.



LEVEL OF EFFORT DESCRIPTION:

A total effort of 249 man-days is anticipated at a labor cost of approximately \$75,000. Equipment, travel, and subsistence (except while in field camps) are estimated at \$35,000 for a total Task cost of \$110,000. Costs of establishing and supporting field camps are not included nor is the cost of boats, aircraft, vehicles and snowmobiles.

PERSONNEL ASSIGNED:

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Dames & Moore will be responsible for all work in this Task. However, it is anticipated that portions of the field study will be performed by ADF&G through arrangements to be negotiated.

CATEGORY: <u>C</u>	ENVIRONMENTAL STUDIES	

ASSIGNMENT C-4 EXHIBIT "W" ENVIRONMENTAL REPORT

TASK TITLE C-4-13 Land Use

LEVEL OF EFFORT: <u>120 Man-days</u>

SCHEDULE: February 1980 to January 1982

ESTIMATED COST: \$51,000

RESPONSIBILITY: J. Everingham (EDAW)

PURPOSE:

To identify and define regional land use patterns, policies, and plans in order to estimate the potential impacts engendered by the project and its alternative and to delineate mitigation measures.

SCOPE:

• Identify and characterize land use patterns and trends within the region to be affected by the project.

- Identify and interpret policies and plans relative to land use and transportation network.
- Assess the magnitude of direct and indirect impacts on land use and transportation activities and identify mitigation opportunities.

Initial Reconnaissance for Planning Studies

The objective of this Task is to provide early overview of regional and site-specific land use conditions and potential issues as input to Project Planning Studies.

Activities will include:

- Identification and definition of regions of interest from a land use and transportation networks standpoint.
- Identification of data sources including agencies, plans, aerial photos, etc.
- Preliminary identification of land use and transportation issues likely to be of concern in the assessment of energy source alternatives.

INTERNATIONAL ENGINEERING COMPANY NO

Baseline Data Collection

Present land use of the project area is principally wilderness or undisturbed. Therefore, a traditonal characterization of land use types would reveal little land use diversity. The characterization of project area land use will focus on the senstivity of the land to accommodate a range of temporary and long-term uses. This classification will incorporte ecological and recreational elements in the development of a sensitivity rating scheme. A characterization of the land-use types and activities of the Railbelt region will be developed.

Activities will include:

- Collection of land use plans and policies from federal, state, regional and local agencies for geographical areas of concern.
- Agency presonnel will be interviewed to ascertain the relevancy of published plans, current planning and use activity and future trends.
- Project area sensitivity maps and regional land use maps will be prepared depicting present and future conditions.
- Aerial photographs will be used to prepare and/or update and verify land use planning maps.
- Special plans of adjacent or nearby areas such as Mt. McKinley National Park, State parks, wildlife refuges and BLM wilderness study areas will be reviewed and summarized.

Impact Assessment and Mitigation

For each of the project elements to be constructed, changes in existing land use and associated activities, using sensitivity ratings as a measure of impact magnitude, will be assessed. Short-term construction-related changes, such as temporary living accommodations and services, will be identified. Long-term effects of the completed project in terms of regional growth and accompanying changes in land use will be projected.

Mitigation analysis will include the involvement of planning and land management agencies early in the project to facilitate development and coordination of long-range planning activities with the APA power development program.

A complete and understandable analysis of the potential impacts on the quality of life and life styles will be part of the land use analysis.

DOCUMENTATION:

The analysis of land use conditions and potential impacts will be assembled in text and map form and provide as one of a series of environmental studies for direct incorporation into the FERC License Application Environmental Report, Exhibit W.



CATEGORY: C ENVIRONMENTAL STUDIES

ASSIGNMENT: C-4 EXHIBIT "W" ENVIRONMENTAL REPORT

TASK TITLE: <u>C-4-14 Land Ownership</u>

LEVEL OF EFFORT:	130 Man-days
SCHEDULE:	February 1980 to January 1982
ESTIMATED COST:	\$55,000
RESPONSIBILITY:	J. Everingham (EDAW)

PURPOSE:

To determine the existing and expected future ownership of project lands, to assess the potential impacts thereto, and to identify mitgation opportunities.

SCOPE:

- Identify and characterize the existing land ownership patterns within the project area and within the region to be affected by the project.
- Prepare maps to describe ownership and jurisdictional controls for the project area sites and transmission corridors.
- Assess the magnitude of direct and indirect impacts of the project on land values and ownership in the project area, region transmission corridors, access routes and construction related sites.

Baseline Data Collection

Most of the lands within the Devil Canyon and Watana project areas have been designated as powersite withdrawals (February 1958) and are presently under the jurisdiction and administration of the Bureau of Land Management (BLM). However, these same lands are also in an area designated under the Alaska Native Claims Settlement Act for village deficiency withdrawals. Accordingly, ownership status is currently in a state of transition. The major element in the collection of baseline data will be the determination of the existing and expected future ownership status of Project lands. The Cook Inlet Native Regional Corporation (CIRI) has prepared a detailed ownership and parcel map of the project area for use in Native Claims Settlement negotiations. Close coordination with CIRI, BLM and the Alaska State Division of Lands is anticipated in the characterization of existing ownership status and patterns.

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Activities will include:

- Collection and verification of ownership data (from BLM and Alaska State Division of Lands.)
- Transfer of ownership and parcel data to ownership base maps.
- Preparation of ownership notebook for APA for use in the public participation program.

Information developed under Tasks for Assignment B-6, Real Estate, performed by CIRI-H&N, will be utilized in the performance of this activity.

Impact Assessment and Mitigation

Land ownership status identified in baseline studies and population and employment forecasts will be used as the basis for assessing the potential impacts of the project and its alternatives on local and regional land ownership and mitigation opportunities to identified impacts.

Activities will include:

- Interviews with landowners and land management agencies to determine future development plans and possible changes in land status attributable to the project.
- Identification of project lands which would require acquisition.
- Identification of land ownership constraints on opportunities in transmission corridor analysis, access roads analysis.
- Determination of unavoidable adverse impacts to the project area, region and affected communities.
- Identification of mitigation opportunities.
- Preparation of graphics as appropriate.

DOCUMENTATION:

The analysis of land ownership conditions, potential impacts and mitigation opportunities will be assembled in text and map form for direct incorporation into the FERC License Application, Environmental Report, Exhibit W.

CATEGORY: C ENVIRONMENTAL STUDIES

ASSIGNMENT: C-4 EXHIBIT "W" ENVIRONMENTAL REPORT

TASK TITLE <u>C-4-15 Recreation</u>

 LEVEL OF EFFORT:
 65 Man-days

 SCHEDULE:
 February 1980 to May 1982

 ESTIMATED COST:
 \$26,000

 RESPONSIBILITY:
 P. Miller (EDAW)

PURPOSE:

To assess existing recreational resources, and to estimate the project's and alternatives' impacts.

SCOPE:

- Inventory and analyze the recreation resources, existing recreational development, and existing public and private recreation programs of the Railbelt area.
- Assess the effects the project and the associated recreation plan (Exhibit R) will have on the region.

Baseline Data Collection

Activities will include:

- Initial contact with recreation interests public planning agencies, private interest groups, commercial recreation outfitters including and organizations, guides, lodge owners.
- Collection, review and summary of existing recreation planning and analysis documents, plans, studies, concepts and proposals (Federal, State and local).
- Identification of data deficiencies.
- Interviews with public agencies, interest groups, and commercial outfitters and organizations to collect necessary data.
- Definition and documentation of recreation study areas.
- Documentation of existing and planned primary and secondary recreation access facilities.

- Description of existing and projected recreation use patterns and trends for study area and Railbelt Region (without Susitna Project).
- Description of demonstrated and anticipated recreation demand projections for study area (without Susitna Project).

Impacts and Mitigation

Activities will include:

- Description of existing recreation facilities and/or activities lost through implementation of the project.
- Description of existing recreation activities altered through implementation of the project.
- Contrast of Exhibit R proposals and user projections with:
 - Existing recreation use patterns of study area and region.
 - Anticipated recreation demand of study area and region.
- Identification and description of relationships of Exhibit R proposals to recreation-related resource base to include fisheries, wildlife, vegetation, downstream hydrology.
- Description of potential effects on recreation management agencies to include:
 - Personnel requirements.
 - Operations and maintenance requirements and financing.
 - Capital improvement financing.
- Summary of Exhibit R proposals.

DOCUMENTATION:

The recreation analysis will be assembled in text and map form for direct incorporation into the FERC License Application, Environmental Report Exhibit W.

REFERENCES:

1. Statewide Outdoor Recreation Plan Studies:

Alaska Outdoor Recreation Plan, 1976-1980; Alaskan Recreation Trail Plan and Outdoor Recreation Responsibility in Alaska by the Alaskan Division of State Parks.



TASK: C-4-15 Recreation

- 2. Regional and Subregional Studies:
 - Phase I Technical Memorandum Recreation Needs Assessment South Central Alaska Water Resources Study (Level B) by the Alaska Water Study Committee.

Southcentral Management Plan by the BLM.

3. Area and Project Specific Studies:

Upper Susitna River Inventory and Evaluation of Environmental, Aesthetic and Recreation Resources by Jones and Jones for the Corps of Engineers.

Recreation Assessment Section Appendix I, Upper Susitna River Basin Hydroelectric Power Development Feasibility Report by the Corps of Engineers.

CATEGORY: C ENVIRONMENTAL STUDIES

ASSIGNMENT: C-4 EXHIBIT "W" ENVIRONMENTAL REPORT

TASK TITLE: <u>C-4-16 Transportation</u>

LEVEL OF EFFORT:_	126 Man-days
SCHEDULE:	February 1980 to January 1982
ESTIMATED COST:	\$47,000
RESPONSIBILITY:	M. Trembley (EDAW)

PURPOSE:

To assess existing and planned transportation facilities, to determine the anticipated impacts of the project and its alternatives, and to identify mitigation measures.

SCOPE:

- Provide a basis for the assessment of alternative construction and operational access routes and methods for the Watana and Devil Canyon dams and transmission corridors.
- Assess the magnitude of direct and indirect impacts of alternative access routes and methods on existing transportation uses, land uses, resources and wildlife communities.
- Provide recommendations for coordinating proposed access plans with existing networks and policies to reduce conflicts and impacts.
- Suggest specific mitigation measures to minimize visual, recreational, commercial and wildlife impacts.

Initial Reconnaissance for Planning Studies

The goals of this Task are to document the surface and air transportation networks in the Railbelt and project sites, and to identify key issues. Required activities will be to:

- Assemble plans and projections regarding existing and proposed levels of use.
- Review appropriate State and Federal agency policies affecting or affected by access plans.

- Assemble land-use and topographic maps and air photos to characterize the Railbelt region and project areas from a transportation standpoint; identify key issues of concern for program refinement.
- Establish study area boundaries, goals and schedules.

Baseline Data Collection

Proposed transportation plans involving both construction and operational components must be adjusted to existing and future conditions. The goal for this Task is to determine the degree of agreement or conflict with these conditions. Activities will be to:

- Prepare transportation network maps showing present and future conditions.
- Assemble land ownership maps to identify rights-of-entry to project sites.
- Assemble and coordinate data from wildlife, geology, transmission routing and other environmental studies of relevance to access route planning.
- Identify transportation system technologies relative to project requirements.
- Depict by mapped and other graphic means the location and extent of proposed temporary and permanent access roads to damsites, transmission corridors, construction intrasite trails, haul trails and related access modes.
- From analysis of all pertinent data, show specific conflicts and opportunities between proposed access plans and other transportation users.

Impact Assessment and Mitigation

The assessment of mitigation measures associated with proposed access routes and policies and the presentation of mitigation measures are the objectives of this Task. Activities will include:

- From the composite map developed for the evaluation of transmission corridor alignments, assess the direct and indirect impacts relating to access routes serving the damsites and transmission corridors.
- Presentation of impacts associated with access routes in matrix format.
 Prepare input to engineering studies.
- Suggestions for specific mitigation concepts.

DOCUMENTATION:

The analysis of transportation conditions and potential impacts will be assembled in text and map form and provided as one of a series of environmental studies for direct incorporation into the FERC License Application, Environmental Report, Exhibit W.

CATEGORY: C	ENVIRONMENTAL	STUDIES
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ASSIGNMENT: C-4 EXHIBIT "W" ENVIRONMENTAL REPORT

TASK TITLE: C-4-17 Air Quality and Noise

LEVEL OF EFFORT: 30 Man-days

SCHEDULE: February 1980 to January 1982

ESTIMATED COST: \$12,000

RESPONSIBILITY: C. B. Fahl (Dames & Moore)

PURPOSE:

- To describe the air quality and noise conditions of the Upper Susitna River basin before the proposed project.
- To assess the constraints and relative impact on air quality and noise that would be associated with a Susitna hydroelectric project and various non-Susitna alternatives.

 To recommend measures to minimize potential impacts to air quality and noise that could occur during the construction of a Susitna project.

SCOPE:

Initial Reconnissance for Project Planning Studies

The objective of this Task is to provide air quality and noise input to the Plan Synthesis Studies (Category G) so that an overall environmental assessment can be made of the relative constraints and potential impacts associated with various energy source alternatives.

An assessment of the relative impact of energy source alternative will be made solely on the basis of existing information.

Baseline Development, Impact Assessment and Mitigation

The existing air quality and noise conditions of the Upper Susitna basin will be described in qualitative terms or the parameters of air quality and noise will be described as a range of values. The need to develop detailed monitoring to establish a baseline is not considered necessary to make an assessment of the impact of a constructing and operating a Susitna hydroelectric project. An adequate discussion is contained in the BLM Final Environmental Assessment Record for the Susitna Feasibility Study (1979).

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An assessment will be performed to define potential impacts of the project, if any, on baseline climatology, meteorology, air quality, and noise. The impact review will begin in parallel with Phase I work so that changes can be made in the monitoring programs if needed to assess baseline impacts.

Potential impacts to be evaluated include:

- Air quality impacts from increased vehicular traffic and anthropogenic emissions.
- Noise impacts due to construction impacts and operation of large hydroelectric generators.
- Noise impacts of transmission lines.
- Noise impacts from other permanent or intermittent man-made sources such as vehicular traffic and recreational boats.

Positive and negative impacts will be included, and their effects will be quantitatively balanced, along with any quantitative mitigations, wherever possible. Discussions will be held with State and Federal EPA agencies on the extent and importance of the various impacts and on the value of mitigation.

Mitigations that will be studied, among others, include:

- Dust suppression during construction.
- Revegetation of exposed earth.
- Controls on vehicular traffic and speed.
- Road construction, methods, and maintenance.
- Noise regulations and control measures.
- Burning restrictions, both for open fires and exhausted combustion sources and control measures.
- Fuel controls for all combustion sources, stationary and mobile.
- Restrictive use rates for any recreation areas associated with the reservoirs.

DOCUMENTATION:

The setting impacts and mitigation measures will be prepared in the appropriate format for Exhibit W of the FERC License Application.

ASSIGNMENT: C-4 EXHIBIT "W" ENVIRONMENTAL REPORT

TASK TITLE: C-4-18 Population and Demography

EVEL	OF	EFFORT:	100 Man-days	'S
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SCHEDULE:	February	1980	to	January	1982
ESTIMATED COST:	\$40,000				

RESPONSIBILITY: D. O'Donoghue (EDAW)

PURPOSE:

To ascertain present population trends, population growth and distribution impacts of the project and its alternatives, and interactions with other aspects of the environment; and to identify mitigation opportunities.

SCOPE:

- Define the region of interest in terms of political, institutional, legal, social and economic boundaries as these relate to the proposed project and to potential impacts.
- Describe the population and social characteristics of the existing communities and groups within the region of interest.
- Describe the population and social characteristics of expected in-migrants, including construction and operation employment plus secondary or induced population growth stemming from these activities, as distinct from energyinduced growth discussed in Task Assignment C-2 Energy Supply and Demand Assessment.
- Analyze population trends and projections with and without the proposed project plus the physical and financial capacity of existing communities to absorb growth in terms of infrastructure and community stability.
- Correlate trends and projections with other tasks, especially economic, land use, recreation, transportation and cultural tasks.
- Determine the population and social impacts of the proposed project and measures to mitigate these impacts, especially the probability and extent of population growth relative to possible boom-bust phenomenon.
Potential Major Issues Definition

Activities will include:

• Determination of issues associated with local and regional, temporary and longterm population growth, and impacts of these on housing, land use, goods, services, taxes, and the quality of life.

Initial Reconnaissance for Planning Studies

Activities will be to:

- Provide an overview of local and regional population centers in the Railbelt, especially those areas such as Gold Creek and Talkeetna.
- Make site visit and initial interviews to identify individuals and other sources helpful in describing the existing setting and potential impacts.

Baseline Date Collection

Activities will be to:

- Collect published population and demographic data.
- Identify and define the geographic areas requiring analysis according to potential impacts, political and institutional boundaries, and data availability, reliability, and timeliness.
- Define and classify the population in the above-defined geographic areas.
- Rank according to timing and probability the growth-inducing proposals that might affect these areas; check against past trends and existing projections of population growth made by public and private interest groups.

Impact Assessment and Mitigation

Activities will be to:

- Demonstrate the impacts on population and community stability with respect to timing, location and reversibility.
- Assess sociocultural problems associated with rapid growth and subsequent withdrawal.
- Examine community attitude subject to change and the effects on social well-being, mobility and access.

Information and assessments will be correlated with Task C-4-19, Economics.

DOCUMENTATION:

The analysis of population and demography will be assembled in text, chart, pictorial and map form and provided as one of a series of environmental studies for direct incorporation into the FERC License Application Environmental Report, Exhibit W.

CATEGORY C ENVIRONMENTAL STUDIES

ASSIGNMENT: C-4 EXHIBIT "W" ENVIRONMENTAL REPORT

TASK TITLE: C-4-19 Economics

LEVEL OF EFFORT: 310 Man-days

SCHEDULE: February 1980 to January 1982

ESTIMATED COST: \$103,000

RESPONSIBILITY: D. O'Donoghue (EDAW)

PURPOSE:

To ascertain the existing economic setting, the potential impacts and mitigation opportunities of the project and its alternatives.

SCOPE:

- Define the study area in a local, regional and statewide context with respect to major economic sectors and their relative importance.
- Describe the existing and projected employment numbers and characteristics by location and timing without the proposed project.
- Describe the impact of increased primary and secondary employment on local and regional areas as a result of the project.
- Describe losses and benefits in other employment sectors that could occur.
- Determine the institutional, financial and political processess that could mitigate potential impacts.

Initial Reconnaissance for Planning Studies and Baseline Data Collection

The objective of this Task is to establish existing regional and local economic settings and to determine economic trends.

Activities will include:

- Review and analysis of government documents and reports from private data sources.
- Comparison of data with population and economic assumptions and findings in Task C-3-1 Socioeconomic Input to Energy Demand Forecasts.

• Verification and analysis of economic trends.

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Identification of Political, Institutional, and Governmental Framework Objectives and Policies

The purpose of this Task is to identify Federal, State, and local policies and regulations that affect population and economic projections and those that will affect the proposed project and its alternatives.

Activities will include:

- Formal solicitation of the objectives of public agencies, private citizens, and special interest groups concerning the ultimate use, development, and appearance of the study area.
- Analysis of these objectives.
- Comparison of this analysis with an analysis of existing policies and plans to identify major areas of consensus and conflict.
- Input from other Tasks will be correlated with this Task.

Where communications with and information from public agencies and the private sector are required to fulfill the foregoing Tasks, the activities will be intergrated with the Public Information and Participation and Public Agency Coordination Programs.

<u>Projections of Employment and Economic Conditions to Determine Impacts and Identify</u> <u>Mitigation Opportunities</u>

- Employment projections will be developed with and without the project, and with alternatives to the project, accounting for other proposals known to affect the study area.
- Impacts of speculative or inflationary wage, land, and housing costs increases will be assessed.
- The long-term effect of the project on regional employment will be estimated.
- Potential mitigation opportunities will be identified.
- Impacts and mitigation measures will be correlated with those of C-4-18, Population and Demography.

DOCUMENTATION:

The analysis of economic conditions, impacts of the project and alternatives, and mitigation measures will be assembled as one of a series of environmental studies for direct incoporation into the FERC License Application, Environmental Report - Exhibit W.

CATEGORY: C ENVIRONMENTAL STUDIES

ASSIGNMENT C-4 EXHIBIT "W" ENVIRONMENTAL REPORT

TASK TITLE: <u>C-4-20 Cultural Resources</u>

LEVEL OF EFI	ORT: 1320	Man-days
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SCHEDULE: February 1980 through May 1982 (Pre-FERC Submittal)

ESTIMATED COST: \$338,000

RESPONSIBILITY: Dr. E. J. Dixon, Jr. and G. S. Smith (University of Alaska Museum)

PURPOSE:

To identify and mitigate significant historic and prehistoric resources that may be adversely affected by the proposed Susitna project, consistent with the spirit and intent of The Historic Preservation Act of 1966 (P.L. 89 - 665) the National Environmental Act of 1969 (P.L. 9-180), the Reservoir Salvage Act of 1960 (P.L. 86-523) and the Alaska Historic Preservation Act of 1975.

INTRODUCTION:

A review of literature directly related to the history and prehistory of the study area as found in the Alaska Heritage Resource Survey indicates that six prehistoric and thirteen historic sites have been recorded in the study area. The apparent paucity of sites in this area may be attributed to the fact that little archeological research has been carried out in the study area, although both Irving (1957) and Bacon (1976) have conducted limited surveys. In surrounding areas where archeological research has been more intensive, the number of sites documented is considerably higher. In the eight USGS quads surrounding the study area, 630 sites have been documented. Because of the minimal quantity of data available on the cultural resources of the study area, the reconnaissance and intensive surveys developed for the Susitna project are of paramount importance in identifying and recommending appropriate mitigation for the cultural sites that would be affected by this project.

SCOPE:

The regulations cited above define what cultural resource preservation efforts are required by federal and state law to satisfy licensing requirements. These tasks include at minimum:

- Identification and documentation of cultural resources within the project area.
- Formulation and explication of recomemdations for mitigation of each site identified.

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However, any proposal to identify cultural resources and make recommendations for preservation must also permit mitigation of potential damage to sites during the course of the impact study. The scope of work recognizes this need and has been conceptually divided into:

- Effort necessary to obtain the FERC License.
- Effort necessary to mitigate possible adverse effects during the course of study essential to obtaining the FERC License.
- Effort necessary to mitigate damage to sites that will be impacted by construction.

The scope of work includes six major subtasks:

Subtask 1

Includes prefield season tasks; literature review; analysis of the existing data base; development of a research design and sampling strategy; application for necessary permits; and staging for field work.

Subtask 2

Includes a reconnaissance level archaeological survey of all project areas based on priorities determined by the sequence of construction events. As it is not the intent of a reconnaissance level survey to cover 100 percent of the study area, preselected areas identified in Subtask 1 will be selected for survey. Within these areas field crews will implement surface and subsurface testing procedures in order to locate, document and inventory historic and prehistoric sites. The dam impoundment areas, associated facilities and transmission corridors will be surveyed as well as those areas that will be impacted during the study phase such as soil and seismic testing areas, access roads needed for reaching testing locations or any other preconstruction activity. Every effort will be made to conduct the archaeological survey early in each ground disturbing activity and undertake immediate mitigation if necessary. These measures may include avoidance, preservation and excavation.

Subtask 3

Includes the preparation of an interim report that satisfies the FERC License Application requirements and contains a description of the history and prehistory of the study area, a discussion of each site recorded during the study period, recommendations for mitigating adverse effects to sites during the construction phase and a suggested program for intensive testing.

Subtask 4

Includes the intensive testing of sites discovered in Subtask 2 to determine the horizontal and vertical dimensions, identify the kinds of materials contained within them and delineated specific mitigation measures. A limited amount of effort under this subtask will no doubt be required concurrently with the identification of sites in Subtask 2. Site maps and soil profiles will be prepared. Photographs will be taken to document artifacts and features in situ.

TASK: C-4-20 Cultural Resources

Subtask 5

Includes the preparation of the final report. All individual reports from previous subtasks will be compiled, all data synthesized and a detailed mitigation plan developed including an estimated budget for any archaeological excavation that must be done prior to the start of actual construction.

Subtask 6

Includes deposition of all recovered artifactual material and supporting documentation with the University of Alaska Museum. The collection would be curated in accordance with State and Federal requirements pertinent to the preservation of antiquities.

SCHEDULE DESCRIPTION:

- Subtask 1 : Initial
- Subtask 2 : Summer Field Season of 1980 and 1981
- Subtask 3 : Late 1981
- Subtask 4, 5 and 6: 1982-1983.

PERSONNEL ASSIGNED:

- Dr. E. James Dixon, Jr. (Principal Investigator, University of Alaska Museum).
- Mr. George S. Smith (Project Supervisor, Univerity of Alaska Museum).

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CATEGORY: C ENVIRONMENTAL STUDIES

ASSIGNMENT: C-4 EXHIBIT "W" ENVIRONMENTAL REPORT

TASK TITLE: <u>C-4-21 Public Safety</u>

LEVEL OF EFFORT	40 Man-days
SCHEDULE:	February 1980 to July 1981
ESTIMATED COST:	\$14,000
RESPONSIBILITY:	D. Sanders (IECO), K. DeRubertis (EDAW)

PURPOSE:

To describe any impacts resulting from accidents and natural catastrophes which might occur, and provide an analysis of the capability of the area to absorb predicted impacts. Describe project design and operational features that have been incorporated into project facilities to ensure the integrity of facilities and the public safety.

SCOPE:

Initial Reconnaissance for Planning Studies

The objective of this aspect of the Task is to provide an early overview of public safety and dam reliability issues as input to Stage 1 - Plan Formulation Studies.

Activities will include:

- Identification and review of data sources pertaining to public safety and reliability of energy source alternatives.
- Preliminary assessment of relative public safety and project reliability of energy source alternatives.

Baseline Data Collection

Geologic and hydrologic data pertinent to issues of public safety and project reliability that are developed as part of separate tasks under HYDROLOGICAL STUDIES (Category D) and GEOTECHNICAL STUDIES (Category E) will be reviewed and summarized.

Special consultant Dr. H. C. Shah will provide expert advise in the area of risk analysis.

TASK: C-4-21 Public Safety

Impact Assessment and Mitigation

This discussion will be a summary of studies performed under Categories D. HYDROLOGICAL STUDIES and E. GEOTECHNICAL STUDIES as they relate to public safety and project reliability.

Specific topics to be address include:

- A brief discussion of the design flood used for spillway designs.
- A summary of geologic hazards including the design earthquake, seepage potential, landslide potential, permafrost constraints, erosion and sedimentation at the dam and reservoir sites and a discussion of how these constraints have been accounted for in project design.
- An evaluation of the downstream effects during the passing of the design flood.
- Delineation of the downstream flood zone and an assessment of the effects of downstream flooding should a failure occur. The downstream flood zone will be determined by a mathematical model developed by Hydrocomp.
- An assessment of the effects of flooding use to a dam failure including an estimate of the potential for loss of property and life.

DOCUMENTATION:

The analysis of public safety and project reliability will be assembled in text and map form, where appropriate, for inclusion in Exhibit W of the FERC License Application.

CATEGORY: C ENVIRONMENTAL STUDIES

ASSIGNMENT: <u>C-4</u> EXHIBIT "W" ENVIRONMENTAL REPORT

TASK TITLE: <u>C-4-22 Visual Resources</u>

LEVEL OF EFFORT: 175 Man-days

SCHEDULE: ______ February 1980 to January 1982

ESTIMATED COST: \$70,000

RESPONSIBILITY: <u>M. Bowie (EDAW)</u>

PURPOSE:

The purposes of the visual studies are to:

- Determine the significant visual effects of the Watana and Devil Canyon Dam structures, reservoirs, certain access roads, proposed recreation sites, construction camps, borrow and spoils areas and other ancillary facilities.
- Simulate the appearance of main project components in an objective and realistic manner leading to the identification of visual impacts and suggested mitigation measures.
- Establish criteria for scenic quality which provides the basis for comparative evaluation of proposed project features and alternative energy sources.

SCOPE:

Initial Reconnaissance and Baseline Data Collection

This task will focus on documenting the visual characteristics of the regional and site-related landscapes, identify key issues and assess data requirements. The following activities will comprise this task:

- Assemble and review existing topographic and land use maps, agency plans, vertical, oblique and site photographs; identify data deficiences.
- Evaluate new potential sources of data that meet deficiency needs, e.g., LANDSAT photography, "Viewit" computer programs, etc., as inputs to program refinement.
- Review government regulations and policies, e.g., BLM, EPA, etc. that relate to visual resource management.

