

LEG. FINANCE - BILLS 1979 - 1980 1254

SB 63 cont. , 1254

PLAN FORMULATION (PF)

THESE PLAN FORMULATION ACTIVITIES SPECIFY THE PROCESS USED BY THE PLANNER IN DEVELOPING THE BEST CONCEPTUAL PLAN OF DEVELOPMENT FROM AMONG THE RANGE OF POSSIBILITIES, AND IN THEN REFINING THAT PLAN INTO ONE WHICH BEST SATISFIES THE REGION'S WATER RESOURCE NEEDS. TO ASSIST IN THIS ENDEAVOR, THE PLAN FORMULATOR EMPLOYS ALL THE INFORMATION RELATED TO PLAN BENEFITS, COSTS, AND ENVIRONMENTAL EFFECTS DEVELOPED BY THE VARIOUS OTHER DISCIPLINES.

REVIEW OF PREVIOUS STUDIES.

1. Review 1976 feasibility report.
2. Update power values.

EVALUATION CRITERIA.

3. Establish evaluation criteria.

PLANS AND PRELIMINARY EVALUATION.

4. Identify possible solutions.

ANALYZE SPECIFIC PLANS OF HYDROPOWER DEVELOPMENT.

5. Establish site layouts.
6. Conduct mass take-offs and provide cost estimates.
7. Assess reregulation dam costs.
8. Develop power benefits and assess economic attractiveness.

IMPACT IDENTIFICATION AND EVALUATION.

9. Make preliminary assessment of alternatives.

ON-GOING EVALUATION OF ALTERNATIVES.

10. Update the impact analysis as needed.

IDENTIFICATION OF HYDRO SYSTEM OPERATION IN REGIONAL LOAD.

11. Study feasibility of future units and downstream reregulation.
12. Conduct hourly loading studies.
13. Assess sensitivity to load growth.

ALTERNATIVE SYSTEM STUDIES.

14. Conduct system studies on alternative developments.

BENEFIT AND COST CALCULATION.

15. Collect and compare benefit and cost estimates.

PLAN FORMULATION

Activity Designation: PF-1

Activity: Review 1976 feasibility report.

Description: Review the preauthorization feasibility report to identify formulation tasks which have already been completed and can serve as direct input to the present Plan Formulation efforts. This will include a review of alternative development plans to determine if they should be reanalyzed in more depth as a result of an updated data base. Those conclusions which are still current will be used directly in the formulation process.

Seasonal Constraint: None

Cost: \$1,000

CORRECTION

**THIS DOCUMENT
HAS BEEN REPHOTOGRAPHED
TO ASSURE LEGIBILITY**

PLAN FORMULATION

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Seasonal Constraint: None

Cost: \$1,000

PLAN FORMULATION

Activity Designation: PF-2

Activity: Update power values.

Description: Benefits and costs of the several alternative plans must be calculated on a comparable basis. This will necessitate updating the power values upon which power benefits are based. The power values are the costs of capacity and energy produced by the most economical available nonhydro alternative, in this case coal generation. The power values used in the 1976 Feasibility Report will be updated to reflect changes in generation cost since 1975. These updated power values will be utilized during the preliminary screening, while more refined values developed in conjunction with activity PM-11 will be used in the detailed feasibility analysis.

Seasonal Constraint: None

Cost: \$3,000

PLAN FORMULATION

Activity Designation: PF-3

Activity: Establish evaluation criteria.

Description: This activity will be aimed at describing the marketing and technical parameters associated with hydroelectric that will be used in evaluating the energy capabilities of the various alternative developments, and the economic value of the resource. Technical criteria will entail such aspects as tailwater rating curves, hydraulic loss curves, evaporation rates, leakage and seepage losses, transmission losses, sedimentation rates, operating rule curves, drawdown limitations, etc. Criteria associated with economics would entail seasonal energy demand, projected energy and capacity requirements, a projection of usable energy and capacity, and an estimate of the unit value of prime energy, secondary energy, dependable capacity, and interruptible capacity. The objectives are the National, State, and local water and related land resource management needs specific to the railbelt area that can be addressed to enhance national economic development and environmental quality. During the preauthorization studies, specific objectives were identified from expressions of governmental agencies, industry, special interest groups, and private citizens. They included a projected need for increased supplies of electrical energy, a need for reduction or prevention of flood damages, a need for improved small boat and deep draft navigation conditions, a need for increased municipal water supply, a need for future supplies of irrigation water, a need for reduction of air pollution in Fairbanks and Anchorage, a need to conserve and enhance fish and wildlife resources, a need for additional recreation opportunities, a desire to preserve and maintain "the Alaskan way of life," a national desire to achieve energy independence, and the national desire to conserve nonrenewable resources. It will be necessary to reevaluate these objectives based on national policy and expressions of desires to be obtained from public input.

Seasonal Constraint: None

Cost: \$5,000

PLAN FORMULATION

Activity Designation: PF-4

Activity: Identify possible solutions.

Description: This activity will be aimed at identifying the alternatives available to meet the study objectives. The purpose will be to insure that all alternatives are evaluated during the screening and evaluating process. This will require an inventory of resources available within the immediate area. It will also entail a literature review to ascertain the present state-of-the-art associated with developing some of the exotic resources. This will entail a review of the economics and environmental impacts. Finally, specific development ideas mentioned in previous documents and reports for the railbelt area will be identified. The pre-authorization report identified the following energy alternatives: coal, natural gas, oil, wind, tide, geothermal, solar, no growth, nuclear, wood, intertie, solid waste, and hydropower. To this list might be added soft techniques or others which may become available during the planning phase. This activity will include refining alternative plans without concentrating on detailed engineering and design considerations. These alternative plans will help to make obvious the consequences that concentration on one of the other objectives will cost in terms of the remaining objectives. Thus, considering each alternative's contribution to the national and local objectives will disclose that many of the alternatives can be eliminated without an indepth analysis. The first screening will eliminate the obviously unfulfilling alternatives because of their economic inferiority or detrimental effect on the environment.