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- Document, by mapped and simulated photographic means, the general visual characteristics of the proposed project facilities, with text descriptions of basic elements of size, form, color and texture.
- From the findings of reconnaissance data sources, determine the relative visual impacts associated with each of the energy source alternatives that will be evaluated as part of Category G Plan Synthesis Studies.

Develop and Identify Visual Sensitivity Levels

The principal concern with this aspect of the Visual Studies is to catalog the various views, settings of the dam structures and supporting facilities in terms of effects on candidate and surrounding areas, and to evaluate the relative acceptability of the local view relations to the settings. Specific steps implementing this objective are:

- Identify viewer populations, e.g., hunters, boaters, residents, etc., and characterize their view expectations.
- Select view stations by level of viewer use from among existing and proposed settings.
- Develop a qualitative view sensitivity rating system in terms of acceptability of views from selected settings to damsites and associated ancillary facilities.
- Rate and assign sensitivity levels to each view setting, according to viewer distance; display sensitivity ratings in matrix and map formats.

Visual Impact Assessment and Mitigation

Visual impact analysis will focus on the contrast between the existing landscape and future landscape as depicted by photographically simulated models. The differences in contrast will be analyzed according to perceived changes in the basic landscape elements of form, line, color and texture. In addition, the Impact Analysis will consider how much visual contrast could be perceived by viewers from various locations.

Mitigation measures will be expressed in terms of planning and design suggestions involving the arrangment of plant materials and ground forms, the control of views and other measures contributing to the orderly arrangement of project appearance. Required activities are:

- Describe long and short term construction and operational visual effects using sensitivity ratings.
- Show contrast between selective existing and future landscapes using photographic study models.
- Present mitigation suggestion--alternative sites, screening, view control, etc.; discuss comparative mitigation costs of proposed project vs. alternatives.
- Prepare visual analysis findings for input to engineering studies and design (Category F).

TASK: C-4-22 Visual Resources

DOCUMENTATION:

The analysis of visual conditions and potential impacts will be assemble in text and map form and provided as one of a series of environmental studies for direct incorporation into the FERC License Application, Environmental Report, Exhibit W.

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CATEGORY: C ENVIRONMENTAL STUDIES

ASSIGNMENT: C-4 EXHIBIT "W" ENVIRONMENTAL REPORT

TASK TITLE: C-4-23 Transmission Routing Environmental Aspects

LEVEL OF EFFORT:_	461 Man-days		¢.'
SCHEDULE:	February 1980 to January 1982		
ESTIMATED COST:	\$173,000		
RESPONSIBILITY:	M. Bowie (EDAW)	-1	

PURPOSE:

To evaluate proposed transmission corridors for the Susitna project, to estimate their impacts, and suggest mitigation measures.

SCOPE:

- Provide a concise environmental framework by which to evaluate comparatively the Nenna 1 and Susitna 1 corridors, as well as the Watana and Devil Canyon corridor to the point of tie-in, and other potential corridor alignments.
- Document a clear record of decision-making which provides the basis of defensibility of the route selection process.
- Identify anticipated environmental, economic and social impacts of preferred transmission corridors and access routes.
- Suggest mitigation measures as input to engineering design studies relating to corridor alignment, tower placement and design, right-of-way treatment, as well as operation and maintenance requirements.

Program Refinement

This Task will include the identification of study team members, development of detailed work programs and schedules, refinement of goals and policies based on proposal review, definition of transmission system technologies, and determination of study area boundaries. These objectives require:

- Planning meetings with consultants and APA.
- Evaluate of current transmission system technology relative to project requirements and appropriateness in reducing environmental and social impacts.

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 Refinement of study area boundaries through map and air photos as well as initial field reconnaissance.

Corridor Identification

The main objective of this Task is to identify significant environmental, engineering, cultural and economic factors that will impact or will be impacted by the construction and operation of transmission facilities, access roads or other ancillary facilities. These factors will be defined as either constraints or opportunities for routing. Required tasks will be:

- Establish the study area data base.
- Interpret and prepare a series of working maps illustrating appropriate data relevant to existing and future conditions of significance to transmission and access routing.
- Describe how environmental factors are affected by and influence corridor locations. Visibility zones will be mapped and correlated with other environmental factor maps.

Corridor Evaluation and Ranking

The purpose of this Task is to produce a composite map of study area constraint factors by which to evaluate and rank selected and alternative transmission and access corridor alignments. Activities will involve:

- Establishment of route identification criteria through team workshop approach by evaluating all natural and cultural features which should be avoided or excluded from consideration; use input from local officials and citizens in evaluation process.
- Determination of routing constraint/identification factors through group consensus techniques.
- From group consensus, produce a composite map of study area constraint factors and select alternative corridor alignments for future evaluation.

Corridor Alignment Selection

The preparation of recommendations for selection of preferred alignments is the goal of this Task. Activities will include:

- Presentation of evaluation criteria in matrix format for selected and alternate corridor alignments.
- Establishment of weighting and ranking scales for each criteria through team workshop consensus techniques.
- Summation of total scores for each corridor and access alignment; prepare and present recommendations.

Impact Assessment and Mitigation

The presentation of associated environmental impacts for each corridor alignment as well as potential construction and operation mitigation measures and costs is the purpose of this Task. Activities will be:

Describe long- and short-term impacts.

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 Suggest specific mitigation concepts for recommended alignments-underground vs. overhead transmission, right-of-way treatment, tower placement and design, access road management and maintenance requirements.

DOCUMENTATION:

The analysis of transmission routing and potential impacts will be assembled in text and map form and provided as one of a series of environmental studies for direct incorporation into FERC License Application, Environmental Report, Exhibit W and Natural Scenic and Cultural Values, Exhibit V.



CATEGORY	С	ENVIRONMENTAL	STUDIES
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ASSIGNMENT: C-4 EXHIBIT "W" ENVIRONMENTAL REPORT

TASK TITLE: C-4-24 Prepare Final Report

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LEVEL OF EFFORT:_	850 Man-days
SCHEDULE:	February 1980 to June 1982
	\$272,000
RESPONSIBILITY:	J. Everingham (EDAW)

PURPOSE:

To provide the framework for project management of Environmental Studies and to assemble the findings of the detailed Environmental Studies into the format of Exhibit W so that the findings can be used by FERC for the preparation of the Draft Environmental Impact Statement.

SCOPE:

Exhibit W will be prepared in accordance with and to the standards required by FPC Order No. 485 and 18 CFR 2.81 (a) and 2.82 (e), the National Environmental Policy Act of 1969 (NEPA), and the final regulations as issued by the Council on Environmental Quality (CEQ) pertaining to NEPA.

A major activity of this Task will be the project management and coordination of all aspects of the Exhibit W-related environmental studies including work program, work product, scheduling, day-to-day performance of the tasks, production and quality control.

The process to be employed in the preparation of Exhibit W is enumerated in the following activities:

- Prepare base maps for project area and region.
- Prepare project area and regional data maps.
- Graphically portray reservoir fluctuation and stream hydrographs.
- Prepare draft of "Description of Proposed Action" (Chapter 1).
- Prepare draft of "Description of Existing Environment" (Chapter 2).
- Analyze and describe short-term construction effects of project.

TASK: C-4-24 Prepare Final Report

- Analyze and comparatively evaluate alternate transmission routes.
- Describe procedures to arrive at preferred alternative.
- Compile and evaluate opportunities to minimize adverse effects.
- Analyze and describe long-term effects of the project.
- Prepare draft of "Alternatives" (Chapter 8).
- Review project siting and operation requirements in light of environmental impacts.
- Prepare draft of "Environmental Impact" (Chapter 3).
- Recommend mitigation measures to minimize construction and operational impacts.
- Prepare draft of "Mitigation" (Chapter 4).
- Prepare draft of "Unavoidable Effects" (Chapter 5).
- Prepare draft of "Short-term versus Long-term Productivity" (Chapter 6).
- Prepare draft of "Irreversible Commitment of Resources" (Chapter 7).
- Prepare draft of "Compliance with Regulations, Permits, Codes" (Chapter 9).
- Document "Public Participation Program" and prepare "Bibliography" (Chapter 10).
- Compile and refine the entire report.
- Print review copy of Exhibit W.
- Make necessary revisions based on APA review.

CATEGORY:	<u>C</u>	ENVIRONMENTAL STUDIES
ASSIGNMENT	C-5	EXHIBIT "R" RECREATION PLAN
TASK TITLE:	C-5-1	Formulate Goals and Operational Objectives
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LEVEL OF EFF	ORT	16 Man-days
SCHEDULE:		July 1980
ESTIMATED CO	OST:	\$6,000
RESPONSIBIL	ITY:	P. Miller (EDAW)
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PURPOSE:

To develop a plan for public utilization of project waters and adjacent lands for recreational purposes insofar as it would be consistent with the proper operation of the project for the development of water power and other public purposes.

The primary objectives of the recreation plan are:

- To define and develop a recreation market potential for the project consistent with the resource base of the area and identified needs of both residents and tourists.
- To accommodate for project-induced recreation use.
- To offset recreational resources lost by construction of the proposed project.

SCOPE:

Six major factors typically influence the recreation planning process and the ultimate design of the recreation plan:

- Developed objectives and management goals of the Alaska Power Authority and appropriate recreation management agencies.
- Operational characteristics of the Susitna project.
- Resource constraints and opportunities of the area, including climate and land resources such as vegetation, fish, wildlife and water quality.
- Development constraints and opportunities, including those associated with the proposed project.

TASK: C-5-1 Formulate Goals and Operational Objectives

- Recreation demand both demonstrated and anticipated.
- Financial obligation and responsibility of the Alaska Power Authority and other key management agencies in either the development, management or operations of the recreation plan.

The overall approach will be to analyze each of the above factors and in a unified effort between agencies, consultant and the APA to develop several conceptual recreation schemes. Each scheme will represent different levels of use; patterns of use; levels of financial investment for facilities and land acquisition by the Alaska Power Authority; implications for management roles of the Alaska Power Authority, BLM, Alaska Division of Parks, Cook Inlet Region Inc., and appropriate Native village corporations.

These schemes will be graphically portrayed through the following:

- Alternative recreation development plans which outline the facilities to be built as part of the project and lands to be acquired.
- Alternative recreation management plans which address, through zoning issues such as all-terrain vehicle use and recreation vehicle camping controls.
- A comparison matrix summarizing the pros and cons of each scheme relative to their recreation values.
- A comparative summary of the impacts on the resource base, particularly in relation to hunting and fishing activities.

From these, a preferred recreation plan will be identified and refined under close review by the Alaska Power Authority and key public and private interests.

Specific Activities

- Field Reconnaissance.
- Meet individually with Alaska Power Authority and key agency representatives including:
 - Heritage, Conservation and Recreation Service
 - Bureau of Land Management
 - Alaska Division of Parks Statewide Recreation Resource Study Group
 - Alaska Division of Parks State Parks System Planning Group
 - Alaska Department of Fish and Game
 - Cook Inlet Region, Inc.
 - Native Village Corporation
- Identify individual agency planning goals which have potential bearing on the development of the Susitna recreation plan. Identify and document conflicts which may exist between individual goals.
- Meet collectively with Alaska Power Authority and key agency representatives to agree in principle upon planning goals/guidelines for the preparation and evaluation of the recreation plan.

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SUSITNA HYDROELECTRIC PROJECT

CATEGORY: C ENVIRONMENTAL STUDIES

ASSIGNMENT: C-5 EXHIBIT "R" RECREATION PLAN

TASK TITLE: C-5-2 Determine Recreational Land Use Suitability

LEVEL OF EFFORT: 48 Man-days

SCHEDULE: July, August 1981

ESTIMATED COST: \$15,000

RESPONSIBILITY: P. Miller (EDAW)

PURPOSE:

To preparae documents for Exhibit R of FERC License Application as described in Task C-5-1.

SCOPE:

- Summarize and synthesize the findings of environmental work conducted as part of Exhibits W, S, and V.
- Prepare data maps identifying resource opportunities and constraints, seasonal contraints.
- Determine suitability of areas within the influence of the proposed project for potential recreation uses such as:
 - Water related uses rafting, boating, fishing.
 - Hunting
 - Day uses picnicking, and interpretation.
 - All-terrain vehicle use.
 - Overnight use camping, including campers, trailers or recreational vehicles.
- Conduct field inspections.
- Re-evaluate area suitability.
- Document conclusions.

CATEGORY: C ENVIRONMENTAL STUDIES

ASSIGNMENT C-5 EXHIBIT "R" RECREATION PLAN

TASK TITLE C-5-3 Assess Recreation Demand

LEVEL OF EFFORT:_	16 Man-days
SCHEDULE:	August, September 1981
ESTIMATED COST:	\$7,000
RESPONSIBILITY:	P. Miller (EDAW)

PURPOSE:

To prepare documents for Exhibit R of FERC License Application as described in Task C-5-1.

SCOPE:

In order to focus upon the need for recreation activities relative to the project features, existing regional and local patterns and trends of recreation use with the Railbelt area will be examined.

- Determine recreation market area. (See Task Assignment C-4, Task C-4-15 -Recreation.)
- Analyze and document public recreation roles of Federal and State governments, private entrepreneurs, outfitters and guides.
- Review and document socioeconomic characteristics from both a regional and local point of view (leisure trends, seasonality factors, tourism). (See Task Assignment C-4, Task C-4-15 - Recreation.)
- Conduct three public involvement workshops. Summarize and document results.
- Document existing proposed recreation use regionally and within the immediate project area. User information, such as number of visitor days per various activities, will be generated as part of Exhibit R work. (See Task Assignment C-4, Task C-4-15 Recreation.)

CATEGORY:	С	ENVIRONMENTAL STUDIES
ASSIGNMENT:	C-5	EXHIBIT R - RECREATION PLAN
TASK TITLE:	C-5-4	Develop Conceptual Recreation Schemes

LEVEL OF EFFORT:_	40 Man-days
SCHEDULE:	October 1981
ESTIMATED COST:	\$11,000
RESPONSIBILITY:	P. Miller (EDAW)

PURPOSE:

To prepare documents for Exhibit R of FERC License Application as described in Task C-5-1.

SCOPE:

The purpose of this task will be to synthezise recreation land use suitability data determined in Task C-5-2 with recreation demand data generated in Task C-5-3 to create conceptual alternatives which illustrate the range of realistic recreational development options available.

Alternative plans will be general in design, but specific in terms of how much, where, and what kind of recreation use is proposed. In addition, sufficient information will be presented to the Alaska Power Authority to portray the policy implications of each concept.

- Develop alternative recreational plan maps.
 - Document land acquisition options.
 - Document facility development options.
- Develop alternative management plan maps.
- Develop preliminary cost estimates.
- Portray policy implications.
- Prepare comparative matrix summarizing the following:
 - Recreation values of alternatives to existing and projected demand.
 - Impacts on resource base.

CATEGORY	С	ENVIRONMENTAL STUDIES	
ASSIGNMENT:	C-5	EXHIBIT "R" RECREATION PLAN	1

TASK TITLE: C-5-5 Review Alternative Plans With APA and Appropriate Agencies

LEVEL OF EFFORT:	11 Man-days	· · · · · · · · · · · · · · · · · · ·
SCHEDULE:	November 1981	
ESTIMATED COST:	\$4,000	
RESPONSIBILITY:	P. Miller (EDAW)	

PURPOSE:

To prepare documents for Exhibit R of FERC License Application as described in Task C-5-1.

SCOPE:

Workshop meetings shall be held with the Alaska Power Authority and key agencies as required to review alternative plans and to refine the approach and direction of the preferred recreation development and management plans.

A major goal of this review process will be to reach a consensus on major objectives of the recreation plan. In addition, the review process will serve to refine the identification of areas, various levels of development and what that means in terms of activities, investment in recreation facilities and management implications.

SUSITNA HYDROELECTRIC PROJECT

PLAN OF STUDY

CATEGORY:	С	ENVIRONMENTAL	STUDIES	

ASSIGNMENT: C-5 EXHIBIT "R" RECREATION PLAN

TASK TITLE: C-5-6 Select and Refine Preferred Recreational Use Plan

LEVEL OF EFFORT: 49	Man-days
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SCHEDULE: December 1981

ESTIMATED COST: \$15,000

RESPONSIBILITY: P. Miller (EDAW)

PURPOSE:

To prepare documents for Exhibit R of FERC License Application as described in Task C-5-1.

SCOPE:

The preferred recreation use plan will be selected and refined by the Alaska Power Authority and ${\tt EDAW}{\mbox{.}}$

- Produce detailed recreation development program:
 - Identify specific development areas.
 - Designate activity types and levels of use by management areas.
 - Recommend priorities for development.
 - Prepare cost estimates.
- Produce detailed recreation management plan.
- Field verify development areas and management boundaries.

CATEGORY:	С	ENVIRONMENTAL	STUDIES	

ASSIGNMENT: C-5 EXHIBIT "R" RECREATION PLAN

TASK TITLE: C-5-7 Prepare Final Report

LEVEL OF EFFORT: 54 Man-days

SCHEDULE: January to June 1982

ESTIMATED COST: \$15,000

RESPONSIBILITY: P. Miller (EDAW)

PURPOSE:

To prepare Exhibit R of FERC License Application as described in Task C-5-1.

SCOPE:

Review Detailed Recreation Use Plan with the Alaska Power Authority and Appropriate Agencies

- Establish concurrence relative to the objectives of the recreation use plan in term of:
 - Experience levels.
 - Quality and quantity of recreation facilities.
 - Management issues.
 - Initial phase construction.
- Solicit input in completing and refining cost estimates for recreation construction, operation and maintenance of facilities and other administrative costs as deemed necessary.

Prepare Final Report

- Prepare and assemble final text and maps for review by the Alaska Power Authority to include:
 - Planning goals.
 - Existing recreation in Railbelt region.
 - Factors influencing the design of the recreation plan.
 - Identification of optimum use limits.
 - Development Plan.
 - Management Plan.
 - Estimates of use levels.
 - Plan implementation.
 - Cost estimates including development costs and administration/operation costs.
- Incorporate additions and alterations subsequent to review.

CATEGORY:	С	ENVIRONMENTAL STUDIES	

ASSIGNMENT: C-6 EHIXIBIT "V" NATURAL, SCENIC AND HISTORIC RESOURCE PROTECTION PLAN

TASK TITLE: C-6-1 Formulate Goals and Objectives

LEVEL OF EFFORT: 10 Man-days

SCHEDULE: February, March 1981

ESTIMATED COST: \$5,000

RESPONSIBILITY: M. Bowie (EDAW)

PURPOSE:

To describe the project area, the project design and steps to be taken in all phases of project construction and operation so as to protect and enhance the natural, scenic and historic resources of the project area for inclusion as Exhibit V of FERC License Application.

SCOPE:

In order to formulate these goals and resolve questions relating to FERC guidelines and requirements, a workshop meeting will be held early in the project with APA and key Federal, State and local agency representatives and other interested parties.

PERSONNEL ASSIGNED:

Michael Bowie (EDAW) Bill Perkins (EDAW) Mark Trembley (EDAW) Dr. James Dixon (University of Alaska)

CATEGORY C	ENVIRONMENTAL	STUDIES
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ASSIGNMENT C-6 EXHIBIT "V" NATURAL, SCENIC AND HISTORIC RESOURCE PROTECTION PLAN

TASK TITLE: C-6-2 Analysis of Federal, State and Local Guidelines

LEVEL OF EFFORT: 15 Man-days

SCHEDULE: February, March 1981

ESTIMATED COST: \$5,000

RESPONSIBILITY: M. Bowie (EDAW)

PURPOSE:

To prepare documents for Exhibit V of FERC License Application as described in Task C-6-1.

SCOPE:

All available planning guidelines will be assembled including FERC's "Guidelines for Protection of Natural, Historic, Scenic, and Recreational Values in the Design and Location of Rights-of-Way Transmission Facilities," with respect to political jurisdictions and land use controls which affect the region as well as specific sites and areas.

CATEGORY:	<u>C</u>	ENVIRONMENTAL STUDIES
ASSIGNMENT:	C-6	EXHIBIT "V" NATURAL, SCENIC AND HISTORIC RESOURCE PROTECTION PLAN
TASK TITLE:	C-6-3	Cultural Resource Identification, Impact and Mitigation

LEVEL OF EFFORT:	3 Man-days
SCHEDULE:	October 1981 to January 1982
ESTIMATED COST:	\$1,000
RESPONSIBILITY:	M. Bowie (EDAW)

PURPOSE:

To prepare documents for Exhibit V of FERC License Application as described in Task C-6-1.

SCOPE:

The majority of work to be performed in the cultural resource study will be completed as part of the Exhibit W - Environmental Report program. Exhibit V will contain a summary of the cultural resource study including a description of the sites found in the reconnaissance level survey and intensive surveys; a discussion of the significance of each site; a description of the mitigation measures (i.e., avoidance, preservation and excavation) implemented during the study program to protect sites that would be adversely affected by the activities of the study phase; and a detailed plan for mitigation of adverse effects to sites during the construction phase. Detailed cost estimates will be provided indicating the recommended action relative to each historic and prehistoric site, the investigative time required and the staff/funding required.

CATEGORY:	С	ENVIRONMENTAL STUDIES	
ASSIGNMENT:	C-6	EXHIBIT "V" NATURAL, SCENIC AND HISTORIC RESOURCE PROTECTION F	PLAN
TASK TITLE:	C-6-4	Transmission Line Corridor Analysis	

 LEVEL OF EFFORT:
 15 Man-days

 SCHEDULE:
 April 1981 to January 1982

 ESTIMATED COST:
 \$6,000

 RESPONSIBILITY:
 M. Bowie (EDAW)

PURPOSE:

To prepare documents for Exhibit V of FERC License Application as described in Task C-6-1.

SCOPE:

An analysis will be made of the transmission routing requirements of the Susitna hydroelectric project as part of Exhibit W. (Task C-4-23). The analysis will provide a concise environmental framework by which to comparatively evaluate the Nenana I and Susitna I corridors, as well as the Watana and Devil Canyon corridor to the point of tie-in, and other possible corridor alignments.

Exhibit V will contain a summary of the transmission corridor analysis with specific emphasis on protection of natural, scenic and historic resources.

The transmission study will result in the presentation of associated environmental impacts for each corridor alignment as well as potential construction and operation mitigation measures. Specific mitigation concepts will deal with such measures as the merits of overhead versus underground transmission lines for segments of the corridor alignments; corridor right-of-way treatment; tower placement and design, as well as access roads management, maintenance and operational requirements.

CATEGORY:	С	ENVIRONMENTAL STUDIES	

ASSIGNMENT: C-6 EXHIBIT "V" NATURAL, SCENIC AND HISTORIC RESOURCE PROTECTION PLAN

IASK TITLE: C-6-5 Visual Resource Identification, Impact and Mitigation

LEVEL OF EFFORT:	10 Man-days
SCHEDULE:	July 1981 to January 1982
ESTIMATED COST:	\$4,000
RESPONSIBILITY:	M. Bowie (EDAW)

PURPOSE:

To prepare documents for inclusion in Exhibit V of FERC License Application as described in Task C-6-1.

SCOPE:

The visual studies of the Upper Susitna River basin will be conducted as part of Exhibit W (Task C-4-22) and will determine the significant visual effects of the Watana and Devil Canyon dam structures, reservoirs, certain access roads, recreation sites, construction camps, borrow and spoil areas, and related facilities. The visual studies, furthermore, will document and catalog the various view settings of the dam structures and supporting facilities in terms of effects on surrounding areas, and evaluate the relative visual quality acceptability of the local view relations to the settings.

The visual impact analysis will focus on the contrast between the existing landscape and future landscapes, as modified by project features, and depicted by photographically simulated study models. Differences in contrast will be analyzed according to changes in such basic landscape elements of form, line, color and texture.

Exhibit V will detail the costs of mitigation required to minimize adverse visual effects of the project. Mitigation measures will be expressed in terms of planning and design suggestions involving the arrangement of power plant components and ground forms, the control of views, and other measures contributing to the orderly arrangement of project appearance. Other mitigation measures that will be considered are:

- Landscape planting for screening and buffers.
- Use of color on dam structure components.
- Treatment of construction yards, spoil sites and borrow pits.
- Reservoir clearing considerations.
- Consideration of comparative mitigation costs.

CATEGORY: C ENVIRONMENTAL STUDIES

ASSIGNMENT: C-6 EXHIBIT "V" NATURAL, SCENIC AND HISTORIC RESOURCE PROTECTION PLAN

TASK TITLE: C-6-6 Prepare Final Report

LEVEL OF EFFORT: 12 Man-days

SCHEDULE: January to June 1982

ESTIMATED COST: \$5,000

RESPONSIBILITY: M. Bowie (EDAW)

PURPOSE:

To prepare Exhibit V of FERC License Application as described in Task C-6-1.

SCOPE:

Prepare the final report for Exhibit V on the basis of the studies and work described in Tasks C-6-1 through C-6-5.

CATEGORY	С	ENVIRONMENTAL STUDIES	
ASSIGNMENT	C-7	EXHIBIT "S" FISH AND WILDLIFE RESOURCES PROTECTION PLAN	

TASK TITLE: C-7-1 Describe Pre-Project Biological Setting

LEVEL	OF	EFFORT:	10 Man-days
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SCHEDULE: January 1982

ESTIMATED COST: \$5,000

RESPONSIBILITY: J. Hemming (Dames & Moore)

PURPOSE:

To prepare documents for Exhibit S, Fish and Wildlife Resources Protection Plan which will address the following:

- Summarize the results of baseline fish and wildlife studies within the proposed project area.
- Describe positive and negative impacts of the proposed hydroelectric project on fish and wildlife resources and their habitat.
- Assemble techniques and present designs and drawings for mitigation of effects on fish and wildlife resources.
- Identify and describe the costs of implementing a mitigation plan.
- Develop a detailed plan for coordination and information exchange with natural resource agencies, including the Alaska Department of Fish and Game, U.S. Fish and Wildlife Service, National Marine Fishery Service, Bureau of Land Management, and the Alaska Department of Natural Resources.

SCOPE:

Following a review of baseline studies of vegetation, anadromous fisheries, resident fisheries, large mammals, birds, air quality, and water quality, the pre-project biological setting will be described.

SCHEDULE DESCRIPTION:

The work for Assignment C-7 will begin in mid-1981 and will be accomplished in approximately 5 months. The groundwork for the data and information required in Exhibit S will be accomplished in the biological studies conducted for Assignment C-4, preparation of Exhibit W. LEVEL OF EFFORT

A total effort for the tasks comprising Assignment C-7 of 50 man-days is anticipated at a labor cost of approximately \$15,000. Equipment, travel, and subsistence are estimated at 8,000 for a total Task cost of \$23,000. Individual Task breakdowns are given for each Task.

PERSONNEL ASSIGNMENT:

This assignment will be accomplished by an interdisciplinary team of eight specialists consisting of the Principal Investigators from the various environmental tasks and a technical writer/editor. Project leader will be James E. Hemming.



CATEGORY	С -	ENVIRONMENTAL	STUDIES

ASSIGNMENT: C-7 EXHIBIT "S" FISH AND WILDLIFE RESOURCES PROTECTION PLAN

TASK TITLE: C-7-2 Assess Impacts to Fish and Wildlife

LEVEL OF EFFORT: 10 Man-days

SCHEDULE: February 1982

ESTIMATED COST: \$5,000

RESPONSIBILITY: J. Hemming (Dames & Moore)

PURPOSE:

To prepare documents for inclusion in Exhibit S of FERC License Application as described in Task C-7-1.

SCOPE:

Potential changes to habitat of fish and wildlife populations resulting from construction and operation of the Susitna hydroelectric project will be described including the relative level of impact.

INTERNATIONAL ENGINEERING COMPANY, INC.

CATEGORY: C ENVIRONMENTAL STUDIES

ASSIGNMENT: C-7 EXHIBIT "S" FISH AND WILDLIFE RESOURCES PROTECTION PLAN

TASK TITLE: C-7-3 Prepare Mitigation Plan

LEVEL OF EFFORT: 12 Man-days

SCHEDULE: March to May 1982

ESTIMATED COST: \$5,000

RESPONSIBILITY: J. Hemming (Dames & Moore)

PURPOSE:

To prepare documents for inclusion in Exhibit S of FERC License Application as described in Task C-7-1.

SCOPE:

A mitigation plan will be prepared including specific methods and designs such as areas and techniques for controlled burning projects to improve moose winter range as mitigation for losses of riparian vegetation within the reservoir area. Detailed costs of implementing the mitigation plan will also be developed.

CATEGORY: C ENVIRONMENTAL STUDIES

ASSIGNMENT: C-7 EXHIBIT "S" FISH AND WILDLIFE RESOURCES PROTECTION PLAN

TASK TITLE: C-7-4 Coordination With Natural Resources Agencies

LEVEL OF EFFORT	10 Man-days
SCHEDULE:	January to May 1982
ESTIMATED COST:	\$5,000
RESPONSIBILITY:	J. Hemming (Dames & Moore)

PURPOSE:

To prepare documents for Exhibit S of FERC License Application as described in Task C-7-1.

SCOPE:

Throughout the mitigation plan development process, continuous involvement by the natural resource agencies will be required. Therefore, one of the first Tasks will be to develop a list of key agency personnel and a schedule of meetings, field trips, and workshops to assure that adequate agency input is included in the mitigation plan.

INTERNATIONAL ENGINEERING COMPANY, INC.

CATEGORY C ENVIR	ONMENTAL	STUDIES
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ASSIGNMENT: C-7 EXHIBIT "S" FISH AND WILDLIFE RESOURCES PROTECTION PLAN

TASK TITLE: C-7-5 Prepare Final Report

LEVEL OF EFFORT: 8 Man-days

SCHEDULE: May 1982

ESTIMATED COST: \$3,000

RESPONSIBILITY: J. Hemming (Dames & Moore)

PURPOSE:

To prepare Exhibit S of FERC License Application as described in Task C-7-1.

SCOPE:

Prepare final report of Exhibit S including each of the items described in Tasks C-7-1 through C-7-4.
Hydrological Studies

D-1		PRINCIPAL-IN-CHARGE, HDYROLOGICAL STUDIES
	D-1-1	Management and Technical Supervision
D-2		DATA COLLECTION, GAGING AND SAMPLING
	D-2-1	IECO Coordination and Review
	D-2-2	Install and Operate Stream Gaging Stations
	D-2-3	Sediment and Water Quality Data Sampling
D-3		DATA MANAGEMENT
	D-3-1	Collect and Compile Existing Hydrometeorologic Data
	D-3-2	Compile Data from New Hydrometeorologic Stations
	D-3-3	Establish Computer Based Data Library
D-4		MATHEMATICAL MODELING AND SIMULATION
	D-4-1	Develop Comprehensive Watershed Model
	D-4-2	Develop Specific Models for Arctic Conditions
	D-4-3	Calibrate and Verify Models
D-5		BASIN YIELD AND FLOOD STUIDES
	D-5-1	Preliminary Hydrologic Investigations for Plan Formulation
	D-5-2	PMP and PMF's for Project Sites
	D-5-3	Statistical and Graphical Analysis
	D-5-4	Glacial Water Balance
	D-5-5	Correlation and Extension of Streamflow Data
D-6		RIVER HYDRAULICS, SEDIMENTATION, AND WATER QUALITY
	D-6-1	Tailwater Rating Curves and Water Surface Profiles
	D-6-2	Reservoir Sedimentation and Stratification Studies
	D-6-3	Downstream Sediment Transport and Water Quality
	D-6-4	Effects of Ice Formation and Breakup
	D-6-5	Reservoir Filling and Emergency Drawdown Criteria
	D-6-6	Downstream Hazards from Dam Failure

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ASSIGNMENT: D-1 PRINCIPAL-IN-CHARGE, HYDROLOGICAL STUDIES

TASK TITLE: D-1-1 Management and Technical Supervision

LEVEL OF EFFORT:_	180 Man-days
SCHEDULE:	Intermittent - January 1980 to July 1982
ESTIMATED COST:	\$64,000
RESPONSIBILITY:	C. J. Chan (IECO)
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PURPOSE:

To organize, plan and direct the activities for all Task Groups within the Hydrological Studies Category and to coordinate with principals-in-charge in other disciplines.

SCOPE:

The primary function of the principal-in-charge is the effective management, administration and overall technical supervision of the Hydrological Studies project group. His responsibilities include:

- Evaluate and define the scope of the hydrologic studies required for the project.
- Direct and coordinate activities with Task Group Leaders and schedule work tasks and staff personnel for each task.
- Establish criteria and guidelines and overall technical supervision of all hydrological studies.
- Review work performed within the Group to ensure technical soundness and conformity with study objectives.
- Coordinate with principals-in-charge of other disciplines and provide hydrologic information and studies as required in other Work Categories.
- Assist Project Manager in technical meetings with the Client and in public participation meetings as required.

INTERNATIONAL ENGINEERING COMPANY, INC.

CATEGORY:	D	HYDROLOGICAL STUDIES

ASSIGNMENT: D-2 DATA COLLECTION, GAGING AND SAMPLING

TASK TITLE: D-2-1 IECO Coordination and Review

LEVEL OF EFFORT:	85 Man-days
SCHEDULE:	Intermittent - January 1980 to July 1982
	\$29,000
RESPONSIBILITY:	W. C. Peterson (IECO)

PURPOSE:

To coordinate work on all hydrometeorologic data collection with Subcontractors and the Hydrological Studies task group leaders, and to review the quality of data collected.

SCOPE:

The IECO Coordinator will provide overall coordination and liaison with the data collection activities. The USGS is responsible for the collection of streamflow, sediment and water quality data; and Dames & Moore is responsible for the collection of meteorologic data for both the Hydrological Studies and Environmental Studies. The IECO coordinator will work closely with all concerned to:

- Plan and locate suitable sites in the field for all hydrometeorologic stations.
- Discuss requirements with other Task Groups to obtain and specify type of data required and observation intervals for these data.
- Provide services in the selection and ordering of equipment.
- Assist and represent APA in recommending and allocating expenditures.
- Ensure data gathering is proceeding on schedule.
- Assist and coordinate work with Data Management Task Group in the collection of existing data and in contacting different agencies where the data are required.
- Review quality of data obtained.
- Transfer data obtained to the Data Management Task Group for compilation, updating and analysis.

CATEGORY	: D	HYDROLOGICAL	STUDIES

ASSIGNMENT: D-2 DATA COLLECTION, GAGING AND SAMPLING

TASK TITLE: D-2-2 Install and Operate Stream Gaging Stations

LEVEL OF EFFORT:_	535 Man-days
SCHEDULE:	February 1980 to July 1982
ESTIMATED COST:	\$446,000
RESPONSIBILITY:	USGS

PURPOSE:

To obtain streamflows from different parts of the project basin for the modeling of the rainfall-runoff, glacial, erosion, sediment transport and water quality processes, for flood calibration in flood studies; for deriving repesentative streamflows at project sites for reservoir operation studies; and for environmental studies.

SCOPE:

The installation and operation of 8 new project gages and the continuation of data gathering at the 3 existing stations would be by the USGS, with the costs borne by the APA.

The stream gaging stations, listed below, are selected on basis of their importance in representing the flows of different subbasins in the project watershed.

- 1. Susitna River at Gold Creek (Existing)
- 2. Susitna River near Denali (Existing)
- 3. Maclaren River near Paxson (Existing)
- 4. Tyone River near Mouth
- 5. Oshetna River near Mouth
- 6. Susitna River at Cantwell (Former Gage)
- 7. Watana Damsite
- 8. Devil Canyon Damsite
- 9. Susitna River at Highway 3 Bridge Crossing below Talkeetna
- 10. Chulitna River near Talkeetna
- 11. Special "Glacial Gage" (to measure the majority of the summer runoff from the glacial areas, to be located after site visit)

The operation would cover the 2-1/2 years study period. Continuous recording gages would be installed. Annual site visits are about 5 times during the open water period and 3 times during periods of ice cover.

CATEGORY	D	HYDROLOGTCAL	STUDIES
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ASSIGNMENT: D-2 DATA COLLECTION, GAGING AND SAMPLING

TASK TITLE: D-2-3 Sediment and Water Quality Data Sampling

LEVEL OF EFFORT:	145 Man-days
SCHEDULE:	April 1980 to July 1982
ESTIMATED COST:	\$109,000
RESPONSIBILITY:	USGS

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PURPOSE:

To obtain sediment data and data on the essential water quality parameters for Reservior Sedimentation and Stratification Studies; for determining pre-project and post-project sediment transport and water quality conditions; and for supplementing other data that will be gathered in the Environmental Studies.

SCOPE:

The work on this Task is to be carried out in conjunction with Task D-2-2, the gathering of streamflow data. Sampling locations are at the streamflow gaging stations as proposed in the D-2-2 Task. Data to be gathered consist of:

- Sediment loads
- Water temperature
- Dissolved oxygen
- Conductivity or pH

At the proposed stream gaging stations, in addition to gaging streamflows, the installed equipment will also record daily water temperatures. Sediment and water quality samplings will be performed during the routine site visits. During annual floods and high flow periods, more frequent samplings may be required. Samplings collected will be sent to the laboratory for analysis. The water quality parameters specified above represent the basic data required for the various hydrologic studies. Throughout the study period, if required, other chemical and biological elements, such as nitrates, phosphates, total dissolved solids, nitrogen, heavy metals, total organic carbon, turbidity, nutrients, phytoplankton and zooplankton can also be sampled. All the sediment loads and water quality data sampled will also be used in conjunction with the additional grab samplings that will be gathered for use in various Environmental Studies.

Similar to Task D-2-2, the work for this Task will be performed by the USGS through APA funding and with the IECO Task Group Leader as coordinator.

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ASSIGNMENT: D-3 DATA MANAGEMENT

TASK TITLE: D-3-1 Collect and Compile Existing Hydrometeorologic Data

LEVEL OF EFFORT:	110 Man-days
SCHEDULE:	January to April 1980, July 1980
ESTIMATED COST:	\$46,000
RESPONSIBILITY:	J. L. Kittle (Hydrocomp)

PURPOSE:

To establish a data bank of all historic meteorologic, hydrologic and water quality data in and near the Upper Susitna basin.

SCOPE:

All historic U.S. Weather Bureau, State of Alaska, and local meteorologic records for the following will be collected:

- Precipitation
- Temperature
- Dewpoint
- Wind Movement
- Solar Radiation

- Snow Course
- Cloud Cover
- Snow Depth and Density
- Ice Cover on Streams and Lakes
- Glacial Volume and Glacial Movements

This activity will be coordinated with the Environmental Studies Task Group, in conjunction with their meteorological data gathering for the Climatic Studies for the Upper Susitna basins and the transmission line corridor.

All historic streamflow and water quality records from U.S. Geological Survey, U.S. Environmental Protection Agency, and other sources will be collected. These records include but are not limited to the following:

- Streamflow
- Water Temperature
- Dissolved Oxygen and BOD
- pH or conductivity

- Nutrients
- Photoplankton and Zooplankton
- Total Organic Carbon
- Turbidity



D-3 DATA MANAGEMENT ASSIGNMENT:

D-3-2 Compile Data from New Hydrometeorologic Stations TASK TITLE:

LEVEL OF EFFORT:	75 Man-days
SCHEDULE:	February 1980 to July 1982
ESTIMATED COST:	\$33,000
RESPONSIBILITY:	J. L. Kittle (Hydrocomp)

PURPOSE:

To compile data from new hydrometeorologic stations in the Upper Susitna basin for a data bank of all meteorologic, hydrologic and water quality data in and near the basin.

SCOPE:

- Review data needs for all hydrologic, sediment, and glacial studies with Hydrological Studies Task Group.
- Establish computer communications equipment and connections and obtain the **A** meteorologic data and hydrologic data from the new streamflow and climatic stations.
- Compile these new data into the data bank on the HSPF Comprehensive Modeling System.
- Monitor the new records as they are collected and received to check that data is reasonable and consistent.
- Report any problems to the Gaging and Sampling Task Group.

	n	HYDROLOGICAL	STUDIES
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ASSIGNMENT: D-3 DATA MANAGEMENT

TASK TITLE: D-3-3 Establish Computer Based Data Library

LEVEL OF EFFORT:	495 Man-days
SCHEDULE:	February 1980 to July 1982
ESTIMATED COST:	\$204,000
RESPONSIBILITY:	J. L. Kittle (Hydrocomp)

PURPOSE:

To establish a computer based data bank of all historic and currently observed hydrologic and meteorologic data to provide an efficient and convenient basis for hydrologic, environmental and project design studies.

SCOPE:

- Review project requirements for data storage and manipulation, and plan data bank operations to meet needs efficiently.
- Review available software for data management and extend this software where necessary.
- Arrange computer hardware to satisfy disk and tape storage needs and arrange graphics equipment to plot data.
- Arrange and test communications equipment so that all members of the project teams, Client, and cooperating state and federal agencies can use the data bank.
- Read all historic data into the data bank and check data for validity.
- Read newly collected data into the data bank and advise the appropriate agencies if data are incomplete or inaccurate.
- Operate the data bank to meet modeling and other project requirements during the life of the project.
- At the completion of the project, write the data bank to magnetic tape and transfer to the Client.

CATEGORY:	D	HYDROLOGICAL	STUDIES

ASSIGNMENT: D-4 MATHEMATICAL MODELING AND SIMULATION

TASK TITLE: D-4-1 Develop Comprehensive Watershed Model

LEVEL OF EFFORT:_	105 Man-days
SCHEDULE:	February to October 1980
ESTIMATED COST:	\$46,000
RESPONSIBILITY:	N. H. Crawford (Hydrocomp)

PURPOSE:

To assemble and develop modeling and statistical analysis methods for the hydrologic, project planning and environmental analyses in the Upper Susitna basin.

SCOPE:

Comprehensive modeling tools for the Upper Susitna basin will be selected and assembled. Continuous, physically based, modeling of both water quantity and quality processes will be used. A mathematical model, representing the Upper Susitna basin will be created. This model will be called the Susitna Modeling System (SMS). The Hydrocomp new EPA-HSPF modeling system will be the tools used in the SMS, because it combines water quantity and quality processes and good data management into one efficient package. The HSPF model also allows straight-forward connection of submodels to form a comprehensive model system. Additional monitoring routines will be written for SMS to log and index computer runs so that particular runs can be traced. Input to the SMS will be streamlined so that computer runs can be made efficiently. Extensions to the HSPF modeling algorithms will be made where they are needed by the project. Full routing equations for the study of flood wave movement from the Hydrocomp FULEQ model for flood waves and catastrophic dam failure analysis will be included into the SMS.

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CATEGORY:	D	HYDROLOGICAL	STUDIES

ASSIGNMENT: D-4 MATHEMATICAL MODELING AND SIMULATION

TASK TITLE: D-4-2 Develop Specific Models for Arctic Conditions

LEVEL OF EFFORT:	320 Man-days
SCHEDULE:	March 1980 to April 1981, July 1981 to January 1982
ESTIMATED COST:	\$151,000
RESPONSIBILITY:	N. H. Crawford (Hydrocomp)

PURPOSE:

To develop or adopt specific mathematical models for arctic conditions unique to the Upper Susitna climatic and physical setting.

SCOPE:

Specific mathematical models for arctic conditions will be developed, tested and documented. These specific models can be individual or submodels that will be attached to the SMS to form a comprehensive watershed model unique to the Upper Susitna basin. The University of Alaska Geophysical Institute will be performing special arctic research and studies discussed under the project Task Assignment E-5, Special Arctic Studies. Where possible, their research data and study inputs will be incorporated.

The specific mathematical models consider the arctic conditions for glacial mass balance and sediment production, for ice formation, melt and movement, for soil erosion, and for stratified reservoirs with ice cover. Existing, well-documented models will be used where possible. Where suitable models are not available, these specific models will be developed from theoretical studies, equations and field data. The stratified reservoir model which will be reviewed carefully is the WESTEX, the most recent Corps of Engineers model from the Waterways Experiment Station. Ice formation and ice movement algorithms will be added to this model.

CATEGORY:	D	HYDROLOGICAL STUDIES

ASSIGNMENT: D-4 MATHEMATICAL MODELING AND SIMULATION

TASK TITLE: D-4-3 Calibrate and Verify Models

LEVEL OF EFFORT:	325 Man-days
SCHEDULE:	March 1980 to April 1981
ESTIMATED COST:	\$141,000
RESPONSIBILITY:	N. H. Crawford (Hydrocomp)

PURPOSE:

To use physical information on the Susitna basin and concurrent meteorologic and hydrologic data to calibrate SMS models and simulate pre-development hydrologic sediment and, water quality data.

SCOPE:

After the Susitna Modeling System (SMS) models are developed and compiled in Tasks D-4-1 and D-4-2, the SMS models will be calibrated for accuracy using a suitable length of data. Simulation runs will also be made to show pre-project conditions. The work will include:

- Compile basin information on topography, land slopes, soils, vegetation, erosion rates and geology.
- Assemble data on stream channel cross-sections and slopes.
- Select watershed segments, channel reaches and initial parameter levels for modeling.
- Calibrate the hydrologic regime of the Upper Susitna using both historic data and data from the new climatological stations and stream gage sites.
- Calibrate sediment and water quality processes using the newly collected field data.
- Calibrate the glacial models, and the ice formation, melt and movement process.
- Test the stratified reservoir model to check for consistency of operation.
- Simulate a period of historic years for hydrologic, sediment and water quality results for the existing (pre-development) conditions.

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CALEGUAT. D HIDROLOGICAL STUDIES	CATEGORY:	D	HYDROLOGICAL STUDIES	
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ASSIGNMENT: D-5 BASIN YIELD AND FLOOD STUDIES

TASK TITLE: D-5-1 Preliminary Hydrologic Investigations for Plan Formulation

LEVEL OF EFFORT:	25 Man-days
SCHEDULE:	April to July 1980
ESTIMATED COST:	\$11,000
RESPONSIBILITY:	C. J. Chan (IECO)

PURPOSE:

To perform hydrologic investigations and give preliminary but adequate data and results for the project planning and sizing of the various hydro alternatives during the Plan Formulation Stage and for initial reconnaissance in the Environmental Studies.

SCOPE:

The activities under this Task are for the initial planning and screening of hydro sites and alternatives, prior to the detailed hydrologic analyses. These activities will utilize all the existing data and information that have been collected during the start of the project. These activities include:

- Delineate on USGS topographic maps the drainage areas for all potential sites and sub-basin boundaries for the Upper Susitna basin.
- Provide preliminary reservoir area-capacity curves.
- Estimate average tailwater conditions at all potential sites.
- Estimate reservoir evaporation rates from existing data.
- Develop preliminary monthly streamflow data at all hydro sites on the Upper Susitna basin.
- Provide preliminary spillway design floods at potential hydro sites.
- Provide streamflow data on other non-Susitna hydro sites as required and requested by other Task Groups.
- Provide preliminary identification of hydrologic conditions and impacts for the initial environmental assessments during the reconnaissance stage.

CATEGORY: D HYDROLOGICAL STUDIES

ASSIGNMENT: D-5 BASIN YIELD AND FLOOD STUDIES

TASK TITLE: D-5-2 PMP and PMF's for Project Sites

LEVEL OF EFFORT:_	115 Man-days
SCHEDULE:	September 1980 to July 1981
ESTIMATED COST:	\$48,000
RESPONSIBILITY:	C. J. Chan (IECO)

PURPOSE:

To develop probable maximum precipitation (PMP), and meteorologic and hydrologic conditions for the basin, and compute probable maximum floods (PMF) for spillway design at project sites.

SCOPE:

The probable maximum precipitation for the Upper Susitna basin had already been developed by NOAA. IECO has retained Mr. Joseph L. Paulhus as Special Consultant on Meteorology to review and advise on the PMP and the meteorologic conditions. If necessary, NOAA will be contracted to update and/or expand the data from their original studies. The activities under this task include:

- Obtain and review the PMP study by NOAA. If required, subcontract NOAA to perform an expanded study.
- Review of the PMP sequence and the meteorologic conditions prior to and during PMP by the Special Consultant on Meteorology.
- Review and tabulate maximum hydrologic conditions prior to PMP for use in the probable maximum flood simulation.
- Compile all design data and parameters into the SMS model.
- Use the SMS model to simulate probable maximum floods and the spillway flows for two project sites and report on the results.
- Reroute the computed PMF's through the project reservoirs and the selected spillway and outlet configurations, if necessary.

CATEGORY:	D	HYDROLOGICAL STUDIES
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ASSIGNMENT: D-5 BASIN YIELD AND FLOOD STUDIES_

TASK TITLE: D-5-3 Statistical and Graphical Analysis

LEVEL OF EFFORT:	195 Man-days	
SCHEDULE:	March 1980 to February 1982	
ESTIMATED COST:	\$82,000	
RESPONSIBILITY:	C. J. Chan (IECO)	

PURPOSE:

To perform a statistical and graphical analysis of all historic data, newly gathered data from the field, and of SMS model results; and to check input data reliability and display key model results in an easily understood fashion for the Hydrological Studies, Environmental Studies and Plan Synthesis.

SCOPE:

In the SMS model, the Data Management and the EPA-HSPF contained most of the statistical utilities that can be used for statiscal and graphical analysis. Throughout the project study period, these statistical subprograms will be used to monitor data input, perform analysis and display results whenever needed by the Hydrological, Environmental, and Plan Synthesis Task Groups. These statistical tools will show: maxima and minima, frequency of extremes, cross-correlations of selected meteorologic, hydrologic, and water quality data series, auto-correlations, regression and trends, double mass analysis and duration analysis. New data from meteorologic, hydrologic and water quality stations can be individually analyzed or combined with available historic data to carry out all the statistical studies as mentioned above. These data or results can be tabulated or displayed in graphical form. The statistical tools will also be used to evaluate the duration and frequency of "critical period" streamflows using historic data and mathematical modeling results performed in other tasks.

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CATEGORY:		HTDRULUGICAL STUDIES
ASSIGNMENT:	D-5	BASIN YIELD AND FLOOD STUDIES
TASK TITLE:	D- <u>5-4</u>	Glacial Water Balance
LEVEL OF EFF	ORT:	65 Man-days
SCHEDULE:		December 1980 to May 1981
ESTIMATED CO	OST:	\$28,000
RESPONSIBIL	ITY:	C. J. Chan (IECO)

PURPOSE:

To use the glacial model in the SMS and historic hydrometeorologic data to simulate an extended period of record on glacial mass balance and sediment outflows.

SCOPE:

The University of Alaska Geophysical Institute will be performing the Special Arctic Studies (Geotechnical Studies, Task Assignment E-5). Work under the present task will be coordinated with the Geophysical Institute, incorporating their information, data, and their first year research preliminary results on the physical processes of glacial movements and ice formation in rivers. The activities under this task include the compilation of historical changes in glaciers, including surges. The glacial model in the SMS, which is based on historical behavior of glaciers as correlated with climatic variables, will be run for a period of up to fifty years. Glacial water balance will be graphed in combination with parameters such as mean temperatures and precipitation. Where possible, glacial processes will be linked to known climatic changes or other key parameters indicated as a result of the Special Arctic Studies. Important findings from the Glacial Water Balance Study will be included in Task D-5-5 to determine the basin water yield and in the sedimentation studies to include the effects of sediment outflows from glacial processes.

CATEGORY: D HYDR	OLOGICAL STU	DIES
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ASSIGNMENT: D-5 BASIN YIELD AND FLOOD STUDIES

TASK TITLE: D-5-5 Correlation and Extension of Streamflow Data

LEVEL OF EFFORT:	125 Man-days	
SCHEDULE:	December 1980 to April 1981, September 1981	
ESTIMATED COST:	\$52,000	
RESPONSIBILITY:	C. J. Chan (IECO)	

PURPOSE:

To develop long-record streamflows for project reservoir sizing and power optimization, and to estimate minimum or "critical period" streamflows for project firm power determination and system reliability analysis.

SCOPE:

A 30-year streamflow record at all stream gage sites and damsites based on recorded flow data will be developed. Use of the SMS model will be made for cross-correlation and regression analysis of historic streamflow records and to simulate ungaged local area runoff. The newly gathered stream flow and meteorologic data will be input into the SMS model and combined with the historic meteorologic data collected within a 200-mile radius of the Susitna basin (see Task D-3-1). The daily streamflow record, using the SMS model, at each stream gage site and damsite will be extended to the length of the meteorologic records in the Susitna region. Daily flows of about 50 or more years in length can thus be developed. From the results of Task D-5-4, Glacial Water Balance, the long-term variability of glacial runoff and its importance to minimum or "critical period" flows will be investigated. The "critical period" flows in the simulated 50-year daily flows will be examined to see what portion of the "critical period" low flows is from glacial runoff. The 50 years of flows will be compared with the results of the Glacial Water Balance to determine whether the glacial runoff in the last 50 years is higher or lower than normal. This in turn will help in estimating the true frequency of minimum flows observed in the Susitna. Stochastic generation of monthly streamflows is also an option in generating additional years of record based on the simulated 50 years. Several hundred traces of flows, each trace containing 50 years of generated data, can be generated using Markovian processes. In each generated trace, the "critical period" flows are identified and used in estimating the frequency of the minimum flows. Costs for the Stochastic Generation option are not included in this Task.

CATEGORY:	D	HYDROLOGICAL	STUDIES

ASSIGNMENT: D-6 RIVER HYDRAULICS, SEDIMENTATION, AND WATER QUALITY

TASK TITLE: D-6-1 Tailwater Rating Curves and Water Surface Profiles

LEVEL OF EFFORT:	35 Man-days	
SCHEDULE:	December 1980 and May 1981	
ESTIMATED COST:	\$15,000	
RESPONSIBILITY:	F. H. Wu (IECO)	

PURPOSE:

To develop tailwater rating curves at project sites for use in Reservoir and Power Operation Studies. Compute water surface profiles for proposed reservoirs for use in the Environmental Studies and for delineating reservoir boundaries in Exhibit K of FERC License Application.

SCOPE:

The water surface profiles under the steady flow conditions are computed for the selected project sites to obtain tailwater rating curves. Backwater profiles for proposed reservoirs will be computed to determine water surface elevations along the entire length of reservoirs, and also for determining the maximum dam height and reservoir elevation of the lower reservoir without encroaching on the tailrace of the upper dam. The HEC-2, "Water Surface Profiles" computer program, developed by the Corps of Engineers, Hydrologic Engineering Center, will be used for these studies. The activities under this Task include:

- Collect and review stream cross-section data from work obtained under Surveying and Mapping.
- Estimate channel roughness coefficients, measure channel lengths and identify channel overbanks.
- Code and punch data on cards.
- Calibrate parameters with gaging station discharge rating curve, if available.
- Perform backwater runs for a range of discharges to obtain tailwater rating curves at project sites.
- Make final runs to determine maximum reservoir water surface elevations for project reservoirs after the dam heights and other operating criteria are finalized.

CATEGORY: D HYDROLOGICAL STUDIES

ASSIGNMENT: D-6 RIVER HYDRAULICS, SEDIMENTATION, AND WATER QUALITY

TASK TITLE: D-6-2 Reservoir Sedimentation and Stratification Studies

LEVEL OF EFFORT:_	150 Man-days
SCHEDULE:	March to October 1981
ESTIMATED COST:	\$66,000
RESPONSIBILITY:	F. H. Wu (IECO)

PURPOSE:

To forecast probable reservoir sedimentation and water quality for alternative operating policies of physical facilities.

SCOPE:

- Collect and tabulate data on the watershed topography, surface area, reservoir storage capacities and physical setting of the reservoir sites.
- Collect and compile design information and discharge rating curves for spillways and outlet works, and plans for reservoir operating policies.
- Operate the stratified reservoir submodel in the SMS model to predict water temperature, sediment concentrations, and other water quality parameters to cover a period of several years.
- Show results continuously and also by duration analysis.
- Evaluate the effects of alternative operating policies on water temperature, sedimentation, reservoir mixing and oxygen depletion and report on these findings.

CATEGORY: D_ HYDROLOGICAL STUDIES

ASSIGNMENT: D-6 RIVER HYDRAULICS, SEDIMENTATION, AND WATER QUALITY

TASK TITLE: D-6-3 Downstream Sediment Transport and Water Quality

LEVEL OF EFFORT:	170 Man-days
SCHEDULE:	June 1981 to January 1982
ESTIMATED COST:	\$76,000
RESPONSIBILITY:	F. H. Wu (IECO)

PURPOSE:

To predict the effects of the Upper Susitna reservoirs on downstream flows, sediment transport and water quality.

SCOPE:

The study reach of the Susitna is from the project sites down to Talkeetna. The SMS model will be used to simulate pre-project and post-project sediment transport and water quality conditions. The activities include:

- Collect and review river cross-section data from work obtained under Survey and Mapping.
- From studies made on Task D-6-1, Tailwater Rating Curves, estimate channel roughness for different reaches of the Susitna from damsite down to Talkeetna. Recalibrate if necessary.
- Operate model and perform additional pre-project condition runs, if necessary, to supplement runs made under Task D-4-3.
- Coordinate work with Task D-6-2, Reservoir Sedimentation and Stratification Studies, and obtain operating polices and reservoir outflows.
- Operate model for post-project condition. Simulate data to cover a period of several yars to predict downstream sediment and water quality for the with-reservoirs condition.
- Present the results in duration plots and also graphically as a continous plot.