Seasonal Constraint: None

Cost: \$8,000

PLAN FORMULATION

Activity Designation: PF-5

Activity: Coordinate site layout activities.

Description: This activity will entail the identification of specific damsites that could be developed within the Upper Susitna Basin, and the combinations of dams which would compose the various systems of development. For each proposed system, major project features will be laid out and reconnaissance-grade design will be accomplished. This will insure that major features are compatible with the local topography and foundation conditions. Major attention will be given to dam heights and types of structures. The selection of plans to be evaluated will be accomplished by the organization responsible for reservoir regulation studies. That organization, however, will have to work closely with foundations and materials specialists to insure that specific sites appear to be feasible to develop. Each dam evaluated will require that a number of structural heights are analyzed. This will insure optimum scoping of each project.

Seasonal Constraint: None

Cost: \$40,000

PLAN FORMULATION

Activity Designation: PF-6

Activity: Conduct mass take-offs and develop cost estimates.

Description: The only plan of development that will be cost estimated in detail will be the plan recommended for final development. Thus, during plan formulation, the estimates will be of reconnaissance grade. This will require mass take-offs to which unit prices can be affixed. For each damsite evaluated, it will be necessary to provide cost estimates for a variety of dam heights and structural types. The estimates should be of sufficient detail, however, that they are compatible with the detailed cost estimate for the selected plan. Estimates will be for all design features (transmission line, powerhouse, dam, spillway, access road, etc.) based on present-day price levels. Contingencies should be in the 15 to 20 percent range.

Seasonal Constraint: None

Cost: The cost and duration of this activity has been included under the design consideration portion of the Plan of Study.

PLAN FORMULATION

Activity Designation: PF-7

Activity: Include reregulation dam in costs if necessary.

Description: Based on activity PS-3, if it is determined that a reregulation dam is necessary, then the design and cost of such a structure would be required. The possibility of installing generating capacity in the reregulator should also be explored. This would also require that sufficient environmental information is gathered to allow for effect assessment of downstream effects.

Seasonal Constraint: None

Cost: \$1,000

PLAN FORMULATION

Activity Designation: PF-8

Activity: Develop preliminary power benefits and assess economic attractiveness.

Description: The purpose of this activity will be to determine the economic value of the major plans for development in light of the criteria established under the power marketing analysis. In essence, it will entail comparing project benefits to project costs. Project benefits can be estimated by determining the amounts of energy and capacity that can be absorbed into the load during the life of the project. This will be influenced by the load growth of the area, the amount of thermal generation in the existing system, the condition of the existing generation, and the value of the hydro in relation to new and existing energy plants. Then by determining the value of the hydro (which is really the cost of developing the most feasible alternative to hydro and comparing this to the cost of hydro development), the economic value of the various alternatives can be determined. The value of the hydro should be estimated by a life cycle analysis of the energy resource that would be developed in lieu of the hydro project. Thus the replacement cost and future value of the fuel and O&M components will be present worthed to a present day value. This will be compared against the amortized cost of project construction.

Seasonal Constraint: None

Cost: \$10,000

PLAN FORMULATION

Activity Designation: PF-9

Activity: Make preliminary assessment of alternative plan costs, benefits, and impacts.

Description: This screening analysis will attempt to narrow the choice of available alternatives down to a chosen few which will be evaluated in specific detail. Thus, the screening process will be accomplished in three phases. This second stage will be based on a more indepth analysis of the environmental impacts and economics of specific plans for development than was accomplished under the first screening. Thus, reconnaissance grade cost estimates and benefit assessments will be necessary as will effect assessment. The alternatives will be evaluated in terms of the contribution to State and national economic objectives as well as to environmental preservation. Only those plans that appear to be economically feasible will be considered for plan selection. From this screening will come a detailed comparison of the remaining alternatives (presumably hydropower and coal) as to their relative environmental and socio-economic impacts. Determination of impacts will require a reasonable degree of accuracy at this stage, which in turn is dependent upon sufficient structural and design detail to more precisely evaluate the differences among the remaining alternatives. Detailed effects on water and land resources and economic and social aspects of human use will be measured or described by a determination of incremental changes in the applicable factors of affected environmental components. Wherever possible this will require quantification, particularly of effects on water and land resources. The same factors will be quantified for each alternative. Evaluation of the alternative plans in terms of environmental preservation will reflect societal preferences for the environmental contributions to the alternative plans. This will actively address the planning objectives in a way which emphasizes, aesthetic, ecological, and cultural contributions. Since it is assumed that strict adherence to environmental preservation will significantly preclude physical construction or development, it is necessary that some positive action be identified to assure that a "no development" plan be realized. Consequently, energy evaluation will require an interpretation of State objectives toward economic development.

Seasonal Constraint: None

Cost: \$5,000

PLAN FORMULATION

Activity Designation: PF-10

Activity: Update the impact analysis as needed.

Description: For each of the several alternative plans that are carried beyond the second screening, the tabulation of plan impacts will be kept updated. As phase I studies progress and as plans are refined, significant impacts will be identified and evaluated through various impact studies discussed elsewhere. This activity will consist of drawing upon these studies to develop an on-going table of differential plan impacts for use in impact assessment and plan formulation.

Seasonal Constraint: None

Cost: \$20,000

PLAN FORMULATION

Activity Designation: PF-11

Activity: Study feasibility of future units and downstream reregulation.

Description: From the production cost model (PS-4), the need for and timing of additional units will be determined. From the routing studies (PS-2) and related environmental studies, the need for a reregulator will be determined. With data on most likely thermal alternative (PM-11 and PS-4), benefits will be computed. With data on cost of added units and reregulator, economic feasibility of added units will be determined. It may be desirable to test several rates of load growth to see if they have any impact on feasibility of added units. The study will have to consider sunk costs and present worth of future costs and benefits.

Seasonal Constraint: None

Cost: \$4,000

PLAN FORMULATION

Activity Designation: PF-12

Activity: Conduct hourly loading studies.

Description: Studies must be made to determine the most likely loadings of Susitna hydro on an hourly basis. This must be done as input for streamflow routing studies. It will also serve as input data on hourly system load growth studies and will be done for selected times of the year (one for each definable season, at least) and for various points in time (5- or 10-year intervals from 1985 to 2015). Using input data on other available generating resources (PM-5 & 10), loading of Susitna hydro under the various conditions will be done with the help of the production cost model (PS-4).

Seasonal Constraint: None

Cost: \$3,000

PLAN FORMULATION

Activity Designation: PF-13

Activity: Assess sensitivity to load growth.

Description: This activity will entail an assessment of the economics of the selected plan should the projected load growth be significantly greater or less than that anticipated.

Seasonal Constraint: None

Cost: \$1,000

PLAN FORMULATION

Activity Designation: PF-14

Activity: Conduct system analysis studies on alternative developments.

Description: These studies will be conducted in order to evaluate the capability of the alternative development to meet system loads. Presumably, coal fired generation will be selected as the most viable alternative to Susitna hydro. By analyzing the coal alternative using the "Production Cost" model, it will be possible to determine how the coal alternative will fit into the integrated load system and if it provides a more flexible alternative than the hydro system. The study may highlight a need for a variety of generating modes that could meet the total system capacity requirements. The study would also indicate the desirability of interconnecting the Anchorage and Fairbanks load centers.

Seasonal Constraint: None

Cost: \$20,000

PLAN FORMULATION

Activity Designation: PF-15

Activity: Compare benefit and cost estimates.

Description: This activity will entail the development of the economics of the selected plan of development. It will include a synopsis of the total cost of the selected plan based on a given time frame. Costs will include total construction costs, interest during construction, engineering and design costs, supervision and administration of construction, and operation and maintenance of the projects. These costs will be amortized at the selected interest rate over the payout period of the project, thus providing an average annual cost. The benefits will also be estimated on an annual basis and will essentially represent the cost of providing an equivalent amount of power by the most likely alternative to the selected plan. A comparison of the benefits and costs will indicate the economic attractiveness of the selected plan.

Seasonal Constraint: None

Cost: \$3,000

POWER STUDIES (PS)

THIS GROUPING OF DIVERSE ACTIVITIES INCLUDES THE ANALYSES NEEDED TO ESTABLISH THE ENERGY CAPABILITIES OF THE VARIOUS ALTERNATIVE PLANS OF DEVELOPMENT OVER A RANGE OF ASSUMED DAM HEIGHTS AND STORAGE VOLUMES. ALSO, STUDIES ASSESS THE NEED FOR REREGULATION OF STREAMFLOWS DOWNSTREAM FROM THE PROJECT AND HELP DETERMINE THE OPTIMUM MODE OF OPERATION FOR THE SELECTED PLAN.

MISCELLANEOUS POWER STUDIES

1. Identify optimum dam heights, reservoir storage and optimum power.
2. Conduct hourly simulated operation.
3. Evaluate downstream impacts with and without a regulating dam.
4. Develop production cost model.

POWER STUDIES

Activity Designation: PS-1

Activity: Identify optimum dam heights, reservoir storage, and optimum power from seasonal regulation studies.

Description: Based on the power available from the various schemes of development and the multitude of combinations of dam heights, types of dam, stage sequences, etc., it should be possible to develop a number of total construction cost estimates for each scheme and combination analyzed. Assignment of benefits based on the combinations for each scheme analyzed should allow identification of the optimum components associated with power development. This would include optimum dam height, maximum drawdown determination, optimum staging, etc. From this type of analysis, the optimum combinations associated with each development scheme can be selected for effect assessment under the preliminary screening. This activity will encompass a description of the turbine specifications and operational capabilities of the selected plan of development. This will require efficiency curves for the turbines and a description of the turbines' operational limits. The limits will entail determination of such items as maximum head, minimum drawdown, tailwater rating curves and placement of the turbine to preclude damage to the turbines caused by low pressure (cavitation). Efficiency curves can be computer-generated or they may be obtained from manufacturers.

Seasonal Constraint: None

Cost: \$40,000

POWER STUDIES

Activity Designation: PS-2

Activity: Conduct hourly operation simulations.

Description: Conduct hourly simulated operation for the more feasible plans, and route them downstream. The work will consist of developing the data for the basic mathematical model consisting of downstream channel geometry, project characteristics, variations in the daily power load for the system, and other similar information. This will be followed by model calibration to insure that the natural system is being properly simulated. It will then be necessary to determine the situations under which the project will operate. This will entail determining seasonal water conditions and seasonal power load shapes, number of electrical generation units at each project, the amount of capacity in each powerhouse, and the availability of a reregulation dam. Results of hourly simulations will be evaluated to determine the effects downstream from the standpoints of navigation and recreation safety, the effects on the winter ice cover, and the effects on the downstream environment.