- Compare the results of the pre-project condition with the results of the postproject condition on water surface profiles, sediment transport and water quality.
- Investigate how downstream sediment transport and water quality responds to changes when discharges are taken at different depths in the reservoirs.
- Evaluate the magnitude and frequency of nitrogen supersaturation from spillway flows and assess downstream recovery rate.
- Report on findings and present results.



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SUSITNA HYDROELECTRIC PROJECT

	D	HYDROLOGICAL	STUDIES
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ASSIGNMENT: D-6 RIVER HYDRAULICS, SEDIMENTATION, AND WATER QUALITY

TASK TITLE: D-6-4 Effects of Ice Formation and Breakup

LEVEL OF EFFORT:	95 Man-days
SCHEDULE:	July to October 1980, January to July 1981
ESTIMATED COST:	\$41,000
RESPONSIBILITY:	F. H. Wu (IECO)

PURPOSE:

To evaluate the potential severity of ice phenomena in reservoirs, and river ice jam and shelving problems on project operations and environmental changes.

SCOPE:

The University of Alaska Geophysical Institute will be performing the Special Arctic Studies under the Geotechnical Task Assignment E-5. The present task will be incorporating the information data obtained by the Geophysical Institute in their research in the project basin. The work under the present task includes:

- Review information on ice conditions throughout the year in the Upper Susitna basin.
- Compile data and use the SMS model to simulate conditions to cover a period of several years on ice formation, melt in reservoirs, and on probable changes in ice behavior below the reservoirs.
- Evaluate effects and changes from the natural regime. Of particular interest are changes, if any, in ice formation downstream because of reservior regulated outflows, and ice in reservoirs and ice breakup that are subject to drawdown that might trap migrating animals.

INTERNATIONAL ENGINEERING COMPANY, INC.

CATEGORY: D HYDROLOGICAL STUDIES

ASSIGNMENT: D-6 RIVER HYDRAULICS, SEDIMENTATION, AND WATER QUALITY

TASK TITLE: D-6-5 Reservoir Filling and Emergency Drawdown Criteria

LEVEL OF EFFORT:_	15 Man-days
SCHEDULE:	November and December 1981
ESTIMATED COST:	\$5,000
RESPONSIBILITY:	F. H. Wu (IECO)

PURPOSE:

To develop criteria for reservoir filling to ensure downstream minimum flows for fish and wildlife are met, and to establish rapid drawdown criteria.

SCOPE:

The work on reservoir filling criteria applies to both the concrete dam and the earthfill dam. Sufficient flows have to be allotted to meet downstream requirements. Rapid reservoir drawdown during an emergency is critical only to the Watana earthfill dam. Initial reservoir filling or rapid drawdown rates should not endanger the stability of any earthfill dam. The work in this Task includes:

- Obtain reservoir area-capacity curves, downstream minimum flow requirements, and maximum raeservoir filling and drawdown rates.
- Select typical monthly flow data from Task D-5-5.
- Obtain spillway and outlet discharge rating curves.
- Develop reservoir filling schedules, ensuring downstream flow requirements are met.
- For the Watana earthfill dam, assume reservoir is filled and compute maximum drawdown rates.

INTERNATIONAL ENGINEERING COMPANY, INC.

CATEGORY:	D	HYDROLOGICAL	STUDIES
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ASSIGNMENT: D-6 RIVER HYDRAULICS, SEDIMENTATION, AND WATER QUALITY

TASK TITLE: D-6-6 Downstream Hazards from Dam Failure

LEVEL OF EFFORT:	95 Man-days
SCHEDULE:	September 1981 to March 1982
ESTIMATED COST:	\$41,000
RESPONSIBILITY:	F. H. Wu (IECO)

PURPOSE:

To evaluate downstream hazards of dam failure because of a catastropic event. Provide flood inundation maps and data for emergency evacuation planning and public safety.

SCOPE:

- Use river cross-section data developed in Tasks D-6-1 and D-6-3.
- Develop additional over-bank and flood plain data at the selected river cross-section locations.
- On topographic maps, check topographic barriers to extremely large floods and incorporate these sections.
- Operate the FULEQ model for alternative projects and dam failure assumptions.
- Map inundated areas and provide warning times.

In a two-dam scheme, three cases of dam failure will be investigated.

- Case 1 The upper dam fails.
- Case 2 The lower dam fails.
- Case 3 Both dams fail.

Geotechnical Studies

E-1		PRINCIPAL-IN-CHARGE, GEOTECHNICAL STUDIES
	E-1-1	Management and Technical Supervision
E-2		ENGINEERING GEOLOGY
	E-2-1	Review Geologic Aspects of Alternative Energy Sources
	E-2-2	Evaluation of Alternative Damsites
	E-2-3	Geologic Reconnaisance of Transmission Line Corridor and Access Road Alignments
	E-2-4	Detailed Geologic Mapping of Watana Damsite, Reservoir and Borrow Areas
	E-2-5	Detailed Geologic Mapping of Devil Canyon Damsite, Reservoir and Borrow Areas
E-3		ENGINEERING GEOPHYSICS
	E-3-1	Seismic Refraction Survey at Watana Damsite and Borrow Areas
	E-3-2	Shear Wave Hammer Testing at Watana Damsite
	E-3-3	Seismic Refraction Survey at Devil Canyon Damsite Borrow Areas
	E-3-4	Shear Wave Hammer Testing at Devil Canyon Damsite
E-4		SEISMOLOGY
	E-4-1	Seismotectonic Studies
	E-4-2	Establishment of Local Seismic Monitoring System
	E-4-3	Regional Seismicity Study
	E-4-4	Earthquake Simulation
	E-4-5	Seismic Risk Analysis and Design Earthquake Development
E-5		SPECIAL ARCTIC STUDIES
	E-5-1	Coordination and Review of Permafrost, Glacier, and Ice Problem Studies by Special Arctic Studies Group
	E-5-2	River and Reservoir Ice Problem Studies
	E-5-3	Mass Balance and Dynamic Behavior of Glaciers
	E-5-4	Permafrost Problem Studies

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CONSTRUCTION MATERIAL INVESTIGATIONS

E	-6-1	Investigate Construction Material Sources for Watana Dam
. E	-6-2	Investigate Construction Material Sources for Devil Canyon Dam
E	5-6-3	Investigate Construction Material Sources for Access Roads
E-7	FOL	INDATION EXPLORATION AND TESTING
E	5-7-1	Investigate Subsurface Geology and Foundation Con- ditions at Watana Damsite
£	-7-2	Investigate Subsurface Geology and Foundation Con- ditions at Devil Danyon Damsite
E-8	LAE	ORATORY TESTING
f	E-8-1	Plan, Coordinate and Review Testing Programs
	E-8-2	Test Samples from Watana Damsite and Construction Material Investigations
I	E-8-3	Test Samples from Devil Canyon Damsite and Construction Material Investigations

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E-8-4 Conduct Mass Concrete Tests

E-6

CATEGORY:	E	GEOTECHNICAL STUDIES
ASSIGNMENT:	E-1	PRINCIPAL-IN-CHARGE, GEOTECHNICAL STUDIES
TASK TITLE:	E-1-1	Management and Technical Supervision

LEVEL OF EFFORT:	140 Man-days
SCHEDULE:	January 1980 to July 1981
ESTIMATED COST:	\$58,000
RESPONSIBILITY:	J. S. Long (IECO)

PURPOSE:

Provide direction and guidance to the Geotechnical Studies Group so that the work will be carried out in an efficient and orderly manner.

SCOPE:

The responsibilities of the Principal-in-Charge will include the following:

- Provide close coordination with other groups to ensure that information and data will be available when needed.
- Review data received and prepare guidelines and criteria for work performed by the group.
- Monitor progress and plan ahead to ensure efficient execution of the work.
- Review results of studies performed by the group to ensure high quality performance.

CATEGORY: E GEOTECHNICAL STUDIES

ASSIGNMENT: E-2 ENGINEERING GEOLOGY

TASK TITLE: E-2-1 Review Geologic Aspects of Alternative Energy Sources

LEVEL OF EFFORT: 23 Man-days

SCHEDULE: February to April 1980

ESTIMATED COST: \$9,000

RESPONSIBILITY: C. W. Wade (IECO)

PURPOSE:

To provide data for evaluating economics of various alternative means of power generation.

SCOPE:

Determine or confirm locations and probable quantity and quality of alternative sources of power, including coal, oil, gas and geothermal energy. Evaluate probable geotechnical restrictions in developing and utilizing each power source.

Task will be accomplished primarily by review of published data and through correspondence and discussions with companies and agencies involved in mineral resource evaluation and exploitation.

CATEGORY:	<u> </u>	GEOTECHNICAL STUDIES		
ASSIGNMENT	<u>E-2</u>	ENGINEERING GEOLOGY		
TASK TITLE:	E-2-2	Evaluation of Alternative Damsites	·	

LEVEL OF EFFORT:_	65 Man-days
SCHEDULE:	April to July 1980
ESTIMATED COST:	\$26,000
RESPONSIBILITY:	C. W. Wade (IECO)

PURPOSE:

To evaluate the geotechnical feasibility of all potential damsites within the project area for consideration in the overall planning study.

SCOPE:

Reports of all previous investigations will be evaluated; all available geologic mapping, reports and imagery will be reviewed.

Sites will be inspected by an evaluation team composed of an engineering geologist and engineers specialized in the design and construction of both earthfill and concrete dams.

All potential sites, including those previously studied and possible new sites, will be evaluated and arranged in order of relative geotechnical suitability.

SUSITNA HYD PLAN OF S	ROELE	ECTRIC PROJECT SHEET 1 of 1
CATEGORY:	E	GEOTECHNICAL STUDIES
ASSIGNMENT:	E-2	ENGINEERING GEOLOGY
TASK TITLE:	E-2-3	Geologic Reconnaissance of Transmission Line Corridor and Access Road Alignments
LEVEL OF EF	FORT:_	28 Man-days
SCHEDULE:		July to September 1980
ESTIMATED C	OST:	\$11,000
RESPONSIBIL	ITY:	C. W. Wade (IECO)

PURPOSE:

To evaluate the general geological conditions of the proposed alignments for purposes of preliminary design and cost estimation.

SCOPE:

The proposed alignments will be studied utilizing aerial photographs, existing geologic maps and reports, and a reconnaissance inspection of the area. A few seismic refraction measurements may be made in critical areas to clarify subsurface conditions if necessary.

CATEGORY:	E	GEOTECHNICAL_STUDIES
ASSIGNMENT	E-2	ENGINEERING GEOLOGY
TASK TITLE:	E-2-4	Detailed Geologic Mapping of Watana Damsite, Reservoir and Borrow Areas
LEVEL OF EFF	ORT:	425 Man-days
SCHEDULE:		April to July 1980, October 1980 to January 1981
	DST:	\$109,000
RESPONSIBILI	TY:	C. W. Wade (IECO)

PURPOSE:

To clearly define the geology in the vicinity of the proposed site to aid in the design and evaluation of the technical feasibility and cost of the project.

SCOPE:

The damsite, reservoir area and borrow areas will be mapped in sufficient detail to clearly define surface geological features and to determine areas where subsurface investigation is needed. The coverage will be sufficiently broad to allow informed consideration of possible alternative alignments or locations of the dam and will precisely define potential geological hazards such as landslides, faults and adverse joint systems. The slope stability and permeability of the reservoir perimeter will be evaluated.

Geologic data obtained from this Task will be combined with data obtained from subsurface exploration to provide a complete geological description of the damsite and reservoir.

The mapping will be performed during the field seasons of 1980 and 1981. Reports and final maps will be prepared during the winter months, along with aerial photo interpretation.



CATEGORY: E		GEOTECHNICAL STUDIES
ASSIGNMENT: E	-2	ENGINEERING GEOLOGY
TASK TITLE:E	-2-5	Detailed Geologic Mapping of Devil Canyon Damsite, Reservoir and Borrow Areas
LEVEL OF EFFC	DRT:_	425 Man-days
SCHEDULE:		July 1980 to April 1981, July 1981 to March 1982
ESTIMATED COS	ST:	\$109,000
RESPONSIBILIT	Y:	C. W. Wade (IECO)

PURPOSE:

To clearly define the geology in the vicinity of the proposed site to aid in the design and evaluation of the technical feasibility and cost of the project.

SCOPE:

The damsite, reservoir area and borrow areas will be mapped in sufficient detail to clearly define surface geological features and to determine areas where subsurface investigation is needed. The coverage will be sufficiently broad to allow informed consideration of possible alternative alignments or locations of the dam and will precisely define potential geological hazards, such as landslides, faults and adverse joint systems. The slope stability and permeability of the reservoir perimeter will be evaluated.

Geologic data obtained from this Task will be combined with data obtained from subsurface exploration to provide a complete geological description of the damsite and reservoir.

The mapping will be performed during the field seasons of 1980 and 1981. Aerial photo interpretation and preparation of maps and reports will be accomplished during the winter months.

CATEGORY. E GEVIELMNICAL STUDIES

ASSIGNMENT: E-3 ENGINEERING GEOPHYSICS

TASK TITLE: E-3-1 Seismic Refraction Survey at Watana Damsite and Borrow Areas

LEVEL OF EFFORT:_	160 Man-days
SCHEDULE:	June 1980 to March 1982
ESTIMATED COST:	\$56,000
RESPONSIBILITY:	E. G. Zurflueh (IECO)

PURPOSE:

Determine depth of overburden and properties of rock at foundation and abutment of dam and along spillway. Determine amount and quality of borrow materials.

SCOPE:

Seismic refraction lines will be measured at the damsite, including foundation, abutments, and spillway. The seismic data will provide information on depth of overburden, quality of foundation rocks, and ease of excavation. A buried channel on the right abutment will be given special attention.

Borrow areas will also be investigated by seismic refraction in order to establish the amount and quality of borrow materials.

The seismic data will supplement information obtained from exploratory drilling. Data from previous refraction surveys will be incorporated in a complete interpretation of available data. The previous surveys were done mostly with long lines; detail is missing, particularly where bedrock is shallow.

To obtain detailed data, line lengths will be variable, chosen according to depth of rock.

Estimated time includes time required for planning and field work, reduction of data and preparation of reports.

CATEGORY:	E	GEOTECHNICAL	STUDIES

ASSIGNMENT: E-3 ENGINEERING GEOPHYSICS

TASK TITLE: E-3-1 Seismic Refraction Survey at Watana Damsite and Borrow Areas

LEVEL OF EFFORT:_	160 Man-days	· · · · · · · · · · · · · · · · · · ·
SCHEDULE:	June 1980 to March 1982	· · · · · · · · · · · · · · · · · · ·
ESTIMATED COST:	\$56,000	
RESPONSIBILITY:	E. G. Zurflueh (IECO)	· · · · ·

PURPOSE:

Determine depth of overburden and properties of rock at foundation and abutment of dam and along spillway. Determine amount and quality of borrow materials.

SCOPE:

Seismic refraction lines will be measured at the damsite, including foundation, abutments, and spillway. The seismic data will provide information on depth of overburden, quality of foundation rocks, and ease of excavation. A buried channel on the right abutment will be given special attention.

Borrow areas will also be investigated by seismic refraction in order to establish the amount and quality of borrow materials.

The seismic data will supplement information obtained from exploratory drilling. Data from previous refraction surveys will be incorporated in a complete interpretation of available data. The previous surveys were done mostly with long lines; detail is missing, particularly where bedrock is shallow.

To obtain detailed data, line lengths will be variable, chosen according to depth of rock.

Estimated time includes time required for planning and field work, reduction of data and preparation of reports.

CATEGORY:	E	GEOTECHNICAL STUDIES

ASSIGNMENT: E-3 ENGINEERING GEOPHYSICS

TASK TITLE: E-3-2 Shear-Wave Hammer Testing at Watana Damsite

LEVEL OF EFFORT:_	160 Man-days		
SCHEDULE:	June to December 1981		
ESTIMATED COST:	\$38,000	• · · · · · · · · · · · · · · · · · · ·	
RESPONSIBILITY:	E. G. Zurflueh (IECO)		

PURPOSE:

To determine variation of shear-wave velocity with depth along the dam alignment. Dynamic elastic parameters derived from these measurements will be used for earthquake-resistant design.

SCOPE:

Four to five locations will be chosen for shear-wave measurements in the area covered by the future dam. At each location two 4-inch-diameter boreholes, spaced about 25 feet apart, will be drilled to a depth of 150 feet. Measurements of shear-wave velocity will be performed at intervals of 5 feet in depth at each location to obtain a complete profile of shear-wave velocity with depth.

The IECO shear-wave hammer, which is the most advanced instrument of its type, will be used for these measurements. Data from the survey, together with density values from laboratory sample measurements, will permit calculation of dynamic elastic parameters for the dam foundation. These parameters are needed to evaluate the stability of the dam under earthquake loading conditions.

Estimated time includes time required for planning and field work, reduction of data and preparation of report.



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CATEGORY:	Е	GEOTECHNICAL	STUDIES

ASSIGNMENT: E-3 ENGINEERING GEOPHYSICS

TASK TITLE: E-3-3 Seismic Refraction Survey at Devil Canyon Damsite and Borrow Areas

LEVEL OF EFFORT:_	160 Man-days			
SCHEDULE:	June 1980 to March 1982			
ESTIMATED COST:	\$55,000	·.	· · ·	
RESPONSIBILITY	E. G. Zurflueh (IECO)			· · · · · · · · · · · · · · · · · · ·

PURPOSE:

To determine depth of overburden and properties of rock at foundation and abutment of dam and along diversion tunnel. A possible shear zone found in previous surveys will be given special attention.

SCOPE:

Seismic refraction lines will be measured at the damsite, including foundation, abutments, and diversion tunnel. The seismic data will provide information on depth of overburden, quality of foundation rocks, and ease of excavation.

Borrow areas will also be investigated by seismic refraction in order to establish the amount and quality of borrow materials.

The seismic data will supplement information obtained from exploratory drilling. Information from previous refraction surveys will be incorporated in a complete interpretation of available data. The previous surveys used long lines and detail is missing, particularly where bedrock is shallow.

Line lengths will be variable, chosen according to depth of rock, to obtain detailed data.

Estimated time includes time required for planning and field work, reduction of data and preparation of reports.

CATEGORY:	E	GEOTECHNICAL	STUDIES

ASSIGNMENT: E-3 ENGINEERING GEOPHYSICS

TASK TITLE: E-3-4 Shear-Wave Hammer Testing at Devil Canyon Damsite

LEVEL OF EFFORT:	160 Man-days
SCHEDULE:	June to November 1980
ESTIMATED COST:	\$38,000
RESPONSIBILITY:	E. G. Zurflueh (IECO)

PURPOSE:

To determine variation of shear-wave velocity with depth along the dam alignment. Dynamic elastic parameters derived from these measurements will be used for earthquakeresistant design.

SCOPE:

Four to five locations will be chosen for shear-wave measurements in the area that will be covered by the future dam. At each location two 4-inch-diameter boreholes, spaced about 25 feet apart, will be drilled to a depth of 150 feet. Measurements of shear-wave velocity will be performed at intervals of 5 feet in depth at each location to obtain a complete profile of shear-wave velocity with depth.

The IECO shear-wave hammer, the most advanced instrument of its type, will be used for these measurements. Data from the survey, together with density values from laboratory sample measurements, will permit calculation of dynamic elastic parameters for the dam foundation. The parameters are needed to evaluate the stability of the dam under earthquake loading conditions.

Estimated time includes time required for planning and field work, reduction of data and preparation of reports.
SUSITNA HYDROELECTRIC PROJECT

PLAN OF STUDY

CATEGORY:	E	GEOTECHNICAL	STUDIES

ASSIGNMENT: E-4 SEISMOLOGY

TASK TITLE: E-4-1 Seismotectonic Studies

LEVEL OF EFFORT:	25 Man-days
SCHEDULE:	January to October 1980
ESTIMATED COST:	\$9,000
RESPONSIBILITY:	C. Pan (IECO)

PURPOSE:

To understand the seismotectonics of the project region, to make detailed field studies of the known and inferred surface faults and identify yet unknown faults, if any, in the proposed damsite and reservoir areas; and to collect seismotectonic activity history and fault parameters for seismic risk analysis and design earthquake development.

SCOPE:

The project is located within a tectonically active region where the North American and Pacific plates confront each other. South of the project region the Pacific plate is being thrust northwestward underneath the North American plate; the Benioff zone is therefore about 50 km to 80 km beneath the proposed damsites. The Denali fault, which is a major strike-slip rupture zone in Alaska, lies less than 80 km north of the damsites. However, the seismotectonics of the project region are not well understood, and recorded seismicity history is short. A detailed seismotectonic field study of the proposed damsite and reservoir areas is therefore a requirement before a seismic risk decision can be made for the project.

A reconnaissance of recent geology in the project region by two USGS geologists identified 16 known and inferred faults in the region. None of these faults was found to have been recently active. However, sufficient seismotectonic information is not presently available for making a reasonable seismic risk analysis or to provide seismic design criteria for the project. Virtually all large, shallow earthquakes are found to be associated with surface faults. A detailed field study of the known or yet to be identified surface faults in the project region therefore must be completed before laboratory analysis of regional seismicity and selection of the design earthquake for the project. The seismic activity cycle in a tectonic region usually extends for several hundred years; a recently inactive fault does not imply seismic security in the future. For a better understanding of the long-term seismicity, a study of Quaternary history of deformation, particularly that of the Holocene in the region, is very important. In order to investigate the fault activities in the region, techniques such as interpretation of

SHEET _____2 of 2

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satellite imagery, geologic mapping, trenching, and core drilling will be used. Radiometric dating may also be used as a method of identifying activity history of the surface faults.

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CATEGORY:	E	GEOTECHNICAL STUDIES
ASSIGNMENT:	E-4	SEISMOLOGY
TASK TITLE:	E-4-2	Establishment of Local Seismic Monitoring System
LEVEL OF EFF	ORT:_	130 Man-days
SCHEDULE:		June 1980 to July 1982

ESTIMATED COST: \$348,000 (Including \$300,000 for instruments)

RESPONSIBILITY: C. Pan (IECO)

PURPOSE:

To establish a local seismic monitoring network in the proposed damsite and reservoir areas for accurate recording of seismicity in the region and to determine the effect, if any, of filling the reservoir.

SCOPE:

A regional seismic monitoring network did not exist in southern Alaska before 1967. At present there are 120 seismic stations in Alaska; among them the University of Alaska Geophysical Institute owns 52, USGS owns 50 and NOAA owns 18. Some stations of the NOAA network are shared by the University of Alaska and USGS networks. The proposed damsite and reservoir areas are not well covered by the existing seismic networks. In order to obtain more accurate locations and focal depths of earthquakes and for better definition of seismicity in the project region, a local network of seismic stations will be installed in the proposed damsite and reservoir areas. The installation of a local seismic monitoring system well in advance of filling of the reservoirs can also establish the level of natural seismicity in the area for future study of reservoir-induced seismicity.

The local seismic monitoring network planned for the project area will include ten vertical-component stations with radio telemetry (including required repeaters) to a central recording facility, and two three-component strong-motion stations, one at each damsite. The exact site of each station of the network will be selected during the seismotectonic field study. In order to obtain more accurate focal depths of the earthquakes, the distance between stations will be designed to be less than 15 km.

The installation of instruments will be done under the supervision of Dr. E. Zurflueh, IECO Engineering Geophysicist. Actual installation may be subcontracted to the Geophysical Institute of the University of Alaska, or through arrangement by APA, the installation may be made by the USGS.

The seismic network will permit continuous monitoring of the seismicity in the proposed dam and reservoir areas as soon as it is installed. Data recorded by the network will

be analyzed and documented through the construction period and after filling of the reservoirs. This local monitoring system will eventually be incorporated into one of the major regional seismic networks in Alaska, and during the installation and monitoring periods of the system, activities will be closely coordinated with those of seismologists of the USGS and University of Alaska who are in charge of the major regional seismic networks.

	CATEGORY:	E	GEOTECHNICAL STUDIES
2 .	ASSIGNMENT:	E-4	SEISMOLOGY
	TASK TITLE:	E - 4-3	Regional Seismicity Study
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LEVEL OF EFFORT.	20 Mail-Udys	
SCHEDULE:	January to March 1980	
ESTIMATED COST:	\$6,000	
RESPONSIBILITY:	C. Pan (IECO)	

PURPOSE:

To make a thorough study of the seismicity history of the project region and collect data required for the establishment of seismic hazard and site stability design criteria for the project.

SCOPE:

The known seismic history of the project region is short; instrumental monitoring started only at the beginning of this century, and historical earthquake records can be traced back only to the late 18th century. The focal depth of earthquakes in this region, based upon presently available data, ranges from less than 10 km to greater than 175 km. Large earthquakes occurring along the Circum-Pacific seismic belt (the Benioff zone), the Denali fault or the surface faults in the region may produce significantly damaging effects to the proposed dams and reservoirs. A thorough search of existing earthquake data files and seismological literature for the region will be the first step in studying the seismicity of the region. The data collected, together with data available from newly installed local seismic networks, will be used to (1) analyze the spatial, temporal and magnitude distribution of seismicity in this region; (2) find correlations between seismicity distribution and surface faults for identification of fault activity and regional seismotectonic trends; and (3) provide data of selected large earthquakes as input parameters for numerical earthquake simulation. The results of the regional seismicity study and earthquake simulation will be used as the bases to establish the design earthquake for the project.

Before the seismic hazard criteria can be established, a preliminary study to assess possible reservoir-induced seismicity will be made taking into consideration the seismic data available from the newly installed local seismic network.

CATEGORY:	Ε	GEOTECHNICAL STUDIES
ASSIGNMENT:	E-4	SEISMOLOGY
TASK TITLE	E-4-4	Earthquake Simulation
LEVEL OF EFF	ORT:	25 Man-days
LEVEL OF EFF	ORT:	25 Man-days October to December 1980
LEVEL OF EFF SCHEDULE: ESTIMATED CO	ORT:	25 Man-days October to December 1980 \$12,000

PURPOSE:

To simulate numerically maximum credible and expectable earthquakes along each fault zone and to analyze damaging historical earthquakes in the region to produce motion parameters and motion-time histories for the proposed damsites as a basis for the establishment of regional seismic hazard criteria.

SCOPE:

Two- or three-dimensional finite element simulation of near-field seismic ground motions has made great progress in recent years. Simulation techniques and computer codes that can handle quite complex cases of earthquake ground motions and source mechanisms have been developed. Utilizing the existing 2D or 3D finite element codes, maximum credible and expectable earthquakes of each fault in the project region, as well as those along the Benioff zone and Denali fault, will be simulated under either idealized or realistic conditions to obtain motion parameters and time history at each damsite. Large and welldocumented historical earthquakes will also be simulated under realistic conditions. The results of idealized and realistic simulations will be compared and analyzed. The motion parameters and time history obtained from the numerical simulatio will be used as a base for the establishment of seismic hazard criteria and selection of a design earthquake for the project.

CATEGORY: E GEOTECHNICAL STUDIE	ES
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ASSIGNMENT: E-4 SEISMOLOGY

TASK TITLE: E-4-5 Seismic Risk Analysis and Design Earthquake Development

SCHEDULE: November 1980 to January 1981

LEVEL	OF	EFFORT:	25	Man-days	
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ESTIMATED COST: \$12,000

RESPONSIBILITY: C. Pan (IECO)

PURPOSE:

To construct statistical models of seismic risk of the project region and develop the design earthquake for the project.

SCOPE:

Using data collected from seismotectonic and regional seismicity studies as well as results from numerical earthquake simulation, statistical models of seismic risk will be constructed for each seismotectonic zone or surface fault in the project region. Based upon the seismic risk models, probabilistic estimation of the seismic load parameters at each damsite will be made. Maximum credible and expectable earthquakes for the whole project region will finally be chosen and their recurrence estimated. The seismic risk analysis will lead to the final development of the design earthquake for the project.

INTERNATIONAL ENGINEERING COMPANY, INC.

CATEGORY:	E	GEOTECHNICAL STUDIES
ASSIGNMENT:	E-5	SPECIAL ARCTIC STUDIES
TASK TITLE:	E-5-1	Coordination and Review of Permafrost, Glacier, and Ice Problem Studies by Special Arctic Studies Group
LEVEL OF EF	FORT:_	January 1981 to June 1982
SCHEDULE:		75 Man-days
ESTIMATED C	OST:	\$26,000
RESPONSIBIL	.ITY:	C. W. Wade (IECO)

PURPOSE:

To coordinate activities and applications of research by the Special Arctic Studies Group in river and reservoir ice problems, mass balance and dynamic behavior of glaciers, and permafrost problem studies.

SCOPE:

The activities of the Special Arctic Studies Group (Tasks E-5-2, E-5-3, E-5-4) will be supervised and coordinated in this Task. This is to include periodic office review of research and field review of investigations. Priorities for investigations will be set; ongoing investigations will be monitored. The results of the research will be reviewed and disseminated to the appropriate design groups as they become available.