Seasonal Constraint: None

Cost: \$70,000

POWER STUDIES

Activity Designation: PS-3

Activity: Evaluate, for feasible plans, the downstream impacts with and without a reregulating dam.

Description: Downstream routing studies of powerhouse discharges for the more feasible plans of development will be required to determine water level fluctuations that can be expected to occur. The river reach to be studied will be from the Watana project downstream to the town of Talkeetna. Since detailed channel geometry will be available from the water surface profile determinations (HY-16), it is likely that the Gradually Varied Unsteady Flow Computer Program (SOCH) will be utilized. This program is a finite-difference solution to the complete equations of unsteady flow in open channels. The program was originally developed by TVA, and modified slightly by the Corps Hydrologic Engineering Center. It employs detailed channel geometry taken from surveyed cross-sections of the river and estimated channel roughness factors to provide the solution. Evaluation of downstream impacts will require a comparison between simulations with and without reregulation for water surface changes on an hourly, daily, and seasonal basis.

Seasonal Constraint: None

Cost: \$40,000

POWER STUDIES

Activity Designation: PS-4

Activity: Develop production cost model.

Description: This mathematical model will be used to determine the optimum role of Susitna hydro in contributing to the total power load of the Railbelt Area at various points in time (1985-2015), and hence the value of the energy to the system, and the possible need for and timing of additional units (PF-15). It will also aid in the selection of the thermal alternative(s) upon which benefits will be based (PM-11). The work will involve setting up the numerical model for the Railbelt Area, and then developing a program based on a number of scenarios for development of the market area. This will be followed by a series of studies to determine the optimum role of Susitna hydro at various points in time (5- or 10-year intervals, 1985-2015). In similar fashion it will be necessary to evaluate the various thermal alternatives in order to determine the least-cost alternative capable of doing the same job. Then, based on long-range power demand projections, evaluation will be accomplished of additional units for the selected plan at various points in time. Various sensitivity tests will be made as required, such as the impact of different rates of load growth, impact of load shape management, and impact of fuel cost escalation.

Seasonal Constraint: None

Cost: \$48,000

POWER MARKET STUDIES (PM)

THESE ACTIVITIES ADDRESS THE NEED FOR POWER AND THE SALEABILITY OF POWER IN THE REGION. FIRST, ELECTRICITY NEEDS ARE FORECAST BASED ON ESTIMATES OF FUTURE ECONOMIC ACTIVITY LEVELS, POPULATION GROWTH RATES, AND PER CAPITA USE. THE TIMING OF THE POWER DEMAND IS ASSESSED, AS WELL AS THE CAPABILITY OF EXISTING AND PLANNED GENERATION FACILITIES TO SATISFY THE ANTICIPATED DEMAND. THE COST OF SUPPLYING THE POWER BY MEANS OTHER THAN HYDROELECTRIC GENERATION ARE DETERMINED, AND FINALLY THE FINANCIAL FEASIBILITY OF THE SELECTED PLAN IS EXAMINED.

PRELIMINARY LOAD GROWTH ANALYSIS

1. Update power market analysis from feasibility report.

DETAILED LOAD GROWTH AND POWER MARKET ANALYSIS

2. Prepare socio-economic base study.
3. Forecast future development.
4. Prepare employment and population forecasts.
5. Describe existing and planned power generation through 1985.
6. Assess electric energy use trends.
7. Develop electricity demand forecasts by sector.
8. Develop load distribution data and duration curves.
9. Assess long term power outlook and system requirements.
10. Evaluate the retirement of existing and planned power plants.
11. Evaluate alternative power sources.
12. Assess project financial feasibility.

FERC LICENSE

13. Prepare material for draft FERC License.

POWER MARKET STUDIES

Activity Designation: PM-1

Activity: Update power market analysis from feasibility report.

Description: The load growth forecast and marketing assumptions on which the 1976 feasibility report was based will be reviewed. Assumptions of these earlier analyses will be checked against actual events and more recent information and studies. Adjustments will be made as the need is indicated. This activity only constitutes an initial analysis for the purpose of preliminary screening; it will be followed by an extensive power market study that will span the succeeding 2 years and which will be utilized in the detailed feasibility analysis.

Seasonal Constraint: None

Cost: \$6,000

POWER MARKET STUDIES

Activity Designation: PM-2

Activity: Prepare socio-economic base study.

Description: The purpose of this activity is to provide a base-line analysis of the region, which will serve as the basis of forecasting future economic development, employment and population growth, and electric energy demand. The study will define the limits of the region and describe its salient physical features and climatic conditions. Existing data and reports on natural resources of the region will be reviewed, and a fairly detailed discussion of significant natural resources within or directly affected by the region will be represented. Present land use patterns will be described and discussed. Historical and present demographic trends including population characteristics, labor force participation, and employment and unemployment will be evaluated. In addition, major industries within the region will be described, and historical and present economic development trends will be discussed.

Seasonal Constraint: None

Cost: \$75,000

POWER MARKET STUDIES

Activity Designation: PM-3

Activity: Forecast future development.