SUSITNA HYDROELECTRIC PROJECT

PLAN OF STUDY

CATEGORY:	E	GEOTECHNICAL SERVICES

ASSIGNMENT: E-5 SPECIAL ARCTIC STUDIES

TASK TITLE: E-5-2 River and Reservoir Ice Problem Studies

LEVEL OF EFFORT: -

SCHEDULE:

ESTIMATED COST: \$125,000

RESPONSIBILITY: Geophysical Institute - University of Alaska (Subcontract)

Intermittent Over Two Years

PURPOSE:

To investigate and report upon potential ice-related problems -- frazil ice, anchor ice, aufeis and sheet ice -- during construction and in subsequent project operation.

SCOPE:

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 both cofferdam design and the design and operation of the reservoir power system. Field research on river ice dynamics and an in-depth analysis of the potential ice problems can be used for determining the proper design, construction and operational procedures to eliminate or minimize ice-related problems.

A program will be established to determine the dynamics of freeze-up and break-up on the Susitna River with particular attention to timing, progression, volume of ice production, temporal and spatial distribution of the various ice types and delineation of ice-jam sites. The program will also analyze potential ice-problems with emphasis on processes such as filling the reservoir with frazil ice, earlier-than-normal freeze-up, later-thannormal breakup, formation of thick aufeis deposits in the reservoir, clogging of intakes by frazil and anchor ice, ice shelving on the shores of the reservoir and trapping of large mammals (e.g. caribou and moose) in the reservoir. A detailed analysis of the length of open water below the dams will also be covered.

CATEGORY	E	GEOTECHNICAL	SERVICES
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ASSIGNMENT: E-5 SPECIAL ARCTIC STUDIES

SCHEDULE: Intermittent Over Two Years

TASK TITLE: E-5-3 Mass Balance and Dynamic Behavior of Glaciers

LEVEL OF EFFORT: -

ESTIMATED COST: \$130,000

RESPONSIBILITY: Geophysical Institute - University of Alaska (Subcontract)

PURPOSE:

To study the heat, mass fluxes and general dynamics of glaciers feeding Susitna River.

SCOPE:

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 which tends to stabilize the flow of the river.

A study of the heat and mass fluxes and general dynamics of these glaciers will be made to understand their effect on the river. This will involve measurement of the rates of accumulation, ablation and ice flow. The research would begin by locating survey control points along the glacier margins. These points would be used to establish:

- Ground control for aerial photogrammetry.
- Location of stakes placed on the glaciers to measure:
 - accumulation.
 - ablation.
 - glacier flow.

The research would include drilling to the bottom of the glacier at several locations. This can be done effectively with the newly-designed hot-water drill. Drilling will enable direct observation of the nature of ice-rock interface by down-hole t.v. cameras.

The potential for forming glacier-dammed lakes which can drain abruptly and produce flash floods will be investigated. Also, research on sedimentation resulting from glacier surges will be conducted.

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In addition to current aerial photography, negatives of existing aerial photographs will be used. Maps and cross-sections which span 20 to 30 years will be made of selected areas on the glacier and used to calculate gains or losses in ice volume over the longest possible time spans.

CATEGORY:	E	GEOTECHNICAL	SERVICES

ASSIGNMENT: E-5 SPECIAL ARCTIC STUDIES

TASK TITLE: E-5-4 Permafrost Problem Studies

LEVEL OF EFFORT:	
SCHEDULE:	Intermittent Over Two Years
ESTIMATED COST:	\$60,000
RESPONSIBILITY:	Geophysical Institute - University of Alaska (Subcontract)

PURPOSE:

To both delineate potential for encountering and required response to permafrost related problems in both construction and later operation of the project.

SCOPE:

Permafrost, massive ground-ice, ice-rich soils and frost heaving are problems commonly associated with major construction projects in Alaska. The engineering problems associated with these phenomena are:

- Thawing, settlement and drainage under earthen dams on permafrost. It will be necessary to construct a thermal finite difference or finite element model of the dam to analyze this problem.
- Shoreline erosion and, therefore, movement of the shoreline with attendant increased sedimentation in the reservoir and possible landslides and slumping. It will be necessary to delineate (map) the permafrost areas along the shoreline, to construct a thermal finite difference model of the shoreline and to determine the ice content of the permafrost to evaluate this problem.
- High drilling costs to determine soil conditions. These costs can be reduced by using geophysical measurements to design the drilling program and to extrapolate information away from boreholes.

CATEGORY:	E	GEOTECHNICAL STUDIES

ASSIGNMENT: E-6 CONSTRUCTION MATERIAL INVESTIGATIONS

TASK TITLE: E-6-1 Investigate Construction Material Sources for Watana Dam

LEVEL OF EFFORT:	200 Man-days	 ······
SCHEDULE:	May 1980 to March 1982	
ESTIMATED COST:	\$84,000	 ·
RESPONSIBILITY:	L. W. Lobdell (IECO)	

PURPOSE:

To locate, evaluate, and outline limits of possible borrow material sources for use in construction of Watana Dam.

SCOPE:

The program will consist of locating and sampling potential construction material sources by excavation of test pits and drilling. Sufficient materials for construction plus an adequate reserve within a reasonable haul distance will be outlined. Work items will include a review of past exploration and testing, layout of a supplemental sampling program, supervision of field investigations, and preparation of logs, records, test data, and necessary drawings and reports. Samples collected from the various types of borings and test pits will be tested for quality and suitability, as shown in Tasks E-8-1 and E-8-2. The materials investigated will include core material, filter zone material, concrete aggregate, rockfill and riprap.

In selecting borrow material source areas, every effort will be made to minimize environmental impact.

Field exploration and sampling will take place during the summer months. Laboratory testing and organization and evaluation of data will continue throughout the winter months.

CATEGORY:	Ε	GEOTECHNICAL STUDIES
ASSIGNMENT	E-6	CONSTRUCTION MATERIAL INVESTIGATIONS
TASK TITLE	E-6-2	Investigate Construction Material Sources for Devil Canyon Dam

LEVEL OF EFFORT	190 Man-days
SCHEDULE:	June 1980 to February 1982
ESTIMATED COST:	\$60,000
RESPONSIBILITY:	L. W. Lobdell (IECO)

PURPOSE:

To locate, evaluate, and outline limits of possible construction material sources.

SCOPE:

The program will consist of exploration of construction material sources for both the concrete arch dam and the earth or rockfill saddle dam, followed by studies and evaluation of the information obtained in the field to provide data for use in dam design and construction planning. Work items will include a review and analysis of previous exploration and testing, planning of a supplemental exploration program, supervision of field investigations, data preparation, and the preparation of the necessary drawings and reports.

Drilling and test pits will be required in the borrow areas for the earth or rockfill saddle dam. Impervious borrow sources, filter zone material, and rockfill sources will be delineated and sampled for further testing under Task E-8-3. The remainder of the program will consist of delineating concrete aggregate source areas adequate for construction of the arch dam and necessary structures. These areas will be defined by drilling or other appropriate means and will be sampled for aggregate suitability tests as defined by Task E-8-3. Final results will be presented in drawings, tables, graphs, maps and a report to provide input for design of both the concrete arch dam and the earth or rockfill structure.

Final evaluation of alternative sources will also include consideration of the environmental impact of development.

SUSITNA HYDROELECTRIC PROJECT

PLAN OF STUDY

CATEGORY:	E	GEOTECHNICAL	STUDIES
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ASSIGNMENT: E-6 CONSTRUCTION MATERIAL INVESTIGATIONS

TASK TITLE E-6-3 Investigate Construction Material Sources for Access Roads

LEVEL OF EFFORT:_	20 Man-days
SCHEDULE:	July to September 1980
ESTIMATED COST:	\$9,000
RESPONSIBILITY:	L. W. Lobdell (IECO)

PURPOSE:

To locate, evaluate, and outline limits of possible construction material sources for access roads.

SCOPE:

The program will consist of exploration of possible construction material sources, followed by evaluation of the information obtained in the field, to provide data for use in access road planning and design. Materials that will be obtained from required cut sections will be evaluated for suitability as fill material. It is anticipated that limited exploration consisting of auger drill holes and a few test pits will sufficiently delineate source areas. Collected samples will be evaluated, and borrow areas will be designed according to suitability of materials, location relative to the proposed alignment, and environmental considerations.

CATEGORY:	E	GEOTECHNICAL STUDIES
ASSIGNMENT	E-7	FOUNDATION EXPLORATION AND TESTING
TASK TITLE:	E-7-1	Investigate Subsurface Geology and Foundation Conditions at Watana Damsite
LEVEL OF EFI	FORT:_	480 Man-days
LEVEL OF EFF	FORT:_	480 Man-days May 1980 to April 1982
LEVEL OF EFF SCHEDULE: ESTIMATED CO	FORT:	<pre>480 Man-days May 1980 to April 1982 \$552,000 (Including \$339,000 drilling subcontract)</pre>
LEVEL OF EFF SCHEDULE: ESTIMATED CO RESPONSIBIL	FORT: OST: ITY:	480 Man-days May 1980 to April 1982 \$552,000 (Including \$339,000 drilling subcontract) R. C. Dow (IECO)

PURPOSE:

To determine foundation conditions and provide geologic and engineering data for use in definitive project design and cost analysis.

SCOPE:

The program will consist of field exploration and testing to be followed by evaluation of field results. It will include the following items:

• Drilling - Foundation core drilling will be the primary tool used to gather the required data for the following items. It will be supplemented by Tasks E-2 (Engineering Geology), E-3 (Engineering Geophysics), and E-5 (Special Arctic Studies) where appropriate.

Full use will be made of previous investigations and all available drill logs, and records will be gathered and analyzed.

Appropriate supplementary drill holes will be field located. Both abutments, the channel section, and excavation and structure locations will be explored to a degree of detail deemed necessary based upon past work and on-going work. Water pressure tests will be made at both general and specific depth zones and at appropriate pressures to determine rock conditions and potential seepage.

- Extent and nature of frozen zones The areas of frozen soil will be further outlined, and an assessment will be made of their impact upon the structure should thawing occur. Data for the design of remedial treatment will be obtained.
- Relict Channel This feature will be further outlined by drilling or geophysical methods or a combination of the two. Permeability of the alluvial layers will be determined for evaluation of seepage potential and design of remedial measures.

TASK	E-7-1
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- Rock Stability Analyses Detailed studies of the rock lineation patterns will be made to determine best fit of the underground structures. Shear zones, jointing patterns, faults, and rock contacts will be examined in detail and correlated with the coring program.
- Slope Stability Analyses Areas near critical project features will be examined for potential slope instability due to thawing of frozen soils, over-steep slopes, saturation by reservoir water, or the influence of faults or shear zones.

CATEGORY: E	GEOTECHNICAL STUDIES
ASSIGNMENT E-7	FOUNDATION EXPLORATION AND TESTING
TASK TITLE: E-7-2	Investigate Subsurface Geology and Foundation Conditions at Devil Canyon Damsite
LEVEL OF EFFORT:	960 Man-days
LEVEL OF EFFORT:_ SCHEDULE:	960 Man-days May 1980 to April 1982
LEVEL OF EFFORT: SCHEDULE: ESTIMATED COST:	960 Man-days May 1980 to April 1982 \$1,018,000 (Including \$661,000 drilling subcontract)

PURPOSE:

To determine foundation conditions and provide geologic and engineering data for use in definitive project design and cost analysis.

SCOPE:

Items pertinent to the stability of the arch dam concept will be examined and will include the following:

• Drilling - Foundation core drilling will be the primary tool used to gather the required data for the following items. It will be supplemented by Tasks E-2 (Engineering Geology), E-3 (Engineering Geophysics), and E-5 (Special Arctic Studies) where appropriate.

All available drill logs and records will be gathered and analyzed. Appropriate supplementary drill holes will be field-located. Both abutments, underground structures, and appurtenant structures will be explored at the level deemed necessary based upon past work and on-going work. Water pressure tests will be made at both general and specific depth zones and at appropriate pressures to determine rock conditions and potential seepage.

- Rock Stability Analysis Mapped joints, bedding, shears, faults, and lineation
 patterns will be correlated with information from drill holes, and analyzed to
 determine the structural integrity of the rock under stress. Core samples will
 be subjected to tests for determination of physical properties. These and other
 criteria will be used to help determine the optimum fit for the axis of the dam
 and appurtenant structures.
- Slope Stability Analyses Areas near the project features will be examined for potential slope instability problems. These may be related to frozen soils, deep

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weathering, or structural features such as faulting. Particular attention will be given to areas where slope failures are particularly critical such as in the vicinity of diversion tunnels or inlet works.

- Foundations of appurtenant structures This exploration will include cofferdams, spillway, thrust block, earth dike, and switchyard. Each will receive exploration suitable to determine the most appropriate location, strength and nature of foundation materials, and overall adequacy of foundations and slopes.
- Underground Structures This will include the diversion tunnels, underground powerhouse, and related penstocks and outlet works. The intensity of this portion of exploration will be determined as the overall program progresses and the relative feasibility of alternative designs has been evaluated.

INTERNATIONAL ENGINEERING COMPANY, INC.

SUSITNA HYDROELECTRIC PROJECT

PLAN OF STUDY

CATEGORY:	E	GEOTECHNICAL	STUDIES
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ASSIGNMENT: E-8 LABORATORY TESTING

TASK TITLE: E-8-1 Plan, Coordinate and Review Testing Programs

LEVEL OF EFFORT:	76 Man-days							
SCHEDULE:	February to	June	1980,	October	1980	to	March	1982

ESTIMATED COST: \$24,000

RESPONSIBILITY: D. R. Poindexter (IECO)

PURPOSE:

To provide necessary planning, coordination and quality control for the laboratory testing program.

SCOPE:

This Task will consist of the following work items:

- Program planning.
- Coordination with the field engineers, design engineers, and the laboratory testing subcontractors.
- Provide quality control and monitoring of test program.
- Prepare and compile logs, records, test data.
- Review, evaluate, and analyze results of programs.
- Prepare necessary reports, drawings, and graphics and provide input for design.

CATEGORY: E GEOTECHNICAL STUDIES ASSIGNMENT: E-8 LABORATORY TESTING TASK TITLE: E-8-2 Test Samples From Watana Damsite and Construction Material Investigations Material Investigations LEVEL OF EFFORT: N/A SCHEDULE: May 1980 to March 1981

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ESTIMATED COST: \$80,000

RESPONSIBILITY: Shannon and Wilson (Subcontract)

PURPOSE:

To obtain geologic and engineering data for use in dam design and construction planning.

SCOPE:

This task will consist of a comprehensive laboratory test program that will include such items as rock crushing strength, static and dynamic shear strength of construction materials, permeability, consolidation, density, moisture content, compaction characteristics and other tests that may be considered necessary, depending on the materials. Included in the testing program will be bulk, disturbed, and undisturbed samples and rock cores from the Watana damsite foundation investigation and the construction material investigation, which includes concrete aggregate.

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GEOTECHNICAL STUDIES	

ASSIGNMENT: E-8 LABORATORY TESTING

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CATEGORY:

TASK TITLE: E-8-3 Test Samples from Devil Canyon Damsite and Construction Material Investigations

 LEVEL OF EFFORT:
 N/A

 SCHEDULE:
 May 1980 to March 1982

 ESTIMATED COST:
 \$60,000

 RESPONSIBILITY:
 Shannon and Wilson (Subcontract)

PURPOSE:

To obtain geologic and engineering data for use in dam design and construction planning.

SCOPE:

This task will consist of a comprehensive laboratory test program that will include such items as rock crushing strength, static and dynamic shear strength of construction materials, permeability, consolidation, density, moisture content, compaction characteristics and other tests that may be considered necessary, depending on the materials. Included in the testing program will be bulk, disturbed, and undisturbed samples and rock cores from the Devil Canyon damsite foundation investigation and the construction material investigation, which includes concrete aggregate.

CATEGORY: E	GEOTECHNICAL STUDIES
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ASSIGNMENT: E-8 LABORATORY TESTING

TASK TITLE: E-8-4 Conduct Mass Concrete Tests

LEVEL OF EFFORT:_	N/A
SCHEDULE:	June 1981 to March 1982
ESTIMATED COST:	\$40,000
RESPONSIBILITY:	Subcontracted to Specialized Testing Laboratory

PURPOSE:

To develop and test mass concrete design mix to check the suitability of available materials to obtain a concrete mix having the desired physical properties.

SCOPE:

This Task will consist of conducting a comprehensive laboratory test program that will develop a mass concrete design mix using available materials. Trial mixes containing various proportions of cement, pozzolan, other admixtures and available natural aggregate materials will be tested for elastic and strength properties. Compressive strength tests will be made of 6-inch by 12-inch cylinders cast from the trial mixes. A final design mix will be selected for further testing. Compressive strength and elastic properties will be determined for the final design mix at various ages up to the age of one year by tests on 6-inch by 12-inch and 18-inch by 36-inch cast cylinders. Thermal properties, including adiabatic temperature rise, thermal diffusivity and coefficient of thermal expansion, will be determined for design mixes with various proportions of cement and pozzolan.

INTERNATIONAL ENGINEERING COMPANY, INC.

Preliminary Design

F-1		PRINCIPAL-IN-CHARGE, DESIGN
	F-1-1	Management and Technical Supervision
F-2		EMBANKMENT DAMS
	F-2-1	Provide Design Input during Plan Formulation
	F-2-2	Evaluate Design Alternatives for Watana Dam
	F-2-3	Perform Stability Analysis of Watana Dam
	F-2-4	Determine Design and Material Requirements of Watana Dam
	F-2-5	Determine Cofferdam Design for Watana Dam
	F-2-6	Evaluate Design Alternatives for Devil Canyon Saddle Dam
	F - 2-7	Perform Stability Analysis of Devil Canyon Saddle Dam
	F-2-8	Determine Design and Material Requirements of Devil Canyon Saddle Dam
	F-2-9	Determine Cofferdam Design for Devil Canyon - Definitive Project
F-3		CONCRETE DAMS
	F-3-1	Design Input during Plan Formulation
	F-3-2	Arch Dam Layout Studies - Devil Canyon Dam
	F-3-3	Stress and Stability Studies - Devil Canyon Dam
÷.,	F-3-4	Preliminary Design - Devil Canyon Dam
	F-3-5	Establish Criteria and Procedures for Structural Model Test Program
F-4		DIVERSION, SPILLWAYS, AND OUTLETS
	F-4-1	Design Input during Plan Formulation
	F-4-2	Diversion Scheme Study - Watana Site
	F-4-3	Diversion Scheme Study - Devil Canyon Site
	F-4-4	Preliminary Design - Watana Spillway
	F-4-5	Preliminary Design - Devil Canyon Spillway
	F-4-6	Preliminary Design - Watana Outlet Facilities
	F-4-7	Preliminary Design - Devil Canyon Outlet Facilities
F-5		POWER FEATURES
	F - 5-1	Design Input during Plan Formulation
	F-5-2	Power Features Layout Studies - Watana Power Plant
	F-5-3	Preliminary Design - Watana Power Features
	F-5-4	Power Features Layout Studies - Devil Canyon Power Plant
	F-5-5	Preliminary Design - Devil Canyon Power Features

F-6		MECHANICAL FACILITIES
	F-6-1	Design Input during Plan Formulation
	F-6-2	Mechanical Design Studies - Watana Dam
	F-6-3	Preliminary Design - Watana Dam Mechanical Facilities
	F-6-4	Mechanical Design Studies - Devil Canyon Dam
	F-6-5	Preliminary Design - Devil Canyon Dam Mechanical Facilities
F-7		ELECTRICAL FACILITIES
	F-7-1	Design Input during Plan Formulation
	F-7-2	Electrical Design Studies - Watana Dam
	F-7-3	Preliminary Design - Watana Dam Electrical Facilities
	F-7-4	Electrical Design Studies - Devil Canyon Dam
	F-7-5	Preliminary Design - Devil Canyon Dam Electrical Facilities
F-8		TRANSMISSION SYSTEM
	F-8-1	Transmission System Planning
	F-8-2	Transmission Line Route Study
	F-8-3	Preliminary Tower and Foundation Type Study
	F-8-4	Transmission Line, Conductor and Cost Studies
	F-8-5	Switchyard and Substations
F-9		ACCESS ROADS
	F-9-1	Design Input during Plan Formulation
	F-9-2	Preliminary Design - Access Roads - Definitive Project
	F-9-3	Preliminary Design - Bridges - Definitive Project
F-10		CONSTRUCTION PLANNING AND SCHEDULING
	F-10-1	Construction Planning and Cost Input for Plan Formulation
	F-10-1	Construction Schedule and Cost Estimate for Access Roads
	F-10-2	Construction Planning, Scheduling, and Cost Estimate - Watana Dam
	F-10-3	Construction Planning, Scheduling, and Cost Estimate - Devil Canyon Dam
	F-10-4	Construction Schedule and Cost - Transmission Line
	F-10-5	Construction Planning - Construction Camp Infrastructure

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CATEGORY:	F	PRELIMINARY DESIGN
ASSIGNMENT:	F-1	PRINCIPAL-IN-CHARGE, DESIGN
TASK TITLE:	F-1-1	Management and Technical Supervision

LEVEL OF EFFORT:	150 Man-days
SCHEDULE:	January to November 1980, March 1981 to March 1982
ESTIMATED COST:	\$65,000
RESPONSIBILITY:	R. P. Sharma (IECO)

PURPOSE:

To provide direction and guidance to the Preliminary Design Group so that the work will be carried out in an efficient and orderly manner.

SCOPE:

The responsibility of the Principal-in-Charge will include the following:

- Provide close coordination with other groups to ensure that information and data will be available when needed.
- Review data received and prepare guidelines and criteria for work performed by the group.
- Monitor progress and plan ahead to ensure efficient execution of the work.
- Review results of studies performed by the group to ensure high quality performance.

CATEGORY: <u>F</u>	PRELIMINARY DESIGN
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ASSIGNMENT F-2 EMBANKMENT DAMS

TASK TITLE F-2-1 Provide Design Input during Plan Formulation

LEVEL OF EFFORT:	65 Man-days
SCHEDULE:	March to July 1980
ESTIMATED COST:	\$19,000
RESPONSIBILITY:	K. B. King (IECO)

PURPOSE:

To provide design input for embankment dams for project layout studies during plan formulation.

SCOPE:

This Task will consist of site reconnaissance and providing input on embankment dams for plan formulation. The work items will consist of:

- Reconnaissance of all sites considered for plan fomulation study.
- Development of preliminary alternative layouts for embankment dams to provide comparative cost data. Embankment dam may be earthfill or rockfill.
- Layouts of several dam heights, for each of the various damsites considered will be made in order to develop cost versus height relationships for use in selection of optimum layout as performed under Task Assignment G-4.

INTERNATIONAL ENGINEERING COMPANY, INC.

CATEGORY:	F	PRELIMINARY DESIGN	
ASSIGNMENT:	F-2	EMBANKMENT DAMS	

TASK TITLE: F-2-2 Evaluate Design Alternatives for Watana Dam

LEVEL OF EFFORT:_	115 Man-days
SCHEDULE:	April to August 1981
ESTIMATED COST:	\$32,000
RESPONSIBILITY:	K. B. King (IECO)

PURPOSE:

To provide a basis for selection of the optimal design alternative for Watana Dam.

SCOPE:

This Task will consist of evaluating the potential design alternatives and selecting the optimal design. The work items are as follows:

- Determine potential design alternatives. Design alternatives to be evaluated will include thin core or dam facing alternative versus a relatively thick core and side transition zone. The evaluation will provide information necessary to obtain the most economical alternative considering unit costs, construction schedules, and weather constraints.
- Evaluate each alternative taking into consideration the following:
 - cross-section configuration of dam.
 - construction schedule.
 - foundation and dam construction material requirements.
 - performance problems.
- Prepare quantity estimate for cost estimation.
- Select alternative for preliminary design of dam.
- Prepare necessary reports.

CATEGORY:	F	PRELIMINARY DESIGN
	F-2	EMBANKMENT DAMS
TASK TITLE:	F-2-3	Perform Stability Analysis for Watana Dam
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LEVEL OF EFF	ORT:	200 Man-days

ESTIMATED COST:	\$75,000	

RESPONSIBILITY: K. B. King (IECO)

PURPOSE:

SCHEDULE:

To evaluate the stability of selected design sections.

August to December 1981

SCOPE:

This Task consists of all engineering studies, computer computations and activities related to the evaluation of the selected preliminary design for Watana Dam. Work items include the following:

- Establish design criteria based on the results of field exploration and laboratory testing of construction materials.
- Establish failure criteria.
- Evaluate stability of selected design under static loading conditions. Stability analysis of the maximum embankment cross-section developed for the Definitive Project Design will be made for the various conditions, namely: end of construction, steady state seepage, and rapid drawdown. Analysis will be made using two-dimensional finite element method, simulating the incremental embankment construction and loading and non-linear stress dependent behavior of embankment materials. Material properties will be assigned based on results of the field exploration and the laboratory testing of construction materials.
- Evaluation of stability under seismic loading conditions. The stability of the selected embankment section under seismic loading will be checked by state-of-the-art two-dimensional finite element dynamic response analysis techniques using computer programs capable of simulating non-linear strain-dependent embankment material behavior under dynamic loading, such as QUAD-4, FLUSH, etc. Seismic parameters (seismic ground motion input) and material properties used in the analysis will be as established in Category E, and under the first item listed above.

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The stability of the selected structural design will be evaluated from analysis results on the basis of failure criteria, which will be established consistent with type of structure and downstream damage potential.

• Preparation of a report on the stability of the embankment dam.

Special Consultants S. D. Wilson and H. B. Seed will render expert advice on the design and the seismic stability analysis of the embankment dam.

CATEGORY:	F	PRELIMINARY DESIGN
ASSIGNMENT:	F-2	EMBANKMENT DAMS
TASK TITLE:	F-2-4	Determine Design and Material Requirements of Watana Dam

LEVEL OF EFFORT:	65 Man-days
SCHEDULE:	Intermittent - July 1981 to January 1982
ESTIMATED COST:	\$18,000
RESPONSIBILITY:	K. B. King (IECO)

PURPOSE:

To determine and evaluate the preliminary design for the definitive project and to evaluate material requirements.

SCOPE:

The work items are as follows:

- Determine preliminary design.
- Perform analysis of design for the following:
 - Foundation
 - Seepage
 - Settlement
- Evaluate material requirements and compare with results of field investigations.
- Provide input for cost estimate.
- Prepare necessary reports, drawings and graphics.

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CATEGORY	F	PRELIMINARY	DESIGN

ASSIGNMENT: F-2 EMBANKMENT DAMS

TASK TITLE: F-2-5 Determine Cofferdam Design for Watana Dam

LEVEL OF EFFORT:_	50 Man-days
SCHEDULE:	Intermittent - April to October 1981
ESTIMATED COST:	\$14,000
RESPONSIBILITY:	K. B. King (IECO)

PURPOSE:

This Task will determine cofferdam design and consist of interfacing with other groups to establish requirements.

SCOPE:

The work items are as follows:

- Determine hydrologic, diversion and construction requirements for cofferdam design.
- Develop cofferdam design.
- Analyze design for stability, seepage and settlement.
- Prepare necessary reports, drawings and graphics.

CATEGORY:	F	PRELIMINARY DESIGN
ASSIGNMENT	F-2	EMBANKMENT DAMS
TASK TITLE:	F-2-6	Evaluate Design Alternatives for Devil Canyon Saddle Dam

LEVEL OF EFFORT:	90 Man-days
SCHEDULE:	August to November 1981
ESTIMATED COST:	\$25,000
RESPONSIBILITY:	K. B. King (IECO)

PURPOSE:

To evaluate the potential design alternatives for the embankment dam alternative for the Devil Canyon saddle dam to provide a basis for preliminary design selection.

SCOPE:

This Task will consist of the following:

- Determine potential design alternatives using information developed under Category E.
- Evaluate each alternative on the basis of:
 - ~ Cross secton configuration.
 - Construction schedule.
 - Foundation and dam construction material requirements.
 - Performance problems.
- Develop quantity estimates for input to cost estimating.
- Select the favorable alternative for further refinement to develop preliminary design for this feature.
- Prepare necessary reports.

CATEGORY:	F	PRELIMINARY	DESIGN

ASSIGNMENT: F-2 EMBANKMENT DAMS

IASK TITLE: F-2-7 Perform Stability Analysis of Devil Canyon Saddle Dam

LEVEL OF EFFORT:	40 Man-days
SCHEDULE:	October 1981 to January 1982
ESTIMATED COST:	\$12,000
RESPONSIBILITY:	K. B. King (IECO)

PURPOSE:

To evaluate the stability of the selected design for Devil Canyon saddle dam.