Description: The purpose of this activity will be to prepare a range of forecasts of future economic developments and to identify the most probable forecasts. The analysis will be based upon the findings of the baseline socio-economic studies of the region. Alternative assumptions and development scenarios will be formulated, and will be presented to support the range of forecasts that will be derived. Existing econometric models of the region and State will be reviewed, and if possible adapted for use in making the actual forecasts. Since the economic life of the project is 100 years, forecasts will be made for the short-term (present to 1985), intermediate (1986-2036), and long-term (through the end of the project life) conditions. Short- and intermediate-term forecasts will be relatively detailed, while long-term projections will be shown by decade. Those forecasts will serve as the basis for employment and population forecasts.

Seasonal Constraint: None

Cost: \$28,000

POWER MARKET STUDIES

Activity Designation: PM-4

Activity: Forecast employment and population growth.

Description: This activity will follow activity PM-3. The purpose of the employment forecast is to establish a basis for making the population forecast. Both forecasts are required input to the forecast of electrical energy demand. Forecasts will be made in detail comparable to that used for preparation of the economic development forecast, activity PM-3.

Seasonal Constraint: None

Cost: \$11,000

POWER MARKET STUDIES

Activity Designation: PM-5

Activity: Describe existing and planned power generation through 1985.

Description: To determine the optimum role for the Susitna project in meeting the area load, and hence the plant size, it is necessary to describe the system of projects with which Susitna hydro will operate. This will involve inventorying the existing and committed generating resources in the Railbelt Area, and projecting the most likely mix of additional resources which would be built to handle load growth through 1985. In addition, the existing resources will be reviewed to determine if some plants would likely be retired or placed on standby reserve. (Data will be required on plant operating characteristics and costs for input to production cost model PS-4). Most of the data will come from the local utilities and the Federal Power Commission.

Seasonal Constraint: None

Cost: \$3,000

POWER MARKET STUDIES

Activity Designation: PM-6

Activity: Assess electric energy use trends.

Description: The purpose of this activity will be to evaluate historical and current factors which influence the use of electricity within the region. Historical data on electric energy use will be reviewed and evaluated, and trends will be established. Factors which have historically had and/or which probably will have a significant impact on future electric energy use-trends will be considered. Such factors will include but not be limited to the outlook for energy conservation, efficiency in energy use, and the outlook for future energy-intensive industries.

Seasonal Constraint: None

Cost: \$15,000

POWER MARKET STUDIES

Activity Designation: PM-7

Activity: Develop electricity demand forecasts by sector.

Description: The purpose of this activity will be to bring together the results of activities PM-3, 4, and 6, and develop forecasts for regional electricity demand. These forecasts will be made in detail and scope which is comparable to those made during activities PM-3 and 4. In making the analysis, each sector (residential, commercial/industrial, municipal, and other) will be evaluated separately. An integral part of the study will be to assess the sensitivity of demand to relative price changes among energy sources and to evaluate the substitutability of alternative energy sources for energy-intensive industries.

Seasonal Constraint: None

Cost: \$50,000

POWER MARKET STUDIES

Activity Designation: PM-8

Activity: Develop load distribution data and duration curves.

Description: This activity will entail developing monthly load duration curves, developing annual distribution of load by month, and developing typical daily load shapes for selected times of the year and residual daily load shapes to be carried by hydro. This will involve obtaining historical load data from utilities, Alaska Power Administration and the Federal Energy Regulatory Commission, plotting it in the various formats described above, and making adjustments to reflect projected conditions at various future points in time (at 5- or 10-year intervals from 1985 to 2015). Some of this data has already been developed under prior studies. Development of residual hourly load shapes at various points in time will be done in concert with production cost model studies. (PS-4)

Seasonal Constraint: None

Cost: \$15,000

POWER MARKET STUDIES

Activity Designation: PM-9

Activity: Assess long term power outlook and system requirements.

Description: The purpose of this activity will be to bring together the results of long-term electrical energy demand forecasts (activity PM-7) and the preliminary results of power production cost studies (PS-4) in a computer analysis which will identify the probable future power generation system requirements in the region. The principal function of this study will be to predict the most economical additions to the system in the future and to identify the most economical operational position in the future power system for the proposed Susitna project. System capacity and peaking requirements will be analyzed and possible future modifications of the project will be identified. To determine the system energy benefits for Susitna hydro, the role of Susitna hydro in the future system, and the possible need and timing of additional units, it will be necessary to describe operation of the system at various future points in time (5- or 10-year intervals from 1985 to 2015). To do this it will be necessary to describe the mix of generating resources that will likely develop post-Susitna. Consistent with load growth projections, one or more likely systems of additional generating resources will have to be developed. In addition to the projected generating resource mix, data will have to be developed on operating characteristics and costs for PS-4. Retirements of existing generation will have to be considered. Development of the projected systems will be a reiterative process with PS-4.

Seasonal Constraint: None

Cost: \$25,000

POWER MARKET STUDIES

Activity Designation: PM-10

Activity: Evaluate the retirement of existing and planned power plants.

Description: This activity is a detailed assessment of specific Railbelt Area utilities with regard to necessary actions on their part to accommodate the recommended plan of development. The impact of the development on the local utilities will be identified and evaluated.

Seasonal Constraint: None

Cost: \$14,000

POWER MARKET STUDIES

Activity Designation: PM-11

Activity: Evaluate alternative power sources.