SCOPE:

This Task will consist of the all engineering studies, computer computations and activities related to the evaluation of stability of the selected design for Devil Canyon saddle dam. Work items include the following:

• Evaluation of stability under static loading conditions. Analysis of the maximum embankment cross section developed for the definitive project design will be made for the end-of-construction, steady state seepage and rapid drawdown conditions. Material properties will be assigned, based on results of the field exploration and laboratory testing programs to be performed under Category E.

INTERNATIONAL ENGINEERING COMPANY, INC.

CATEGORY	F	PRELIMINARY DESIGN
ASSIGNMENT:	F-2	EMBANKMENT DAMS
TASK TITLE	F-2-8	Determine Design and Material Requirements of Devil Canyon Saddle Dam
LEVEL OF EFF		50 Man-days
SCHEDULE:		October 1981 to January 1982
ESTIMATED CO	ST:	\$14,000
RESPONSIBILIT	「Y:	K. B. King (IECO)

PURPOSE:

To determine and evaluate the preliminary design for definitive project and to evaluate design features and material requirements.

SCOPE:

- Determine preliminary design.
- Evaluate material requirements and compare with results of field investigations.
- Perform analyses of design, for the following:
 - Foundation.
 - Seepage.
 - Settlement.
- Provide input for cost estimate.
- Prepare necessary reports, drawings and graphics.

SUSITNA HYDROELECTRIC PROJECT

CATEGORY:	F	PRELIMINARY DESIGN
ASSIGNMENT:	F-2	EMBANKMENT DAMS
TASK TITLE:	F-2-9	Determine Cofferdam Design for Devil Canyon Dam - Definitive Project
	FORT [,]	65 Man-days

SCHEDULE:	October 1981 to January 1982
ESTIMATED COST:	\$18,000
RESPONSIBILITY:	K. B. King (IECO)

PURPOSE:

To determine cofferdam design and interface with other groups to establish requirements.

SCOPE:

The work items are as follows:

- Determine hydrologic, diversion and construction requirements for cofferdam design.
- Develop cofferdam design.
- Analyze design for stability, seepage and settlement.
- Prepare necessary reports, drawings and graphics.
SUSITNA HYDROELECTRIC PROJECT

CATEGORY:	F	PRELIMINARY DESIGN
ASSIGNMENT:	F-3	CONCRETE DAMS
TASK TITLE:	F-3-1	Design Input during Plan Formulation

LEVEL OF EFFORT:_	130 Man-days
SCHEDULE:	March to July 1980
ESTIMATED COST:	\$36,000
RESPONSIBILITY:	H. E. Jackson (IECO)

PURPOSE:

To provide design input for concrete dams for project layout studies during plan formulation.

SCOPE:

Develop preliminary alternative layouts for concrete arch and/or gravity dams to provide comparative cost data. Layouts of several dam heights for each site will be made in order to develop the cost vs. height relationship for use in selection of optimum layout as performed under Task Assignment G-4.

CATEGORY:	F	PRELIMINARY DESIGN	<u>NPUINT</u>
ASSIGNMENT:	F-3	CONCRETE DAMS	· · · · · · · · · · · · · · · · · · ·
TASK TITLE:	F-3-2	Arch Dam Layout Studies - Devil Canyon Dam	

LEVEL OF EFFORT:_	110 Man-days
SCHEDULE:	April to August 1981
ESTIMATED COST:	\$31,000
RESPONSIBILITY:	H. E. Jackson (IECO)

PURPOSE:

To develop layout for Devil Canyon arch dam for alternative selected during plan formulation.

SCOPE:

Refine dam layout of selected alternative. Additional topographic and geologic data obtained during plan formulation will be used. Several layouts with progressive refinements may be required. Preliminary stress analyses will be performed to check structural adequacy.

CATEGORY:E		PRELIMINARY	DESIGN
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ASSIGNMENT F-3 CONCRETE DAMS

TASK TITLE: F-3-3 Stress and Stability Studies - Devil Canyon Dam

LEVEL OF EFFORT:	570 Man-days
SCHEDULE:	July to December 1981
ESTIMATED COST:	\$180,000
RESPONSIBILITY:	H. E. Jackson

PURPOSE:

To check the structural adequacy of the selected arch dam layout at the Devil Canyon site.

SCOPE:

The study will consist of the following:

- Develop design criteria from field and laboratory data for dam and foundation materials and the design earthquake developed by Task Group E.
- Perform temperature studies involving air and water temperature data analysis.
- Perform static and dynamic stress analyses for various loading combinations of the dam/foundation system by:
 - Trial load analysis method using computer program ADSAS developed by USBR.
 - Three dimensional finite element method using computer program SAPIV.
- Evaluate structural stability of selected design and prepare structural stability report.

CATEGORY	F	PRELIMINARY DESIGN
ASSIGNMENT	F-3	CONCRETE DAMS
TASK TITLE:	F-3-4	Preliminary Design - Devil Canyon Dam

LEVEL OF EFFORT:	130 Man-days
SCHEDULE:	June to August 1981, November 1981 to January 1982
ESTIMATED COST:	\$36,000
RESPONSIBILITY:	H. E. Jackson (IECO)

PURPOSE:

To prepare preliminary design layout of Devil Canyon arch dam for FERC License Application.

SCOPE:

This Task will consist of the following:

- Make any necessary refinements to dam layout indicated by structural stability studies.
- Perform layout and design of appurtenant structures.
- Coordinate layouts of dam, spillway, outlet works, and other project features.
- Prepare quantity estimates.
- Provide layouts and other input data for Exhibit L drawings.

CATEGORY:	F	PRELIMINARY_DESIGN	
ASSIGNMENT:	F-3	CONCRETE DAMS	

TASK TITLE: F-3-5 Establish Criteria and Procedures for Structural Model Test Program

LEVEL OF EFFORT:	45 Man-days
SCHEDULE:	January to March 1982
ESTIMATED COST:	\$13,000
RESPONSIBILITY:	H. E. Jackson (IECO)

PURPOSE:

To verify stress analysis results by structural model testing.

SCOPE:

This Task will consist of the following:

- Establish structural model criteria and procedures.
- Provide input to structural model testing laboratory.
- Provide initial contact and liaison with structural model testing laboratory.

CATEGORY:	F	PRELIMINARY D <u>ES</u> IGN	

ASSIGNMENT: F-4 DIVERSIONS, SPILLWAYS AND OUTLETS

TASK TITLE: F-4-1 Design Input during Plan Formulation

LEVEL OF EFFORT:_	90 Man-days
SCHEDULE:	March to July 1980
ESTIMATED COST:	\$25,000
RESPONSIBILITY:	P. K. Mogera (IECO)

PURPOSE:

To provide design support for diversion, spillways, and outlet facilities during plan formulation.

SCOPE:

This Task will include the following:

- Develop scheme for river diversion during construction for each damsite under consideration. Alternative schemes will be studied and cost comparisons will be made to determine the most suitable scheme for the particular site.
- Determine the type, location, number and size of spillways, sluices and outlet works including type of gates and valves most suitable for each damsite by developing alternative schemes and comparative cost data. The sizes and locations will be selected to minimize adverse impact on water quality and erosion downstream of the dams.
- Prepare preliminary detail of selected schemes for diversion, spillways, and outlet works for cost estimate to serve as a basis for recommending a selected plan for further study during definitive project studies.

ASSIGNMENT: F-4 DIVERSIONS, SPILLWAYS AND OUTLETS

TASK TITLE: F-4-2 Diversion Scheme Study - Watana Site

LEVEL OF EFFORT:	90 Man-days
SCHEDULE:	April to June 1981
ESTIMATED COST:	\$27,000
RESPONSIBILITY:	P. K. Mogera (IECO)

PURPOSE:

To develop an optimum diversion scheme for the Watana site.

SCOPE:

This Task will include preparation of detailed preliminary designs for the selected Watana River diversion scheme and will include the following:

- Sizing of cofferdams, tunnels, channels, etc., to pass the construction flood, including design of closure methods.
- Hydraulic design.
- Structural design.
- Preparation of detailed quantity estimate as input for preparation of detailed cost estimate under Task F-10-3.
- Provision of layouts and other pertinent input for preparation of Exhibit L drawings.

CATEGORY F PRELIMINARY DESIGN						
	CATEGORY:	F	•	PRELIMINARY	DESIGN	

ASSIGNMENT: F-4 DIVERSIONS, SPILLWAYS AND OUTLETS

TASK TITLE: F-4-3 Diversion Scheme Study - Devil Canyon Site

June to August 1981

LEVEL OF EFFORT: 90 Man-days

ESTIMATED COST: \$27,000

SCHEDULE:

RESPONSIBILITY: P. K. Mogera (IECO)

PURPOSE:

To develop optimum diversion scheme for the Devil Canyon site.

SCOPE:

This Task will include preparation of detailed preliminary designs for the selected river diversion scheme including:

- Sizing of cofferdams, tunnels, channels, etc., to pass the construction flood, including design of closure methods.
- Hydraulic design.
- Structural design.
- Preparation of detailed quantity estimate as input for preparation of detailed construction cost estimate under Task F-10-4.
- Provision of layouts and other pertinent input for preparation of Exhibit L drawings.

CATEGORY: F PRELIMINARY DESIGN

ASSIGNMENT: F-4 DIVERSIONS, SPILLWAYS AND OUTLETS

TASK TITLE: F-4-4 Preliminary Design - Watana Spillway

LEVEL OF EFFORT: 130 Man-days

SCHEDULE: May to September 1981

ESTIMATED COST: \$38,000

RESPONSIBILITY: P. K. Mogera (IECO)

PURPOSE:

To develop preliminary design of the Watana spillway.

SCOPE:

This Task will include the preliminary detailed design for the selected spillway for the Watana damsite including:

- Develop size and layouts of spillway geometry, gates, piers, walls, energy dissipators, etc., for required flows considering the impact on erosion downstream.
- Refine hydraulic design.
- Develop rating curves.
- Perform structural design of monoliths, bridges, piers, gates, stoplogs and hoists, etc.
- Perform detailed quantity and cost estimates.
- Provide layouts and other input for Exhibit L drawings.

CATEGORY:	F	PRELIMINARY DESIGN
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ASSIGNMENT: F-4 DIVERSIONS, SPILLWAYS AND OUTLETS

TASK TITLE: F-4-5 Preliminary Design - Devil Canyon Spillway

LEVEL OF EFFORT:	130 Man-days
SCHEDULE:	May to September 1981
ESTIMATED COST:	\$38,000
RESPONSIBILITY:	P. K. Mogera (IECO)

PURPOSE:

To develop preliminary design of the Devil Canyon spillway.

SCOPE:

This Task will include preparation of a preliminary detailed design for the selected spillway for the Devil Canyon damsite including:

- Develop size and layouts of spillway geometry, gates, piers, walls, energy dissipators, etc., for required flows considering the impact on erosion downstream.
- Refine hydraulic design.
- Develop rating curves.
- Perform structural design of monoliths, bridges, piers, gates, stoplogs and hoists, etc.
- Perform detailed quantity and cost estimates.
- Provide layouts and other input for Exhibit L drawings.

CATEGORY:	F	PRELIMINARY	DESIGN
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ASSIGNMENT: F-4 DIVERSIONS, SPILLWAYS AND OUTLETS

TASK TITLE F-4-6 Preliminary Design - Watana Outlet Facilities

LEVEL OF EFFORT:	90 Man-days
SCHEDULE:	July to October 1981
ESTIMATED COST:	\$27,000
RESPONSIBILITY:	P. K. Mogera (IECO)

PURPOSE:

To develop preliminary design for the Watana outlet facilities

SCOPE:

This Task will involve preparing a preliminary detailed design for the selected outlet works for the damsite including:

- Develop size requirements and layout of intakes, gates, bulkheads, sluices, tunnels, air vents, energy dissipators, etc. for required flow considering the impact on water quality and erosion downstream.
- Refine hydraulic design.
- Develop rating curves.
- Perform structural design of tower, gates, bulkheads, trashracks, and outlet structures.
- Check structural stability of tower for static and dynamic loading.
- Perform detailed quantity and cost estimates.
- Provide layouts and other input for Exhibit L drawings.

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CATEGORY: F PRELIMINARY DESIGN

ASSIGNMENT: F-4 DIVERSIONS, SPILLWAYS AND OUTLETS

TASK TITLE: F-4-7 Preliminary Design - Devil Canyon Outlet Facilities

	LEVEL OF	EFFORT:	90	Man-days
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SCHEDULE: July to October 1981

ESTIMATED COST: \$27,000

RESPONSIBILITY P. K. Mogera (IECO)

PURPOSE:

To develop preliminary design for the Devil Canyon outlet facilities.

SCOPE:

This Task will involve performing a preliminary detailed design for the selected outlet works for the Devil Canyon damsite including:

- Develop size requirements and layout of intakes, gates, bulkheads, sluices, tunnels, air vents, energy dissipators, etc. for required flows considering the impact on water quality and erosion downstream.
- Refine hydraulic design.
- Develop rating curves.
- Perform structural design of gates, bulkheads, trashracks, and outlet structure.
- Perform detailed quantity and cost estimate.
- Provide layouts and other input for Exhibit L drawings.

CATEGORY:	F	PRELIMINARY DESIGN
ASSIGNMENT	F-5	POWER FEATURES
TASK TITLE:	F-5-1	Design Input during Plan Formulation
LEVEL OF EF	FORT:	280 Man-days

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ESTIMATED COST: \$78,000

SCHEDULE:

RESPONSIBILITY: 0. Hougen (IECO)

March to July 1980

PURPOSE:

To provide design input services for the basic layout studies of the power facilities at various project sites considered in the study.

SCOPE:

This Task will include layout studies of the power facilities at all project sites during this stage of the studies. The power facilities consist of the power intake, water conductors, surge tanks, powerhouse and tailrace.

Several power facility arrangements will be studied for all project sites in combination with various types of dams, and alternatives will be prepared for various heads and installed capacities.

Based on the existing geological and hydrological data, several layouts of the water conductors will be studied.

Type and location of intake structure, surge tank, penstock arrangement, and tailrace layout will be investigated.

A conventional surface powerhouse will be compared with an underground power station for all sites.

The size of the plant, number of units, future units, etc., will be evaluated in connection with other studies.

Various alternatives of rock reinforcement and roof and wall structures will be considered for the subsurface layouts.

Quantity estimates and preliminary cost estimates will be prepared for all alternatives, for use in selection of the optimum project layout as performed under Task G-4.

CATEGORY:	F	PRELIMINARY DESIGN
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ASSIGNMENT: F-5 POWER FEATURES

TASK TITLE: F-5-2 Power Features Layout Studies - Watana Power Plant

LEVEL OF EFFORT:_	150 Man-days
SCHEDULE:	April to July 1981
ESTIMATED COST:	\$43,000
RESPONSIBILITY:	0. Hougen (IECO)

PURPOSE:

To refine the basic layout of power facilities after additional data are available.

SCOPE:

Two basic layouts of the power plant will be studied:

- A conventional surface power station.
- An underground power station.

The installed capacity, the rated head and the number of units will remain as previously determined in the basic layout studies, unless new information is available that may change this decision.

Additional geologic data will now be available so that each of the above layouts can be refined.

A final location study will be carried out for the power plant and water conductor in close cooperation with geologists, construction experts and other design groups.

Final detail studies will determine:

- Type of intake structure including stop logs, trashrack, gates, etc.
- Type, size and number of penstocks.
- Type and dimensions of surge tanks, if required.
- Arrangement of tailrace bulkhead gates and chamber, if required.
- Layout of tailrace channel or tunnel.

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Refined quantity estimates and a detailed cost estimate will be prepared.

At the end of this stage, a single final layout of the power facilities will be prepared that can be included in the feasibility report and the FERC License Application.

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CATEGORY:	F	PRELIMINARY DESIGN
ASSIGNMENT:	F-5	POWER FEATURES
TASK TITLE:	F-5-3	Preliminary Design - Watana Power Features

LEVEL OF EFFORT:	130 Man-days
SCHEDULE:	June to December 1981
ESTIMATED COST:	\$37,000
RESPONSIBILITY:	O. Hougen (IECO)

PURPOSE:

To prepare a preliminary design for all power features of the layouts prepared during all study phases.

SCOPE:

These design studies will be performed both during the plan formulation and the refinement of the basic layout. The studies will be sufficiently detailed for a feasibility study.

Design criteria will be established for power intake, water conductors and power plant.

All available data from the final geological survey and the subsurface investigation will be used, and the design of all features will be based upon careful analysis of topography and geology.

The preliminary design will also be based on all the available information regarding equipment (dimensions, weight, etc.).

Close cooperation with other design groups and specialists will be maintained during all design phases.

CATEGORY:	F	PRELIMINARY	DESIGN

ASSIGNMENT: F-5 POWER FEATURES

TASK TITLE: F-5-4 Power Features Layout Studies - Devil Canyon Power Plant

LEVEL OF EFFORT:	130 Man-days
SCHEDULE:	June to September 1981
ESTIMATED COST:	\$38,000
RESPONSIBILITY:	O. Hougen (IECO)

PURPOSE:

To refine the basic layout of the power facilities at the Devil Canyon site after additional data are available.

SCOPE:

The refinement of the basic layout will more or less follow the same procedure as outlined for the Watana project.

Studies will be performed for both:

- A conventional surface power plant.
- An underground power plant.

Installed capacity, rated head, number of units, etc., determined in the plan formulation phase, will be verified.

A final location study of the power facilities will be carried out to obtain a refined layout.

The type of intake and arrangement of water conductors will also be studied in more detail during this phase.

If a concrete dam is considered for the Devil Canyon site, special emphasis will be placed on incorporating the intake in the dam and locating the power plant as close to the dam as possible.

Detailed quantity take-offs and cost estimates will be prepared.

Finally, a single final layout of the power facilities will be recommended and exhibits will be prepared for the feasibility report and the FERC License Application.

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CATEGORY:	F	PRELIMINARY DESIGN
ASSIGNMENT	F-5	POWER FEATURES
TASK TITLE:	F-5-5	Preliminary Design - Devil Canyon Power Features

LEVEL OF EFFORT:	130 Man-days
SCHEDULE:	August 1981 to February 1982
ESTIMATED COST:	\$37,000
RESPONSIBILITY:	0. Hougen (IECO)

PURPOSE:

To prepare preliminary designs for all power features of the layouts prepared during all study phases.

SCOPE:

These design studies will be performed both during the plan formulation and the refinement of the basic layout. The studies will be sufficiently detailed for a feasibility study.

Design criteria will be established for power intake, water conductors and power plant.

All available data from the final geological survey and the subsurface investigation will be used, and the design of all features will be based upon careful analysis of topography and geology.

The preliminary design will also be based on all the available information regarding equipment (dimensions, weight, etc.).

Close cooperation with other design groups and specialists will be maintained during all design phases.

SUSITNA HYDROELECTRIC PROJECT PLAN OF STUDY SHEET 10			1 of 1	
CATEGORY: ASSIGNMENT:	F-6	PRELIMINARY DESIGN MECHANICAL FACILITIES	 	
	<u> </u>		 	
LEVEL OF EFF	ORT:	15 Man-days	 	
SCHEDULE:		March to July 1980	 ••••••••••••••••••••••••••••••••••••••	
ESTIMATED CC	ST:	\$4,000		

RESPONSIBILITY: J. Carson (IECO)

PURPOSE:

To provide mechanical equipment selection and costs as design input for the various project layout studies during plan formulation.

SCOPE:

This Task will provide an analysis of mechanical equipment requirements, selection, dimensioning and cost estimates for each of the alternatives and will include the following mechanical equipment:

- Turbine.
- Inlet valve.
- Pressure regulators, if required.
- Cranes and hoists for powerhouse and intake structure.
- Auxiliary mechanical equipment.
- Hoisting equipment for spillway gates, outlets gates and valves, etc.

Sizes and costs will be determined to an accuracy which, along with studies under Task F-5-1, will provide a basis for selection of the favorable site and project layout for further study.

SUSITNA HYDROELECTRIC PROJECT

PLAN OF STUDY

CATEGORY:	F	PRELIMINARY DESIGN	
ASSIGNMENT	F-6	MECHANICAL FACILITIES	

TASK TITLE: F-6-2 Mechanical Design Studies - Watana Dam

LEVEL OF EFFORT:	10 Man-days
SCHEDULE:	May to August 1981
ESTIMATED COST:	\$3,000
RESPONSIBILITY:	J. Carson (IECO)

PURPOSE:

To refine equipment requirements, selection and costs.

SCOPE:

Mechanical equipment requirements, selection and detailed costs will be prepared for each configuration investigated in this phase. Two configurations will be studied:

- Surface power station.
- Underground power station.

Cost data and descriptions will be prepared in the format and in sufficient detail for use in the Definitive Project Report and as input for preparation of the FERC License Application.

CATEGORY: F PRELIMINARY DESIGN	
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ASSIGNMENT F-6 MECHANICAL FACILITIES

TASK TITLE: ____ F-6-3 Preliminary Design - Watana Dam Mechanical Facilities

LEVEL OF EFFORT: 15 Man-days

SCHEDULE: August to December 1981

ESTIMATED COST: \$4,000

RESPONSIBILITY: J. Carson (IECO)

PURPOSE:

To prepare preliminary designs for the selected scheme of development.

SCOPE:

Prepare preliminary design criteria, layouts and designs, and quantities and cost estimates for all mechanical features pertinent to the selected scheme of development.

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CATEGORY: <u>F</u> PRELIM	INARY DESIGN
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ASSIGNMENT F-6 MECHANICAL FACILITIES

IASK TITLE: F-6-4 Mechanical Design Studies - Devil Canyon Dam

LEVEL OF EFFORT:	10 Man-days
SCHEDULE:	August to November 1981
ESTIMATED COST:	\$3,000
RESPONSIBILITY:	J. Carson (IECO)

PURPOSE:

To refine equipment requirements, selection and costs.

SCOPE:

Mechanical equipment requirements, selection and detailed costs will be prepared for each configuration investigated in this phase. It is assumed two configurations will be studied:

- Surface power station.
- Underground power station.

Cost data and descriptions will be in the format and in sufficient detail for use in the FERC License Application.

CATEGORY:	F	PRELIMINARY DESIGN
ASSIGNMENT	F-6	MECHANICAL FACILITIES
TASK TITLE:	F-6-5	Preliminary Design - Devil Canyon Dam Mechanical Facilities

LEVEL OF EFFORT:	15 Man-days
SCHEDULE:	November 1981 to March 1982
ESTIMATED COST:	\$4,000
RESPONSIBILITY:	J. Carson (IECO)

PURPOSE:

To prepare preliminary designs for the selected scheme of development.

SCOPE:

Prepare preliminary design criteria, layouts and designs, and construction quantities and cost estimate for all mechanical features pertinent to the selected scheme of development.

CATEGORY:	F	PRELIMINARY DESIGN
ASSIGNMENT	F-7	ELECTRICAL FACILITIES
1ASK TITLE:	F-7-1	Design Input during Plan Formulation

LEVEL OF EFFORT:	50 Man-days
SCHEDULE:	March to July 1980
ESTIMATED COST:	\$17,000
RESPONSIBILITY:	W. F. Untiedt (IECO)

PURPOSE:

To provide services for the basic studies of the power plant and switchyard facilities at all project sites.

SCOPE:

This Task will consist of basic layout studies of power plant and switchyard facilities, including transmission line tie between power plant and switchyard. Major equipment items such as generators, transformers, circuit breakers, disconnect switches, protective relaying schemes, supervisory controls telemetry and related communications equipment required will be analyzed.

The switchyard and transmission facilities will be studied in conjunction with the substation and transmission studies.

Preliminary studies would look at economical and operational advantages of various power plant schemes and operational advantages of switchyard breaker schemes for each type of installation.

Quantity estimates and preliminary cost estimates will be prepared for all alternatives.

CATEGORY: F PRELIMINARY DESIGN

ASSIGNMENT: F-7 ELECTRICAL FACILITIES

IASK TITLE: F-7-2 Electrical Design Studies - Watana Dam

LEVEL OF EFFORT: 20 Man-days

SCHEDULE: May to August 1981

ESTIMATED COST: \$6,000

RESPONSIBILITY: W. F. Untiedt (IECO)

PURPOSE:

To refine basic studies of electrical facilities.

SCOPE:

This Task will consist of refining basic layouts for conventional surface and underground power stations.

The study will involve finalization of recommended power plant and switchyard facilities.

Refined quantity estimate and a detailed cost estimate will be prepared.

The feasibility report and cost estimate will be presented in the FERC License Application format.

CATEGORY:	F	PRELIMINARY DESIGN
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ASSIGNMENT F-7 ELECTRICAL FACILITIES

TASK TITLE: F-7-3 Preliminary Design - Watana Dam Electrical Facilities

LEVEL OF EFFORT:	10 Man-days
SCHEDULE:	August to December 1981
ESTIMATED COST:	\$3,000
RESPONSIBILITY:	W. F. Untiedt (IECO)

PURPOSE:

To prepare preliminary designs for all electrical features of the recommended project.

SCOPE:

This Task will formulate the refinement of basic layout. The studies will be sufficiently detailed for the feasibility report. Electrical design criteria will be established for the power plant, associated facilities and switchyard.

The preliminary design for the electrical components of the project facilities will be detailed adequately, so that all information required for the feasibility report will be available and prepared in the FERC License Application format.

CATEGORY:	F	PRELIMINARY	DESIGN

ASSIGNMENT: F-7 ELECTRICAL FACILITIES

TASK TITLE: F-7-4 Electrical Design Studies - Devil Canyon Dam

LEVEL OF EFFORT:	15 Man-days
SCHEDULE:	August to December 1981
ESTIMATED COST:	\$4,000
RESPONSIBILITY:	W. F. Untiedt (IECO)

PURPOSE:

To refine basic design studies of electrical facilities.

SCOPE:

This Task will consist of refinement for conventional surface and underground power stations.

The study will involve finalization of recommended power plant and switchyard facilities.

Refined quantity estimate and detailed cost estimate will be prepared.

Input to the feasibility report (Definitive Project Report) and cost estimate will be prepared in the FERC License Application format.

CATEGORY:	F	PRELIMINARY DESIGN	
ASSIGNMENT	F-7	ELECTRICAL FACILITIES	

IASK TITLE: F-7-5 Preliminary Design - Devil Canyon Dam Electrical Facilities

LEVEL OF EFFORT	10 Man-days
SCHEDULE:	November 1981 to March 1982
ESTIMATED COST:	\$3,000
RESPONSIBILITY:	W. F. Untiedt (IECO)

PURPOSE:

To prepare preliminary designs for all electrical features of the recommended project.

SCOPE:

This Task will formulate the refinement of basic layout. The studies will be sufficiently detailed for the feasibility report (Definitive Project Report).

Electrical design criteria will be established for the power plant, associated facilities and switchyard.

The preliminary design for the electrical components of the project facilities will be detailed adequately, so that all information required for the feasibility report will be available.

RESPONSIBILITY: A. Mickevicius (IECO)

CATEGORY:	F	PRELIMINARY DESIGN
ASSIGNMENT	F-8	TRANSMISSION SYSTEM
TASK TITLE:	F-8-1	Transmission System Planning
LEVEL OF EFF	ORT:	230 Man-days
SCHEDULE:		January to July 1980
ESTIMATED CC	ST:	\$94,000

PURPOSE:

To develop a definitive plan for transmission system requirements, to integrate generating plants of the Susitna hydroelectric development within coordinated expansion plans for the interconnected utility systems of the Susitna power market area. The study will also define transmission system requirements for alternatives to Susitna.

SCOPE:

The plan formulation for implementation of the Susitna project must take into consideration the specific requirements for system expansion and transmission interconnection of utilities in the Cook-Inlet, Fairbanks-Nenana and Glennallen-Valdez service areas. This study will extend the work completed during the economic feasibilty study for the Anchorage-Fairbanks Intertie, to determine the appropriate staged expansion plan that will satisfy the objectives of Railbelt utilities and enable the Anchorage-Fairbanks Intertie to form the initial transmission stage that eventually will be part of the ultimate Susitna Transmission System.

The study will encompass the following elements:

- Formulation of a preliminary plan for the ultimate transmission system required to integrate the total generating capacity of the Susitna development with the interconnected utility systems of the power market area.
- Define the initial stage of the ultimate transmission system in relation to the facilities of the Anchorage-Fairbanks Intertie.
- Determine economic voltage level for the ultimate transmission system and compare the relative cost advantages of initial operation of Anchorage-Fairbanks Intertie at derated voltage level for first stage development.

TASK: F-8-1 Transmission System Planning

No.

- Determine the feasibility of extending the interconnected system to the Copper Valley Electric Association (CVEA) at Glennallen, from a substation at one of the Susitna generating plants (Watana Dam or equivalent).
- Develop a plan for staged increments of transmission capacity, to accord with the interconnected system load requirements and the generation expansion plan with the Susitna development.
- Perform power flow studies to test transmission expansion plans.
- Prepare definitive plan for interconnected transmission system expansion, including the staged development of Susitna Transmission System.

In addition to the study of transmission plans with the Susitna development, a similar study will be performed for an alternative plan without Susitna. The Anchorage-Fairbanks Intertie will still be a major element within the alternative expansion plan; however, major increments of coal-fired thermal plant, gas-turbines and other alternative energy sources will require specific transmission facilities within the interconnected systems.

CATEGORY	F	PRELIMINARY DESIGN
ASSIGNMENT	F-8	TRANSMISSION SYSTEM
TASK TITLE	F-8-2	Transmission Line Route Study
LEVEL OF EFF	ORT:	120 Man-days
SCHEDULE:		May to November 1980
ESTIMATED COST:		\$42,000
RESPONSIBILITY		G Israelson (IECO)

PURPOSE:

To establish feasible line routes between the main points of the intertie system to provide a basis for environmental impact studies and transmission line cost estimates.

SCOPE:

Alternate routes were already investigated during the development of the Anchorage to Fairbanks Intertie Study. In the course of this work a number of local authorities and environmental interest groups were consulted, and a very close-to-final route selection was made at that time. Some additional work is anticipated although this would merely involve minor refinements to the route location already established.

It is anticipated that a line connecting Glennallen with the Watana bus would also be of specific interest in this study. Since not much previous route study has been done for this line, and in view of the rather difficult terrain conditions throughout this region, a considerable amount of terrain study is foreseen.

For the purpose of detailed route and environmental studies, both the Anchorage to Fairbanks and the Watana to Glennallen routes will be flown and strip mapped to required scales.

SUSITNA HYDROELECTRIC PROJECT PLAN OF STUDY SHEET 1 of		
CATEGORY: <u>F</u> ASSIGNMENT: F-8	PRELIMINARY DESIGN TRANSMISSION SYSTEM	
TASK TITLE: F-8-4	Transmission Line Conductor and Cost Studies	
LEVEL OF EFFORT:	80 Man-days	
SCHEDULE:	May to August 1981	
ESTIMATED COST:	\$28,000	
RESPONSIBILITY:	G. Israelson (IECO)	

PURPOSE:

To establish optimum design parameters, including conductor type, size and number of conductors per phase, to be used in the final transmission line design. (Anchorage/Fairbanks Intertie-Definitive Project).

SCOPE:

Conductor size will be selected by the use of a Transmission Line Cost Analysis Program (TLCAP) which was specially developed by IECO for this type of study. In this program all pertinent costs, such as installed cost of line, power losses and other time related costs are considered. The program selects the size of conductor that provides the optimum installed line and operational costs. The costs developed in Task F-8-3 will be used for this purpose.

SUSITNA HYDROELECTRIC PROJECT

CATEGORY:	F	PRELIMINARY DESIGN
ASSIGNMENT	F-8	TRANSMISSION SYSTEM
1ASK TITLE:	F-8-5	Switchyards and Substations

LEVEL OF EFFORT:	220 Man-days
SCHEDULE:	May to August 1981
ESTIMATED COST:	\$72,000
RESPONSIBILITY:	C. F. Azalde (IECO)

PURPOSE:

To determine requirements for substations and switchyards, their locations, layouts and ratings of equipment.

SCOPE:

This Task will determine requirements for the two substations, one each at Anchorage and Fairbanks, and others if required, and the two switchyards, one each at Watana and Devil Canyon project sites and will include:

- Investigation of locations and layouts for substations including field verification of locations.
- Development of bus schemes and breaker arrangement for each installation taking into consideration economical and operational advantages of various schemes studied.
- Determination of ratings for major equipment such as transformers, circuit breakers, lightning arresters and switches.
- Studies of protective relaying, telemetry, and related communication equipment.
- Preparation of single-line diagrams and cost estimates.

CATEGORY:	F_	PRELIMINARY DESIGN
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ASSIGNMENT: F-9 ACCESS ROADS

IASK IIILE F-9-1 Design Input during Plan Formulation

LEVEL OF EFFORT:	140 Man-days
SCHEDULE:	March_to_July_1980
ESTIMATED COST:	\$40,000
RESPONSIBILITY:	C. P. Smith (IECO)

PURPOSE:

To provide design input for access roads to the various power project sites considered during plan formulation.

SCOPE:

This Task will consist of the following:

- Develop reconnaissance grade alternative alignment layouts of access roads, including bridges and crossings as required for construction and permanent access to various power project sites considered under plan formulation using USGS maps. Alternative routes will be located from both the Anchorage-Fairbanks highway and the Denali highway.
- Develop longitudinal profiles of access roads along proposed alignments, and cross sections taking the topographic and terrain conditions and availability of construction material into consideration.
- Prepare quantity estimates for input to cost estimate for various project layouts for selection of the favorable project layout for definitive project design.

CATEGORY:	F	PRELIMINARY	DESIGN

ASSIGNMENT: F-9 ACCESS ROADS

IASK TITLE: F-9-2 Preliminary Design - Access Roads

LEVEL OF EFFORT:	200 Man-days
SCHEDULE:	August 1981 to January 1982
ESTIMATED COST:	\$60,000
RESPONSIBILITY:	C. P. Smith (IECO)

PURPOSE:

To prepare preliminary design of access roads to selected damsites and layouts for FERC License Application.

SCOPE:

This Task will consist of the following:

- Refine the access road alignment layouts for construction and permanent access to selected damsites (Watana and Devil Canyon) using more detailed topographic maps as prepared under Task B-5-3. Several layouts with progressive refinements may be required. Layouts will be based on mapped topographic and geologic data. Close coordination between the Geotechnical and Design Groups will be required.
- Develop longitudinal profiles and cross sections.
- Prepare quantity estimates for input to cost estimate of the definitive project design.
- Provide layouts and other data for preparation of FERC exhibit drawings for access roads.

INTERNATIONAL ENGINEERING COMPANY, INC.

CATEGORY:	F	PRELIMINARY DESIGN	
ASSIGNMENT:	F-9	ACCESS ROADS	

IASK TITLE: F-9-3 Preliminary Design - Bridges

LEVEL OF EFFORT:	180 Man-days
SCHEDULE:	September 1981 to January 1982
ESTIMATED COST:	\$50,000
RESPONSIBILITY:	C. P. Smith (IECO)

PURPOSE:

To prepare preliminary designs of bridges required on the access roads to the dams.

SCOPE:

This Task will consist of the following:

- Determination of the number and the type of bridges required on the access routes to the dams, including temporary and permanent bridges of wood, steel and concrete construction.
- Preliminary design of all the required bridges. Foundation design may vary from rock to permafrost.
- Preparation of quantity estimate for input to the cost estimate for the definitive project design.

INTERNATIONAL ENGINEERING COMPANY, INC.
CATEGORY:	F	PRELIMINARY DESIGN
	F-10	CONSTRUCTION PLANNING AND SCHEDULING
TASK TITLE:	F-10-1	Construction Planning and Cost Input for Plan Formulation

LEVEL OF EFFORT:	55 Man-days
SCHEDULE:	Intermittent - April to September 1980
ESTIMATED COST:	\$18,000
RESPONSIBILITY:	T. W. Barber (IECO)

PURPOSE:

To provide construction planning and cost input for various project layout studies at various damsites considered during plan formulation.

SCOPE:

Prepare preliminary construction schedule and narrative describing possible construction methods, and reconnaissance grade estimate of construction cost for Watana and Devil Canyon hydropower developments, access roads and transmission lines.

SUSITNA HYDROELECTRIC PROJECT

CATEGORY:	F	PREI TMTNARY	DESTGN

ASSIGNMENT: F-10 CONSTRUCTION PLANNING AND SCHEDULING

LEVEL OF EFFORT:	40 Man-days
SCHEDULE:	November 1981 to January 1982
ESTIMATED COST:	\$15,000
RESPONSIBILITY:	T. W. Barber (IECO)

PURPOSE:

To provide construction schedule and cost estimate for access roads to selected sites for Watana and Devil Canyon project sites.

SCOPE:

Prepare feasibility grade estimate for construction cost for access roads to Devil Canyon and Watana damsites, including bridges. Costs of clearing the areas for access roads and disposition of merchantable and nonmerchantable timber will be assessed and included in the cost estimate.

Prepare construction schedule and narrative describing construction methods and equipment.

CATEGORY:	F	PRELIMINARY DESIGN
ASSIGNMENT	F-10	CONSTRUCTION PLANNING AND SCHEDULING
TASK TITLE:	F-10-3	Construction Planning, Scheduling and Cost Estimate - Watana Dam
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LEVEL OF EFFORT:	170 Man-d a ys	
SCHEDULE:	November 1981 to March 1982	
ESTIMATED COST:	\$57,000	
RESPONSIBILITY	T. W. Barber (IECO)	

PURPOSE:

To develop construction planning, schedule and construction cost estimate for Watana dam.

SCOPE:

This Task will include the following:

- Prepare construction schedule and narrative description of construction planning, methods and equipment to be used for Watana hydropower development.
- Prepare feasibility grade estimate of construction cost for Watana hydropower development including river diversion, dam, spillway and power plant.
- Assess the costs of reservoir clearing and disposal of merchantable and nonmerchantable timber. The assessed costs will be included in the construction cost estimate.

CATEGORY:		PRELIMINARY DESIGN
	F-10	CONSTRUCTION PLANNING AND SCHEDULING
TASK TITLE:	F-10-4	Construction Planning, Scheduling and Cost Estimate - Devil Canyon Dam
LEVEL OF EFF	ORT:	170 Man-days
SCHEDULE:		November 1981 to March 1982
ESTIMATED CC	DST:	\$57,000
RESPONSIBILI	TY:	T. W. Barber (IECO)

PURPOSE:

To develop construction planning, scheduling and cost estimate for Devil Canyon dam.

SCOPE:

This Task will include the following:

- Prepare construction schedule and narrative description of construction planning and methods and equipment to be used for Devil Canyon hydropower development.
- Prepare feasibility grade estimate for construction cost for Devil Canyon hydropower development including river diversion, concrete arch dam, spillway, saddle dam and power plant.
- Assess the costs of reservoir clearing and disposal of merchantable and nonmerchantable timber. The assessed costs will be included in the construction cost estimate.

CATEGORY:	C	DDEI TMTNARY DESTGN
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ASSIGNMENT F-10 CONSTRUCTION PLANNING AND SCHEDULING

IASK TITLE ______ F-10-5 Construction Schedule and Cost - Transmission Line

LEVEL OF EFFORT: 75 Man-days

SCHEDULE: December 1981 to March 1982

ESTIMATED COST: \$26,000

RESPONSIBILITY: T. W. Barber (IECO)

PURPOSE:

To develop construction schedule and cost estimate for transmission line and associated facilities.

SCOPE:

The Task will consist of the following:

 Prepare construction schedule and feasibility grade estimate of construction costs for transmission facilities including substations, switching stations, and transmission lines linking Watana, Devil Canyon, Anchorage and Fairbanks, including the assessed costs of clearing the transmission corridors and disposal of timber.

CATEGORY: F	PRELIMINARY DESIGN
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ASSIGNMENT: F-10 CONSTRUCTION PLANNING AND SCHEDULING

TASK TITLE: F-10-6 Construction Planning - Construction Camp Infrastructure

LEVEL OF EFFORT:	
SCHEDULE:	October 1981 to March 1982
ESTIMATED COST:	\$59,000
RESPONSIBILITY:	CIRI - H&N (Subcontract)

PURPOSE:

To assist in preparation of detailed plan for infrastructure development during the construction phase.

SCOPE:

The Task will consist of preparing a plan for the infrastructure development required during the construction phase. This plan, as part of the feasibility analysis, will include facility and manpower requirements, construction schedules, related cost estimates, and the development of operations and maintenance standards for the facilities needed to support the primary construction effort, i.e. - camps, airstrips, warehouses, offices, roads, etc. Additionally, this plan will include the development of the logistical systems required to support the overall program.

Plan Synthesis

G-1		PRINCIPAL-IN-CHARGE
	G-1-1	Management and Technical Supervision
G-2		ECONOMICS AND FINANCE
	G-2-1	Analyze Interactions between Alaskan Economy and Projects
	G-2-2	Economic Review of Alternatives
	G-2-3	Economic Analysis of Definitive Project
	G-2-4	Preparation of Financial Analysis and Financial Plan
G-3		POWER MARKET STUDIES
	G-3-1	Review and Update Energy Demand Data Base
	G-3-2	Forecast Socioeconomic Factors for Alaska
	G-3-3	Forecast Future Energy and Power Demands
G-4		PROJECT LAYOUT STUDIES
	G-4-1	Review and Evaluate Data on Susitna Project
	G-4-2	Prepare Basic Layouts of Alternatives
	G-4-3	Develop Data for Project Optimization Studies
G-5		COAL AND GAS ALTERNATIVES
	G-5-1	Review and Evaluate Coal and Gas Alternative
G-6		OTHER ALTERNATIVE ENERGY SOURCES
	G-6-1	Review and Evaluate Other Energy Sources
G-7		POWER STUDIES AND SYSTEM OPTIMIZATION
	G-7-1	Preparation of Data Base
	G-7-2	Hydrothermal Simulation Studies
	G-7-3	Determine Present Values for Construction Sequences
	G-7-4	Operation Studies for Definitive Project
G-8		PLAN FORMULATION
	G-8-1	Evaluate Results of Studies
	G-8-2	Prepare Draft of Plan Formulation Report
	G-8-3	Prepare Final Plan Formulation Report

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G -9		DEFINITIVE PROJECT STUDIES
	G-9-1	Coordinate and Synthesize Definitive Project Studies
	G-9-2	Coordinate Documentation for FERC License Application
	G-9-3	Prepare Definitive Project Report
G-10		FERC LICENSE APPLICATION PREPARATION
	G-10-1	Assist APA in Preparation of Exhibits A through F, and Exhibit T of FERC License Application
	G-10-2	Prepare Exhibits H through O, and Exhibit U of FERC License Application
	G-10-3	Incorporate Exhibits R, S, V, and W of FERC License Application
	G-10-4	Print FERC License Application

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CATEGORY: G FLAN STATIESTS	CATEGORY:	G	PLAN SYNTHESIS
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G-1 PRINCIPAL-IN-CHARGE ASSIGNMENT:

G-1-1 Management and Technical Supervision TASK TITLE:

LEVEL OF EFFORT:	280 Man-days
SCHEDULE:	January 1980 to July 1982
ESTIMATED COST:	\$100,000
RESPONSIBILITY:	A. R. Engebretsen (IECO)

PURPOSE:

To provide direction and guidance to the Plan Synthesis Group so that the work will be carried out in an efficient and orderly manner.

SCOPE:

The responsibilities of the Principal-in-Charge will include the following:

- Provide close coordination with other groups to ensure that information and . data will be available when needed.
- Review data received and prepare guidelines and criteria for work performed . by the group.
- Monitor progress and plan ahead to ensure efficient execution of the work.
- Review results of studies performed by the group to ensure high quality performance.

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ASSIGNMENT: G-2 ECONOMICS AND FINANCE

TASK TITLE: G-2-1 Analyze Interactions Between Alaskan Economy and Projects

LEVEL	OF	EFFORT:	75	Man-days
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SCHEDULE: February to May 1980

ESTIMATED COST: \$25,000

RESPONSIBILITY: A. Duncan (IECO)

PURPOSE:

To identify and quantify reciprocal effects between potential projects and the future economy of Alaska.

SCOPE:

Through review of the key parameters of the Alaskan economy, as well as those of the best alternative projects identified by the study, to clarify and quantify various relationships and synergystic effects. Among subjects to be analyzed are the following:

- Background description of the existing economy of Alaska, highlighting salient features of particular relevance to the power sector.
- Analysis of industries likely to be induced to establish operations in Alaska due to availability of ample power supplies.
- Economic impacts of proposed projects, both during construction and in operational lifetime, including availability of skilled and unskilled labor, equipment, materials and other factors of production.
- Study of existing wage rate structure in construction and industry.
- Analysis and forecast of inflation trends, with and without proposed projects.
- Overview and findings regarding primary and secondary economic effects on the Alaskan economy of implementing the proposed projects, including establishment of such parameters as wage scales, inflation, unemployment, industrial production, retail sales, service industries, immigration and related economic factors.
- Review risk/uncertainty factors and attempt to quantify their impact on the alternative systems under consideration.
- With due consideration of all economic parameters and their probable future trends, prepare comparison tables of alternative systems.

CATEGORY: G PLAN SYNTHESIS

ASSIGNMENT: G-2 ECONOMICS AND FINANCE

TASK TITLE: G-2-2 Economic Review of Alternatives

LEVEL OF EFFORT: 80 Man-days

SCHEDULE: April to December 1980

ESTIMATED COST: \$25,000

RESPONSIBILITY: A. Duncan (IECO)

PURPOSE:

To assist in identifying the most attractive development alternative based on economic criteria and public policy regarding investment decisions.

SCOPE:

Alternative power development sequences will be reviewed in the light of a number of economic criteria. Modern comparative techniques will be applied, as outlined in the following activities:

- Establish range of discount rates to be used in economic calculations.
- Assist in calculating internal rates of return for alternative optimized systems, including analyses of incremental rates of return.
- Assist in performing sensitivity analyses of benefit/cost ratios, net present worths, and internal rates of return to variations in general and in projectspecific parameters (e.g., relatively higher fuel costs); analyze possible future trends thereof.
- Analyze distributional aspects of costs and benefits, to provide an indication of their social/geographic/temporal distribution in the population of Alaska.
- Analyze interactions between power pricing and project investment decisions and make explicit assumptions as a basis for comparison of alternative schemes.

	G	PLAN SYNTHESIS
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ASSIGNMENT: G-2 ECONOMICS AND FINANCE

TASK TITLE: G-2-3 Economic Analysis of Definitive Project

LEVEL OF EFFORT:	40 Man-days
SCHEDULE:	November 1980 to January 1981
ESTIMATED COST:	\$13,000
RESPONSIBILITY:	A. Duncan (IECO)

PURPOSE:

To determine key economic parameters of definitive project.

SCOPE:

The economic aspects of the definitive project will be analyzed and quantified, and to this end the following activities will be performed:

- Establish range of discount rates to be used, service life of facilities, and salvage values.
- Review all cost estimates to identify possible distortions/subsidies, and assess need to substitute shadow prices.
- Calculate present worths and benefit/cost ratios of project, over above range of discount rates.
- Calculate internal rate of return for project.
- Perform sensitivity analyses of benefit/cost ratios, net present worth, and internal rate of return to variations in general and project-specific parameters, and discuss possible future trends thereof.
- Review distributional aspects of costs and benefits and indicate their social/ geographic/temporal distribution in the population of Alaska.
- Review risk/uncertainty factors and attempt to quantify their impacts.
- Submit findings and recommendations in clear unequivocal presentation.

CATEGORY:	G	PLAN SYNTHESIS

ASSIGNMENT: G-2 ECONOMICS AND FINANCE

TASK TITLE: G-2-4 Preparation of Financial Analysis and Financing Plan

LEVEL OF EFFORT:	50 Man-days
SCHEDULE.	December 1981 to February 1982
ESTIMATED COST:	\$16,000
RESPONSIBILITY:	A. Duncan (IECO)

PURPOSE:

To help obtain financing for implementation of the project.

SCOPE:

A study will be made of different financing sources to determine those which could provide financing for the project. Possible sources include:

- Municipal bonds
- Revenue bonds
- State agency bonds
- Government loan programs
- Government grants
- Commercial banks, including the possibility of government or state agency uarantees.

Based on the availability of funds and the financial requirements of the project, a reliminary financing plan will be prepared. The plan will take into account the ptimum combination of available funds with regards to loan availability, interest rates, length of grace period, length of repayment period and other financial terms. IECO's financial analyst, J. L. LePere, will assist in the financial study and planning.

CATEGORY	G	ΡΙΔΝ	SYNTHESIS
UATEQUIT	u	FLAN	STRUCESTS

ASSIGNMENT: G-3 POWER MARKET STUDIES

TASK TITLE: G-3-1 Review and Update Energy Demand Data Base

LEVEL OF EFFORT: 100 Man-days

SCHEDULE: January to May 1980

ESTIMATED COST: \$30,000

RESPONSIBILITY: R. F. Ramirez (IECO)

PURPOSE:

To prepare a data base for estimating future demand for power and energy in the market area.

SCOPE:

The principal activities under this Task will include the following:

- Review and update existing data base developed by the University of Alaska, Institute of Social and Economic Research (ISER). Personnel from ISER will be subcontracted to help in this task. Also review and update the socioeconomic data base developed within the scope of the Man-in-the-Arctic-Program (MAP) under a National Science Foundation grant.
- Develop the basic econometric relationship between socio-economic factors and energy use. The following three relationships will be analyzed and compared with worldwide statistics available from the United Nations and World Bank:
 - Gross Domestic Product (GDP) and consumption of electric energy per capita.
 - Historical growth in GDP consumption of electric energy per capita for selected countries in order to allow comparison with Alaska.
 - Relation between growth of electric consumption and per capita consumption.

CATEGORY:	G	PLAN SYNTHESIS
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ASSIGNMENT: G-3 POWER MARKET STUDIES

TASK TITLE: G-3-2 Forecast Scoioeconomic Factors for Alaska

LEVEL OF EFFORT: 2 Months

SCHEDULE: April to June 1980

ESTIMATED COST: \$20,000

RESPONSIBILITY: R. F. Ramirez (IECO)

PURPOSE:

To develop a basis for estimating future socioeconomic growth in Alaska.

SCOPE:

The University of Alaska, ISER study group, headed by Dr. O. S. Goldsmith will be contracted to provide consistent sets of regional and statewide projections of population and selected economic variables. These forecasts will be made to the year 2010.

CATEGORY:	G	PLAN SYNTHESIS
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ASSIGNMENT: G-3 POWER MARKET STUDIES

TASK TITLE: G-3-3 Forecast Future Energy and Power Demands

LEVEL OF EFFORT: 120 Man-days

SCHEDULE: March to July 1980

ESTIMATED COST: \$37,000

RESPONSIBILITY: R. F. Ramirez (IECO)

PURPOSE:

To provide a basis for system optimization studies.

SCOPE:

This Task will be carried out in several steps as follows:

- Develop forecasts by regions for the entire market area based on the studies performed in Task G-3-2. These forecasts will be made through the year 2010.
- Determine impact of the future price of electricity on the forecast of residential, commercial and industrial consumers.
- Perform sensitivity analyses to determine probabilities of variation in forecasts.
- Develop mathematical models of energy and power demand patterns (load development planning).
- Prepare a report presenting results of all power market studies. A draft of the report will be submitted to the University of Alaska, Institute of Social and Economic Research, for review and comments prior to finalization.

SUSITNA HYDROELECTRIC PROJECT				
PLAN OF 3				
CATEGORY:	G	PLAN SYNTHESIS	•••••	
ASSIGNMENT:	G-4	PROJECT LAYOUT STUDIES		
TASK TITLE:	G-4-1	Review and Evaluate Data on Susitna Project		

of 1

LEVEL OF EFFORT	60 Man-days
SCHEDULE:	January to March 1980
ESTIMATED COST:	\$18,000
RESPONSIBILITY:	P. J. Collins (IECO)

PURPOSE:

To obtain complete knowledge of work already accomplished in connection with the development of the Susitna River for power and energy.

SCOPE:

This Task will involve the following:

- Review in-depth all reports and data pertinent to the project, including the reports prepared by the U.S. Army Corps of Engineers.
- Reconnaissance inspections of the river and potential development sites. These inspections will be made on a team basis to develop a broader understanding of the project on the part of the various specialists involved.
- Internal and external meetings and discussions, including contacts with the APA and other Alaskan agencies, to review the findings obtained under the above and to determine a detailed program for further studies.

CATEGORY: G PLAN SYNTHESIS

ASSIGNMENT: G-4 PROJECT LAYOUT STUDIES

TASK TITLE: G-4-2 Prepare Basic Layouts of Development Alternatives

LEVEL OF EFFORT:	350 Man-days	
SCHEDULE:	March to July 1980	
ESTIMATED COST:	\$100,000	
RESPONSIBILITY:	P. J. Collins (IECO)	
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PURPOSE:

To establish technical characteristics of alternatives and provide a basis for the preparation of cost estimates.

SCOPE:

Potential sites on the Susitna will be studied in detail using data available at that time. Alternative designs will be considered for major structures and major pieces of equipment. Selection will be made on the basis of cost comparisons. As far as possible, all alternatives will be designed to the same criteria and in the same amount of detail. Activities will include the following:

- Establish design criteria. This will include the evaluation by specialists of foundations and sources of construction materials at the various Susitna sites; the determination of hydraulic criteria for the spillway, the outlet works and the river diversion; the selection of allowable stresses in materials; criteria pertinent to the design of the electrical and mechanical equipment; power plant operating criteria; camp and access requirements; and environment constraints.
- Prepare alternative layouts and basic design of major project features including access roads and transmission lines. Special attention will be given to the locations and types of structures to determine the most economic alternative. For each of the selected site alternatives layouts and basic designs will be prepared for different heights of dams and for a reasonable range of generating capacity.

CATEGORY:	G	PLAN SYNTHESIS	

ASSIGNMENT: G-4 PROJECT LAYOUT STUDIES

TASK TITLE: G-4-3 Develop Data for Project Optimization Studies

LEVEL OF EFFORT:	150 Man-days	
SCHEDULE:	June to August 1980	
ESTIMATED COST:	\$45,000	
RESPONSIBILITY:	P. J. Collins (IECO)	

PURPOSE:

To provide cost estimates for use in optimization studies.

SCOPE:

This Task will include the following activities:

- Estimate unit costs and capital costs for the various project alternatives selected for inclusion in the optimization studies. Cost curves will be developed for various dam heights and for a range of generating capacities at each site. Cost estimates will also be made for transmission systems, access roads, land purchases, recreational facilities and environmental measures.
- Prepare construction schedules and determine cash flows of capital expenditures for all construction sequences analyzed.

CATEGORY:	G	PLAN SYNTHESIS
ASSIGNMENT	G-5	COAL AND GAS ALTERNATIVES
TASK TITLE:	G-5-1	Review and Evaluate Coal and Gas Alternatives
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LEVEL OF EFF	ORT:	175 Man-days
SCHEDULE:		January to July 1980
ESTIMATED CO	DST:	\$55,000
RESPONSIBILI	TY:	S. F. Fogleman (IECO)

PURPOSE:

To evaluate the primary alternatives of fossil-fired generation based on Alaskan coal and gas resources for use in system optimization studies, both with and without the Susitna Project.

SCOPE:

This Task will include the following activities:

- Review all available information and compile data for thermal power inventory.
- Select promising alternatives for future fossil-fired expansion programs, based upon reports already completed for planned and proposed developments.
- Identify suitable locations and sizes of thermal plants for long-range development.
- Select alternatives for mine development and fuel transportation routes by specific location (Healy-Nenana, Beluga and other coal fields).
- Determine costs for coal and gas delivered to generation plant sites, including estimates for recovery, handling and transportation.
- Select generating unit sizes for specific plant sites and fuel type, taking into consideration capacity constraints due to system reserve requirements.
- Develop preliminary typical designs and cost estimates of the following types of plants:
 - Coal-fired base-load plants
 - Gas-fired peaking plants
 - Combined cycle plants



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- Compile thermal plant catalog containing the following:
 - Capital costs and cash flows of capital expenditures for specific construction sequences.
 - Technical and operational characteristics
 - Thermal efficiency (unit heat rates)
 - Operating costs, including fuel costs and operating and maintenance costs.
- Develop specific fuel-cost escalation profiles by plant and range of uncertainty applicable to different fuels.

SUSITNA HYDROELECTRIC PROJECT PLAN OF STUDY		
CATEGORY:	G	PLAN SYNTHESIS
ASSIGNMENT:	G-6	OTHER ALTERNATIVE ENERGY SOURCES
TASK TITLE:	G-6-1	Review and Evaluate Other Energy Sources
LEVEL OF EFF	ORT:	195 Man-days
SCHEDULE:		January to July 1980
ESTIMATED COST:		\$60,000
RESPONSIBILITY:		M. H. Wolfe (IECO)

PURPOSE:

To assess and evaluate energy sources, other than depletable fossil fuels and the Susitna Project, that could provide the potential for dispersed generation for energy supply within the equivalent of the Susitna Project power market area. The study will determine the extent to which substitution of alternative energy is reasonable. Cost parameters for use in system optimization studies will be developed only if available data indicate that an alternative would be competitive with coal and gas alternatives.