Description: The purpose of this activity will be to establish the cost of generating electricity in the region by thermal plants. This cost data will establish the baseline or alternative condition against which the economic feasibility of hydroelectric generation in the Susitna will be measured. The study will examine recent industry trends in energy and capacity costs. It will review and establish the availability of various types of fossil fuels for thermal generation; the cost trends of those fuels will be examined on a regional, State, and national basis. Future real cost increases for fuel will also be considered. Engineeringly feasible thermal power generation alternatives will be identified, and construction and operational costs will be examined in order to establish power and energy values for use in evaluating benefits to the Susitna project. Thermal power plant construction cost data for the region and for the western states region will be reviewed. Probable plant locations will be established and general site problems will be identified. Present and pending air and water pollution standards for thermal power plants will be reviewed; the design of all plants considered will include equipment and other features necessary to meet these standards. Pending legislation which will require reclamation of strip-mined land will also be considered, and in the case of coal fired plants, will be included as a cost of mining the coal. Also, transmission facilities required to deliver power to load centers will be considered. The detail and scope of these studies will be such that power and energy cost estimates are at approximately the same confidence level as the costs to be determined for the Susitna project.

Seasonal Constraint: None

Cost: \$75,000

POWER MARKET STUDIES

Activity Designation: PM-12

Activity: Assess project financial feasibility.

Description: Hydroelectric power development of the Susitna will result in hydropower production of approximately 4 times that provided in the region in 1975. The purpose of this study will be to evaluate the market for this power and to determine if the project is financially feasible. Projects are financially feasible if net revenues from power sales are sufficient to reimburse the investment. Based on load growth projections and power production and cost, the price necessary at load centers to recover investment costs with interest over a 50-year period will be determined. Saleability of power at that determined price will be investigated. Since price also influences demand for power, financial feasibility will be determined for various scenarios of load growth and interest rates. The taxing and bonding authorities of the State will be examined, and recommendations for any modifications required to implement the plan will be formulated; also, the State's present and probable future financial condition will be explored as it relates to the financing of the project by the State.

Seasonal Constraint: None

Cost: \$30,000

POWER MARKET STUDIES

Activity Designation: PM-13

Activity: Prepare material for draft FERC License.

Description: If the project is built as a State-owned resource, an FERC License will probably be required (unless the specific project legislation exempts it). A Preliminary Permit application is sometimes filed prior to the detailed planning study to indicate interest in the site and reserve rights for development. This may not be required for Susitna. In any case, a license will be required prior to construction. Most of the technical data for the Preliminary Permit application is already available, and most of the technical data for the license application will be prepared as a part of the main study effort. Work under this activity will consist mainly of consolidating the data, presenting it in the required format, and providing the legal and technical support necessary to carry the application through the various hearings and other proceedings. The Susitna project is enough of a special case that a legal review should be conducted early to determine with certainty whether FPC will have jurisdiction.

Seasonal Constraint: None

Cost: \$150,000, but will vary depending on the complexity of the hearings.

FOUNDATIONS AND MATERIALS (FM)

THESE ACTIVITIES INVOLVE FIELD WORK TO ASSESS GEOLOGIC AND SOIL CONDITIONS IN THE PROJECT AREA, AND DESIGN ACTIVITIES RELATED TO ALL ASPECTS OF FOUNDATION DESIGN. AN EXTENSIVE PROGRAM OF FIELD RECONNAISSANCE, DRILLING, MATERIALS TESTING, AND SEISMIC MONITORING IS OUTLINED. BASED ON THE DATA THUS COLLECTED, SITE CONDITIONS ARE EVALUATED, OPTIMAL DAM TYPES ARE DETERMINED, AND DAM COMPONENTS ARE DESIGNED. ADDITIONALLY, PARALLEL ACTIVITIES ARE CONDUCTED FOR THE ACCESS ROAD AND TRANSMISSION LINE.

REGIONAL GEOLOGY.

1. Conduct regional geology study, fault study, and seismicity evaluation.

SEISMIC MONITORING.

2. Install seismic monitoring system.
3. Operate seismic monitoring system and analyze data.

ACCESS ROAD.

4. Select route.
5. Conduct site geology and soils study.
6. Explore and test for access road.

TRANSMISSION LINE.

7. Select route.
8. Conduct site geology and soils study.
9. Explore and test.
10. Conduct foundation and materials design.

WATANA SITE.

11. Conduct site geology study.
12. Explore and test for site selection.
13. Explore for potential construction materials sources.
14. Evaluate site selection and dam.
15. Explore and test for final design.
16. Conduct geophysical investigations.
17. Perform concrete studies.
18. Perform feature design for embankment dam, cofferdams and diversions. (F&M aspects).
19. Perform feature design for spillway, powerhouse and outlet works (F&M aspects).

FOUNDATIONS AND MATERIALS (cont.)

DEVIL CANYON SITE.

20. Conduct site geology study.
21. Explore and test for site selection.
22. Evaluate for site selection and dam type.
23. Study rock mechanics and conduct in-situ testing.
24. Conduct concrete aggregate studies.

OTHER SITES.

25. Conduct field reconnaissance.
26. Explore and test for site selection and dam type.

FOUNDATIONS AND MATERIALS

Activity Designation: FM-1

Activity: Conduct regional geology study, fault study and seismicity evaluation.

Description: An extensive field reconnaissance of the Susitna area is necessary to provide information basic to site selection, dam design and the environmental impact statement supplement. Regionally, rock formations will be mapped, their boundaries determined, and their geologic structure noted. At the same time, potentially economic mineral deposits within the project area will be identified and mapped. Field data developed will be supplemented by geochemical analyses, satellite image interpretation, and possibly aeromagnetic interpretation and gravity studies.