SCOPE:

This Task will encompass the evaluation of the following alternatives:

- Energy conservation as the equivalent of a low cost generation source. This possibility will be addressed in conjunction with the power market study.
- Geothermal resources within reasonable proximity to load area. Potential sources will be assessed in relation to magnitude, dispersal and seismic factors.
- Hydroelectric developments at sites other than Susitna. These will be evaluated from considerations of scale, location and environmental factors.
- Tidal power development in Cook Inlet. Potential for proposed tidal developments in the Upper Inlet, utilizing Knik Arm and Turnagain Arm basins, will be evaluated from published reports and other pertinent information.
- Wood, peat and solid waste conversion will be considered for energy generation and production of fuels from biomass and municipal waste.
- Solar energy installations adapted to northern latitudes will be evaluated to determine possible appropriate future applications.

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- Wind energy for localized generation. The possibilities for small-scale generation in towns and remote communities will be examined.
- Fuel cell applications at urban load centers will be evaluated, together with other decentralized sources of generation as part of system planning.
- Nuclear energy in Alaska may never be acceptable, but the possibility will be evaluated to complete the study of alternatives.

CATEGORY:	G	PLAN SYNTHESIS
ASSIGNMENT:	G-7	POWER STUDIES AND SYSTEM OPTIMIZATION
LASK TITLE	G-7-1	Preparation of Data Base

LEVEL OF EFFORT:	70 Man-days
SCHEDULE:	February to July 1980
ESTIMATED COST:	\$40,000
RESPONSIBILITY:	J. Kerr (IECO)
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PURPOSE:

To prepare a data base to serve hydrothermal simulation and system optimization studies.

SCOPE:

The activities under this Task will include:

- Recording in data banks of all basic chronologic hydrologic data.
- Recording in data banks of selected and processed hydrologic data, water demand data, power and energy forecast data, and selected results of hydrothermal simulation.
- Recording in data banks of project data such as data on hydro plants, thermal plants and transmission lines.

Processing and recording data related to the various construction sequences considered, such as hydro project combinations, hydrothermal configurations, maintenance schedules, reserve requirements, transmission losses, annual operation information, cash flows of capital expenditures, and various economic parameters.

CATEGORY:	G	PLAN SYNTHESIS	
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ASSIGNMENT: G-7 POWER STUDIES AND SYSTEM OPTIMIZATION

TASK TITLE: G-7-2 Hydrothermal Simulation Studies_

LEVEL OF EFFORT:	300 Man-days
SCHEDULE:	March 1980 to January 1981
ESTIMATED COST:	\$125,000
RESPONSIBILITY:	J. Kerr (IECO)

PURPOSE:

To confirm installation dates, to define failure characteristics and to determine fuel consumption and other operation features.

SCOPE:

Simulation of the operation of hydrothermal systems, corresponding to different construction sequences, on a year-to-year basis into the future:

- With new dams, hydro stations, thermal plants, transmission lines and other works being added as required.
- With the magnitude of water and energy demands also increasing with time.
- With the recorded hydrologic data superimposed on future years in a number of ways equal to the number of years of historic data, in order to define both critical situations (such as failure characteristics) and average conditions (such as mean thermal consumption for all ways of superimposing history on future).
- With maintenance schedules and reserve capacities defined using LOLP procedures and redefined following initial hydrothermal simulation.
- With transmission losses defined using separate procedures and redefined following initial hydrothermal simulation.
- With inclusion of short-time intervals in the hydrothermal simulation, involving conjunctive use of the main hydrothermal simulation model and General Electric or similar models, particularly in the case of critical situations, if it can be shown that such procedures improve the comparisons of alternative expansion programs.

TASK: G-7-2 Hydrothermal Simulation Studies

- With use of stochastic input data (randomly varying critical hydrologic data, forced outages and forecast extremes) for prefinal construction sequences only, and as a secondary decision making aid only, if it can be shown that available models produce reasonably realistic stochastic input data and that the results aid in comparing alternative expansion programs (construction sequences).
- With introduction of mathematical programming techniques (such as linear programming, dynamic programming, and the out-of-kilter algorithm) if it can be shown that such procedures aid in solving specific subproblems within the framework of overall detailed hydrothermal simulation.



CATEGORY:	G	PLAN SYNTHESIS	. 4
ASSIGNMENT:	G-7	POWER STUDIES AND SYSTEM OPTIMIZATION	· ·
TASK TITLE:	G-7-3	Determine Present Values for Construction Sequences	

LEVEL OF EFFORT:	200 Man-days
SCHEDULE:	July 1980 to January 1981
ESTIMATED COST:	\$86,000
RESPONSIBILITY:	J. Kerr (IECO)

PURPOSE:

To determine criteria for the selection of the optimum sequences of development.

SCOPE:

The present values of capital and operating costs will be determined for various construction sequences:

- With and without the Susitna hydroelectric project.
- For construction sequences with and without a transmission interconnection between the Anchorage and Fairbanks areas.
- For construction sequences with and without a transmission interconnection to the Glenallen-Valdez area.
- For construction sequences from the years 1985 to 2010.
- For an all-thermal sequence as the base case.
- For different initial installations (depending on whether hydro or thermal follows in the sequence under consideration, for instance).
- For different final installations (both thermal and hydro) in the sequences including the Susitna Project (and in all other sequences).
- Using average annual thermal consumption, failure characteristics and other operating information derived from detailed hydrothermal simulation.
- Using annual cash flows of capital expenditures for hydro stations, thermal plants, transmission lines and other works.

- Treating secondary water and energy benefits as negative costs (primary benefits, comprising the satisfying of load and energy demands, being identical in all sequences).
- Making four adjustments at the end of each sequence to ensure that the sequences are truly comparable.
- For different interest rates, cost escalation rates, unit thermal costs and other factors, to provide sensitivity analyses resulting in families of curves of sums of present values versus these factors to assist in decision making.

The final product of the study is a catalog of construction sequences, each with its sum of present values and intangible characteristics formalized.

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CATEGORY:	G	PLAN SYNTHESIS	

ASSIGNMENT: G-7 POWER STUDIES AND SYSTEM OPTIMIZATION

TASK TITLE: G-7-4 Operation Studies for Definitive Project

LEVEL OF EFFORT:_	150 Man-days		
SCHEDULE:	June to October 1981		
ESTIMATED COST:	\$62,000	** 7 #AT	
RESPONSIBILITY:	J. Kerr (IECO)		

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PURPOSE:

To define project features and project operation in sufficient detail for FERC License Application.

SCOPE:

Detailed operation studies of the definitive Susitna Project will be performed to determine:

- Reservoir operating rules, considering energy generation, flood control, minimum outflow patterns and environmental considerations.
- Maximum and minimum reservoir elevations and rules for reservoir operation, including flood control.
- Installed generating capacity and number and size of units.
- Operating criteria for daily and weekly operations, taking into account downstream water requirements and the effect of the project on the river regime.
- Duration curves of dependable capacity.
- Average annual energy for each year in the future, including the effects of reservoir filling.

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ASSIGNMENT: G-8 PLAN FORMULATION

TASK TITLE: G-8-1 Evaluate Results of Studies

LEVEL OF EFFORT: 50 Man-days

ESTIMATED COST: \$17,000

RESPONSIBILITY: A. R. Engebretsen (IECO)

PURPOSE:

SCHEDULE:

To select the plan of development which will produce the greatest benefits to the people of Alaska

December 1980 to February 1981

SCOPE:

The activities under this Task will include:

- Review and evaluate the various alternatives studied with respect to National Economic Development, Environmental Quality, Regional Development and Social Well-Being. The results of the various studies performed will be summarized in tables to facilitate the overall evaluation.
- Discuss findings with the principal parties concerned and, if necessary, make additional studies to provide answers to specific questions which may be raised.
- Define and describe the selected plan of development.

PLAN SYNTHESIS CATEGORY: G

ASSIGNMENT: G-8 PLAN FORMULATION

TASK TITLE: G-8-2 Prepare Draft of Plan Formulation Report

LEVEL OF EFFORT: 75 Man-days

December 1980 to March 1981 ESTIMATED COST: \$25,000

SCHEDULE:

RESPONSIBILITY: A. R. Engebretsen (IECO)

PURPOSE:

To permit all parties concerned to make a detailed review of all studies performed for the Plan Formulation, and to comment on the recommended plan.

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SCOPE:

This Task will involve the preparation of a draft report presenting the results of all studies performed having a bearing on the Plan Formulation. It is anticipated that the report will consist of a summary volume and appendixes on hydrology, geology, environmental aspects, Susitna Project alternatives, coal and gas fired alternatives and system optimization studies.

CATEGORY:	G	PLAN SYNTHESIS
ASSIGNMENT	G-8	PLAN FORMULATION
TASK TITLE:	G-8-3	Prepare Final Plan Formulation Report
LEVEL OF EFF	ORT:_	75 Man-days

SCHEDULE: March to May 1981

ESTIMATED COST: \$28,000

RESPONSIBILITY: A. R. Engebretsen (IECO)

PURPOSE:

To present the results of the Plan Formulation Studies in a suitable form for general distribution.

SCOPE:

The final report will be based on the draft report, modified as necessary to take into account comments received. The report will be printed in 200 copies using modern reproduction methods.

INTERNATIONAL ENGINEERING COMPANY, INC.

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17 8	ASSIGNMENT:	G-9	DEFINITIVE PROJECT STUDIES
	TASK TITLE:	G-9-1	Coordinate and Synthesize Definitive Project Studies
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6	LEVEL OF EFI	FORT:_	250 Man-days
	SCHEDULE:		April 1981 to March 1982
R	ESTIMATED COST:		\$75,000

PURPOSE:

RESPONSIBILITY:

To provide guidance for the various studies required to define the Susitna Project in sufficient detail for FERC License Application.

SCOPE:

The activities under this Task will include:

• Prepare a detailed program of all studies required.

P. J. Collins (IECO)

- Coordinate and monitor the work of other task groups.
- Develop overall criteria for design of the various project facilities.
- Direct and supervise economic studies of alternative types of dams, spillways and other project features.
- Analyze and synthesize the results of studies received from other Task Groups.

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ASSIGNMENT: G-9 DEFINITIVE PROJECT STUDIES

TASK TITLE: G-9-2 Coordinate Documentation for FERC License Application

LEVEL OF EFFORT:_	150 Man-days
SCHEDULE:	September 1981 to March 1982
ESTIMATED COST:	\$15,000
RESPONSIBILITY:	P. J. Collins (IECO)

PURPOSE:

To provide guidance for the preparation of project data required for the FERC License Application Documents.

SCOPE:

The activities under this Task will include:

- Monitor progress made by the various groups involved in the Definitive Project Studies.
- Prepare drafting standards for drawings which will be used as FERC License Application Exhibits.
- Review and edit description of project operation and project facilities.
- Review project cost estimates.

CATEGORY: G PLAN SYNTHESIS

ASSIGNMENT: G-9 DEFINITIVE PROJECT STUDIES

TASK TITLE: G-9-3 Prepare Definitive Project Report

LEVEL OF EFFORT:	100 Man-days
SCHEDULE:	January to April 1982
ESTIMATED COST:	\$35,000
RESPONSIBILITY:	P. J. Collins (IECO)

PURPOSE:

To provide a document which will serve as a reference document on the definitive project.

SCOPE:

The activities under this task will include:

- Prepare a general outline of the report.
- Review and edit draft reports received from other task groups pertaining to their studies.
- Supervise and monitor the drafting, typing, printing and reproduction of the various volumes which will make up the report.

CATEGORY:	G	PLAN SYNTHESIS

ASSIGNMENT: G-10 FERC LICENSE APPLICATION

TASK TITLE: G-10-1 Assist APA in Preparation of Exhibits A thru G and Exhibit T of FERC License Application

 LEVEL OF EFFORT:
 60 Man-days

 SCHEDULE:
 April to July 1982

ESTIMATED COST: \$20,000

RESPONSIBILITY: C. B. King (IECO)

PURPOSE:

Provide documents required for FERC License Application.

SCOPE:

Assist APA in the preparation of the following exhibits:

Exhibit		Description
A	-	Laws under authority of which application is made
В	-	Resolution authorizing filing of application
C	-	Special laws for hydroelectric development, if any
D	-	Evidence that Applicant has complied with the requirements of the laws of the State of Alaska
Ε	-	Statement of nature, extent and ownership of water rights for the project
F	-	Statement concerning ownership of lands to be utilized in the pro- posed project
G	_	Statement of Applicant's financial ability and proposed method of financing the construction
Т	-	Statement concerning development and operation by Applicant
SUSITNA HYDROELECTRIC PROJECT PLAN OF STUDY

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CATEGORY:	G	PLAN SYNTHESIS
ASSIGNMENT:	G-10	FERC LICENSE APPLICATION
TASK TITLE	G-10-2	Prepare Exhibit H thru O and Exhibit U of FERC License Application

LEVEL OF EFFORT	160 Man-days
SCHEDULE:	April to July 1982
ESTIMATED COST	\$50,000
RESPONSIBILITY:	C. B. King (IECO)

PURPOSE:

Provide documents required for FERC License Application .

SCOPE:

Prepare the following exhibits:

Exhibit		Description
н	· _	Statement of proposed operation of project
I	-	Estimate of dependable capacity and average annual energy to be generated by the project
J	-	General map covering entire project area
К	-	Detail maps of project area
L		General design drawings
М	-	General description of mechanical, electrical and transmission equipment
N	-	Estimate of project cost
0	-	Statement of time required for commencing and completing construc- tion
U	-	Utilization of project power

SUSITNA HYDROELECTRIC PROJECT

PLAN OF STUDY

CATEGORY:	G	PLAN SYNTHESIS
ASSIGNMENT:	G-10	FERC LICENSE APPLICATION
TASK TITLE:	G-10-3	Incorporate Exhibits R, S, V and W of FERC License Application

LEVEL OF EFFORT:_	10 Man-days
SCHEDULE:	May to July 1982
ESTIMATED COST:	\$6,000
RESPONSIBILITY:	C. B. King (IECO)

PURPOSE:

Provide documents required for FERC License Application.

SCOPE:

Incorporate the following environmental exhibits:

<u>Exhibit</u>		Description
R	-	Recreation use plan
S	-	Protection of fish and wildlife resources
V	-	Protection of natural, historic and scenic values
W	-	Environmental report

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SUSITNA HYDROELECTRIC PROJECT PLAN OF STUDY

CATEGORY: G PLAN SYNTHESIS

ASSIGNMENT: G-10 FERC LICENSE APPLICATION

TASK TITLE: G-10-4 Print FERC License Application

LEVEL OF EFFORT: 30 Man-days

SCHEDULE: June 1982

ESTIMATED COST: \$28,000

RESPONSIBILITY: C. B. King (IECO)

PURPOSE:

Provide documents required for FERC License Application.

SCOPE:

Supervise and coordinate printing of the FERC License Application.

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Follow-on Phases

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	FERC LICENSING
I-1	Ongoing Alaska Power Authority Administrative and Legal Activities
I-2	Miscellaneous Ongoing Activities and Costs
I-3	Perform Follow-on Environmental Studies from Plan of Study Phase
I-4	Legal Consultation (FERC Application)
I-5	Engineering and Environmental Support (FERC Requests)
I-6	Preparation of Testimony and Appearance as Expert Witness
I-7	Develop Supporting Supplemental Data - Structural Model Studies - Devil Canyon Arch Dam
I-8	Develop Supporting Supplemental Data - Hydraulic Model Studies - Watana Spillway
	FINAL DESIGN AND CONTRACT DOCUMENTS
II-1	Perform Additional Geotechnical Studies for Final Design
II-2	Furnish Field Camp and Logistics for Additional Exploration
II-3	Perform Final Design and Prepare Contract Drawings and Specifications
II-4	Assist in Power Sale and Bond Issuance
II-5	Financial Consultants and Bond Counsel
II-6	Procurement and Construction Contracts - Prequalifications, Advertisements and Evaluation of Bids

PHASE:	I	FERC LICENSING
PRINCIPAL ACTIVITY:	I-1	ONGOING ALASKA POWER AUTHORITY ADMINISTRATIVE AND LEGAL ACTIVITIES
ASSUMED SCHEDULE:		54 Months to Award of Contract
ESTIMATED COST:		\$900,000
RESPONSIBILITY:		APA

PURPOSE:

APA administrative and legal costs will increase as the staff is increased to handle the heavier work load required in carrying through an active project.

ACTIVITY:

For rough estimating purposes it is assumed that administrative costs will be double those expected during the Plan of Study Phase.

PHASE:	I	FERC LICENSING
PRINCIPAL ACTIVITY:	I-2	MISCELLANEOUS ONGOING ACTIVITIES AND COSTS
ASSUMED SCHEDULE:		54 Months to Award of Contract
ESTIMATED COST:		\$550,000
RESPONSIBILITY:		APA

PURPOSE:

Certain costs will be expected for maintaining the field camp in good repair in anticipation of its use for additional required exploration and to serve as a nucleus of the future construction camp.

ACTIVITY:

An amount should be allocated for rental of lands occupied by the camp and routine maintenance to preserve it in good condition. Fees paid under agreement with Native corporations would be expected to continue.

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PHASE:	I	FERC LICENSING
PRINCIPAL ACTIVITY:	I-3	PERFORM FOLLOW-ON ENVIRONMENTAL STUDIES FROM PLAN OF STUDY PHASE
ASSUMED SCHEDULE:		12 Months
ESTIMATED COST:		\$1,100,000
RESPONSIBILITY:		Environmental Consultant

PURPOSE:

To complete anadromous fisheries studies and accomplish preconstruction archeological studies at the project areas.

ACTIVITY:

The anadromous fisheries studies which began during the Plan of Study Phase need to carry on for a full three-year cycle so that a final evaluation may be made. A final report covering the total period of studies will be prepared and submitted as supplemental data.

The detail archeological studies, required in the specific areas which will be disturbed by the project, must be completed before construction. In the event that sites of significant importance are located, careful excavation, recording and possible relocation of the finds may be required.

An allowance is made in the estimate for the possibility that additional environmental studies not now envisioned may be required for some reason.

PHASE:	I	FERC LICENSING	-	
PRINCIPAL ACTIVITY:	I-4	LEGAL CONSULTATION (FERC APPLICATION)		
ASSUMED SCHEDULE:		30 Months		
ESTIMATED COST:		\$500,000		
RESPONSIBILITY:		Legal Counsel		

PURPOSE:

To provide liaison with FERC staff in Washington, D.C. and represent client in FERC hearings.

ACTIVITY:

Processing the License Application for a project of the magnitude of Susitna will require the services of a Legal Counsel in Washington, D.C. Undoubtedly there will be FERC hearings, and it will be important that APA be represented by Legal Counsel well versed and experienced in directing the proceedings of such hearings. His services would involve filing documents, preparing supporting briefs, preparing arguments against interveners and assistance in the preparation of written testimony of the Engineering Consultants' and Environmental Consultants' expert witnesses. In addition, he can provide APA with up-to-date status of the license as it is being processed, and can act as direct liaison between FERC and APA.

PHASE:	I	FERC LICENSING
PRINCIPAL ACTIVITY:	I-5	ENGINEERING AND ENVIRONMENTAL SUPPORT (FERC REQUESTS)
ASSUMED SCHEDULE:		12 Months
ESTIMATED COST:		\$150,000
RESPONSIBILITY:		Engineering Consultants and Environmental Consultants

PURPOSE:

To furnish supplemental information to answer FERC requests and agency comments.

ACTIVITY:

FERC staff usually requests additional information on certain exhibits of the application which were presented in less detail than staff requires for their own in-house analysis. Such detailed information is usually not included in the application itself as it is not required by other agencies for their review. For example, detailed calculation for stability and structural analysis of various project features; detailed quantities and cost estimates; drill logs and geologists notes; and other such information would be furnished as supplemental data. It is likely that the bulk of additional information requested will be related to the environmental Exhibits R, S, V and W since the FERC staff will prepare the draft environmental impact statement for the project. In general, providing this information does not involve generation of new data or substantial work.

In addition, FERC gives the Applicant the opportunity to reply to all of the reviewing agencies' comments. Such replies will be prepared by the Engineering and Environmental Consultants team for submittal by APA.

I	FERC LICENSING
I-6	PREPARATION OF TESTIMONY AND APPEARANCE AS EXPERT WITNESS
	12 Months
	\$50,000
	Engineering Consultants and Environmental Consultants
	I I-6

PURPOSE:

To participate in FERC hearings in support of the License Application.

ACTIVITY:

Key members of the Engineering Consultants and Environmental Consultants staffs who were responsible for the designs or services required for preparation of the License Application for the project will be called to testify at FERC hearings on matters concerning their expertise. Under the direction of the Legal Counsel, they will prepare their testimony and appear as expert witnesses in support of the project.

PHASE:	I	FERC LICENSING
PRINCIPAL ACTIVITY	I-7	DEVELOP SUPPORTING SUPPLEMENTAL DATA - STRUCTURAL MODEL STUDIES - DEVIL CANYON ARCH DAM
ASSUMED SCHEDULE:		12 Months
ESTIMATED COST:		\$200,000
RESPONSIBILITY:		Engineering Consultant and Structural Model Laboratory

SHEET 1 of 1

PURPOSE:

To provide confirmation of analytical stress analyses results and support the technical feasibility of the dam design.

ACTIVITY:

Because of the magnitude of the arch dam proposed, and the highly seismic area in which the damsite is located, conclusive evidence of the technical feasibility of the arch dam design, as demonstrated by two independent stress analysis techniques verifying the design conclusions, will be needed before the FERC staff can give unqualified approval.

Structural model tests for dynamic loadings have been conducted by one of the most experienced specialized laboratories of this kind, ISMES, under subcontract to IECO for an IECO-designed 70-meter-high arch dam. Such dynamic model tests of the proposed Devil Canyon dam would be advisable.

PHASE:	I	FERC LICENSING
PRINCIPAL ACTIVITY:	I-8	DEVELOP SUPPORTING SUPPLEMENTAL DATA - HYDRAULIC MODEL STUDIES - WATANA SPILLWAY
ASSUMED SCHEDULE:		12 Months
ESTIMATED COST:		\$125,000
RESPONSIBILITY:		Engineering Consultant and Hydraulics Laboratory

PURPOSE:

To verify the hydraulic adequacy of the spillway design.

ACTIVITY:

Hydraulic model testing of the Watana spillway will be carried out by a qualified hydraulics laboratory. The testing program will be designed to determine the spillway capacity for both free and gate-controlled flow; spillway face pressures; entrance flow conditions to the crest from the reservoir; design of flip bucket or other energy dissipator; scour conditions in the spillway discharge area; and water surface profiles. Consideration should be given to areas of deposition of material scoured from the riverbed at various discharges.

Hydraulic model testing of other features such as power intake and diversion structures might be required depending on the types determined during final design.

PHASE:	II	FINAL DESIGN AND CONTRACT DOCUMENTS
PRINCIPAL ACTIVITY:	II-1	PERFORM ADDITIONAL GEOTECHNICAL FOUNDATION STUDIES FOR FINAL DESIGN
ASSUMED SCHEDULE:		6 Months (Summer Seasons)
ESTIMATED COST:		\$2,000,000
RESPONSIBILITY:		Engineering Consultant

PURPOSE:

To provide necessary data for final project design.

ACTIVITY:

Perform additional foundation and materials investigations to fully define conditions for the various structures as per the definitive project layouts depicted in the FERC License Application. Extent of investigations will be limited to that determined to ensure the suitability of the foundation and materials for the type and size of structure as designed. Core borings, auger holes, backhoe and dozer trenches, and rotary drilling will be utilized. Adits and/or shafts might also be required. If conditions are found to be different than expected and structure locations need to be adjusted, sufficient investigations will be performed to confirm the suitability of the adjusted location. Prime importance will be furnishing sufficient exploratory data regarding foundation conditions to enable the construction contractors to make reasonable estimates of the construction cost.

PHASE:	II	FINAL DESIGN AND CONTRACT DOCUMENTS
PRINCIPAL ACTIVITY	II-2	FURNISH FIELD CAMP AND LOGISTICS FOR ADDITIONAL EXPLORATION
ASSUMED SCHEDULE:		6 Months (Summer Seasons)
ESTIMATED COST:		\$2,000,000
RESPONSIBILITY:		Designated Subcontractor

PURPOSE:

To provide housing subsistence and logistic support during field investigations.

ACTIVITY:

Activate the Watana field camp assumed to have been "moth balled" and maintained in proper order to provide housing and subsistence for geotechnical engineers and drilling personnel during additional investigations. Provide helicopter and fixed-wing supply logistical support during investigations.

PHASE:	II	FINAL DESIGN AND CONTRACT DOCUMENTS
PRINCIPAL ACTIVITY:	11-3	PERFORM FINAL DESIGN, AND PREPARE CONTRACT DRAWINGS AND SPECIFICATIONS
ASSUMED SCHEDULE:		18 to 20 Months
ESTIMATED COST:		\$4,500,000
RESPONSIBILITY:		Engineering Consultant

PURPOSE:

Final design and completion of all bidding and contract documents for the procurement and construction contracts for the project.

ACTIVITY:

The Engineering Consultant will perform engineering services as required to produce bid drawings and other contract documents necessary to obtain bids for all the construction, procurement, and installation contracts. This includes basic design and drawings for civil, mechanical, and electrical works for all features of the project such as dams, spillways, intake structure, tunnels, power plants, and access roads.

PHASE	II	FINAL DESIGN AND CONTRACT DOCUMENTS
PRINCIPAL ACTIVITY:	II-4	ASSIST IN POWER SALE AND BOND ISSUANCE
ASSUMED SCHEDULE:		12 Months
ESTIMATED COST:		\$50,000
RESPONSIBILITY:		Engineering Consultant

PURPOSE:

To assist APA in negotiations of power sale contracts and preparation of bond issuance.

ACTIVITY:

The Engineering Consultant will form a power marketing team which will include representatives from APA to assist in and to monitor the negotiations for sale of power. Assistance will be provided by APA during discussions with potential power purchasers to maintain a firm negotiating position. Services include: compile data pertinent to soliciting proposals for purchase of project power; identify prospective purchasers; prepare documents for use in soliciting power purchase proposals and distribute these documents to the approved list of prospective purchasers; formulate a proposal evaluation procedure; evaluate and identify the most favorable proposal(s) for further consideration; negotiate power sale conditions with the selected purchaser(s) as directed by APA; and assist in preparation of the power sale contract.

The work required to issue bonds for financing of the project will involve coordination of efforts by APA, the Financial Consultants, the Bond Counsel and the Engineering Consultant. During this process, the Engineering Consultant will provide the project description, construction cost estimate, construction schedule, and other information required for inclusion in the Official Statement for sale of bonds.

PHASE:	II	FINAL DESIGN AND CONTRACT DOCUMENTS
PRINCIPAL ACTIVITY	11-5	FINANCIAL CONSULTANTS AND BOND COUNSEL
ASSUMED SCHEDULE:		12 Months
ESTIMATED COST:		\$1,000,000
RESPONSIBILITY:		Financial Consultants and Bond Counsel

PURPOSE:

To arrange for and obtain financing for project construction.

ACTIVITY:

The Financial Consultants' general scope of services would be: review proposed financial plans and modify as required; arrange, implement, schedule and supervise all steps of financing; prepare the Official Statement for bond sales; in cooperation with Bond Counsel, design the financial terms and conditions of the resolution; print, mail and distribute notice of sale, resolutions, Official Statement and other documents to underwriters and institutional buyers writing competitive bids for the bonds; assist APA in special presentations of the proposed program to groups of analysts and underwriters; calculate bids for bonds, and select the lowest bid; sell and deliver the bonds.

The Bond Counsel's general scope of services would be: prepare proceedings for issuance and sale of bonds including the indenture or resolution of issuance and provisions thereof, their security, any sinking funds, reserve funds, special funds and other provisions; review the Official Statement; review power sale agreement; review insurance policies; review construction contracts, performance bonds to the extent necessary in connection with preparation of revenue bond documents; and render such other legal services as requested by APA.

PHASE:	II	FINAL DESIGN AND CONTRACT DOCUMENTS
PRINCIPAL ACTIVITY	II-6	PROCUREMENT AND CONSTRUCTION CONTRACTS - PREQUALIFICATIONS, ADVERTISEMENT, AND EVALUATION OF BIDS
ASSUMED SCHEDULE:		6 to 9 Months
ESTIMATED COST:		\$100,000
RESPONSIBILITY:		Engineering Consultant

PURPOSE:

Formal prequalification of prospective bidders to assure owner that contracted parties are qualified to perform the contracts; advertisement to obtain bids; evaluation of bids to determine the low bidders and probable cost for the project.

ACTIVITY:

If APA elects, the Engineering Consultant will determine through prequalification procedures (i.e. review of past performances) that the bidding contractors are qualified to do the work.

The Engineering Consultant will assist the Owner to obtain bids by public notices and personal contacts with potential contractors. The Engineering Consultant will also assist the Owner in determining the lower bidders and probable final cost by evaluating the offers.