The project is located within a tectonically active region. More information is necessary concerning the activity of known faults and the existence of other faults, if any, and their significance in relation to the project. This study will determine the location of faults throughout the region and determine those which have been active in the geologic past or which may be potentially active during the life of the project. It will develop motion parameters for both sites. Published and unpublished geologic and geophysical work done in the region will be collected and evaluated. Field and office studies then will be made, to relate the regional geology and tectonics to the known seismicity of the region. Special regional geophysical surveys will be used to help compile and understand the tectonic picture. At this stage, evaluation of seismicity will be based on existing seismic data plus evaluation of field data for evidence of recent faulting. No trenching across fault zones is anticipated at this stage, although such trenching may ultimately be required. Work will further include field mapping and checking the tectonic map developed in previous office studies. The field check will be sufficiently complete to include geomorphic evidence of recent fault activity. Geologic maps of the reservoir will be prepared to identify potential areas of land instability in the reservoirs and adjacent areas.

Seasonal Constraint: Field activity will be limited to the snow-free summer months.

Cost: \$470,000

FOUNDATIONS AND MATERIALS

Activity Designation: FM-2

Activity: Install seismic monitoring system.

Description: Purpose of this activity is to establish a seismic monitoring system in the region around the sites to determine level and location of present seismicity. This will provide data to more appropriately evaluate the seismic risk for engineering structures in the area and provide a base for future determination of reservoir-induced seismicity. The system will consist of eight vertical component stations with radio telemetry, including required repeaters, to a central recording facility; and a three-component strong motion station at each damsite. Each vertical station will have a recording tiltmeter installed, with data telemetered to the central recording site.

Seasonal Constraint: Station site location should be completed by the fall of the first year so that the system design equipment acquisition and radio frequency assignment can be completed and tested during the winter period. Installation and in-place testing of the system can then be completed the following summer.

Cost: \$310,000

FOUNDATIONS AND MATERIALS

Activity Designation: FM-3

Activity: Operate seismic monitoring system and analyse data.

Description: Data from the seismic monitoring system installed under activity FM-2 will be collected, analysed, and recorded throughout the construction period, as well as the operational life of the dam. To assist in the evaluation of this data in relation to reservoir-induced seismicity, it is important to establish a preconstruction record. This activity represents the effort and cost of data collection and analysis for the 3-1/2 year study period. It also includes the cost of summer visits to the instrument sites for maintenance.

Seasonal Constraint: Visits to the sites for maintenance should be accomplished between May and September of each year.

Cost: \$225,000

FOUNDATIONS AND MATERIALS

Activity Designation: FM-4

Activity: Select route for access road.

Description: A field reconnaissance of the alternative access routes selected for further study under early stages of activity D-29 will be conducted by Design Branch. During this reconnaissance a Foundation and Materials representative will accompany the Design Branch team. His function will be to examine foundation conditions enroute, evaluate potential material sources, and determine exploration requirements along the alignment and at proposed bridge sites. Photographs will be taken for office use, and preliminary samples will be obtained where possible.

Seasonal Constraint: Field reconnaissance of access routes must be made during the summer or fall when foundations can be evaluated in areas of high water tables and potential permafrost zones.

Cost: \$18,000

FOUNDATIONS AND MATERIALS

Activity Designation: FM-5

Activity: Conduct site geology and soils study - access road.

Description: The purpose of this activity is to map both geology and soils conditions along approximately 64 miles of potential access road. The work will consist of mapping in sufficient detail to determine rock and soil types, geologic boundaries, joint and bedding orientations, location of structural weaknesses in the rock such as folds, faults and shear zones, landslides, rock-slides, or any other geologic features which would affect design and construction of the access road. Similar investigations will be made for the several bridges required.

Seasonal Constraint: Field work limited to the period from June to September, inclusive.

Cost: \$370,000

FOUNDATIONS AND MATERIALS

Activity Designation: FM-6

Activity: Explore and test for access road.

Description: The purpose of this activity is to explore subsurface conditions along approximately 65 miles of access road. Terrain varies along the route, from flat wetlands to rugged rock slopes, and a variety of exploratory procedures will be required. In the marshy areas rotary drill holes will be used to establish depth and quality of the overburden materials and the existence and extent of permafrost. Standard penetration tests will be performed and samples will be taken to enable settlement under load to be evaluated. Core borings will be used to establish the quality of bedrock, and to establish foundation grades for bridges and rock cuts. Test pits will be utilized to explore borrow sources and to examine in-place foundation materials in critical areas. This activity also includes the effort and cost associated with the necessary rock and soil sampling and testing required.

Seasonal Constraint: Exploratory work will be limited to the period from April to October.

Cost: \$1,450,000

FOUNDATIONS AND MATERIALS

Activity Designation: FM-7

Activity: Select route - transmission line

Description: As a part of activity D-22, a field reconnaissance will be made to examine all transmission route alternatives resulting from studies of maps and aerial photos. A Foundations and Materials Branch representative will accompany the team to evaluate the foundation conditions, determine exploration requirements and assess slope stabilities along the routes. Preliminary samples will be taken, as well as photographs for office use.

Seasonal Constraint: Field reconnaissance of transmission routes must be made during the summer or fall season when high water tables and permafrost area can be evaluated.

Cost: \$35,000

FOUNDATIONS AND MATERIALS

Activity Designation: FM-8

Activity: Conduct site geology and soils study - transmission line.

Description: Following the selection of a transmission line route and the provision of controlled topography, this activity will be initiated concurrently with FM-9 and FM-10. Geotechnical engineers in the field will cover the route, mapping the geology, studying soil conditions, planning the exploratory program, recording the exploration results, and collecting the required samples for testing. After completion of this field work, which will be done during the summer months, office studies will analyze the data collected, and the foundation design of the towers will be determined for the varying conditions defined along the route.

Seasonal Constraint: Field work will be limited to the June to September period for much of the route.

Cost: \$185,000

FOUNDATIONS AND MATERIALS

Activity Designation: FM-9

Activity: Explore and test - transmission line.

Description: As a part of the field study along the transmission line, exploratory work of various kinds will be necessary to determine the various foundation conditions to be encountered and to provide the required data for appropriate design of the tower foundations. Exploration activities will entail drilling auger holes in the flatland areas where materials are principally glacial and alluvial deposits, and core drilling at critical tower sites in the mountainous areas where bedrock is exposed or close to the surface. Samples will be taken and material tests will be made to provide design information. There is no intent under this activity to completely explore the line with exploratory holes at each tower site but rather to provide information on typical reaches, sufficient for basic design and required cost estimates. It is recognized, however, that the proposed route will cover more than 350 miles of varying terrain and that access to some necessary exploration sites will be difficult and costly.

Seasonal Constraint: The field work season will be limited over much of the area to the months of June to September.

Cost: \$830,000

FOUNDATIONS AND MATERIALS

Activity Designation: FM-10

Activity: Conduct foundation and materials design - transmission line.

Description: This activity covers the concrete design effort for typical tower foundations for the various types of terrain to be crossed. As a part of activity FM-9, samples of aggregate sources will be collected. The cost of testing these samples for durability and suitability for use in foundation concrete is included in this activity.

Seasonal Constraints: None

Cost: \$80,000

FOUNDATIONS AND MATERIALS

Activity Designation: FM-11

Activity: Conduct site geology study - Watana

Description: A detailed geologic study of the Watana damsite area will be made, beginning in the first summer of the study period. Fractures, joint patterns and faults will be studied in detail, and this surface data will provide direction to the subsurface exploration program. As subsurface data is obtained, three-dimensional relationships will be developed, fractures and/or fault planes defined, and optimum dam locations determined. Subsequent to site selection the geology study will move into the area of specific features. Precise rock lines, depth of weathered rock, limits of foundation excavation and grouting requirements will be determined. Rock quality and structural attitudes of bedding planes will be assessed for underground features and tunnels, and requirements for rock bolting, support bents and concrete linings will be evaluated. The geology of the right abutment terrace will be closely examined to assess the deep deposits revealed by previous geophysical explorations. Permeabilities will be examined. The existence and extent of permafrost will be defined.

Seasonal Constraints: Field work, which amounts to approximately 60 percent of the effort for this activity, will be limited to the period from June to September inclusive.

Cost: Included in activities FM-12 through 16

FOUNDATIONS AND MATERIALS

Activity Designation: FM-12

Activity: Explore and test for site selection - Watana

Description: Conduct sufficient geologic mapping and subsurface exploration to permit evaluation of site, select location and type of dam, and locate appurtenant structures. It is assumed that the dam will be located near the present site between Deadman and Tsusena Creeks. Work will include preliminary mapping at the site, core drilling, air rotary drilling and bulldozer work to make trenches and drill site access roads. Air rotary drilling will be done on the right abutment terrace and will provide information on the suitability of the overburden material for borrow as well as foundation information. Air rotary drilling will also be performed in the valley alluvium upstream and downstream to check extent and suitability.

Seasonal Constraint: Field work limited to 4 summer months.

Cost: \$210,000

FOUNDATIONS AND MATERIALS

Activity Designation: FM-13

Activity: Borrow exploration and testing - Watana

Description: An earth/rockfill dam at the Watana site will require in excess of 50 million cubic yards of embankment materials. Under this activity all potential sources within reasonable haul distances will be located and explored for quality, using air rotary and churn drill holes for glacial and alluvial deposits and core borings for rock quarry sites. Samples will be taken from these borings as well as from test pits and bucket auger drill holes. These samples will be tested for quality and suitability as construction materials. Particular attention will be directed toward material shear strengths under high confining pressures and toward response to dynamic cyclic loading, which relates to material response to seismic shaking. During the winter months the test data will be collected and organized into a convenient format for use by soils design engineers. Certain test results, e.g. gradation analyses and permeability test results, will be combined to form envelopes indicative of available materials. Quantities of materials represented will be tabulated, and locations of explorations permanently recorded on borrow area maps. Completion of this activity will provide embankment designers with the quantity and quality parameters to be used in developing a detailed dam design.

Seasonal Constraints: Field work will be done in the June to September periods.

Cost: \$845,000

FOUNDATIONS AND MATERIALS

Activity Designation: FM-14

Activity: Evaluate site selection and dam - Watana

Description: The data obtained under activity FM-12 will provide sufficient detail relative to foundation structure and quality to permit selection of the specific damsite. The information will also be used with other relevant data to select the type of dam, i.e. earth fill or concrete gravity. The location of appurtenant structures will be determined, and the exploration program for detailed dam design will be developed. Sufficient design work is required at this time to make the necessary cost estimates required in this decision-making activity.

Seasonal Constraints: None

Cost: \$170,000

FOUNDATIONS AND MATERIALS

Activity Designation: FM-15

Activity: Explore and test for final design - Watana

Description: Under this activity, explorations at the Watana damsite will be continued to fully define the rock structure and to expose fracture patterns and any minor faulting in the foundation for the main dam as well as other individual dam features. Core borings will be utilized extensively for this phase of the activity. At the higher elevations, including the deep deposits behind the right abutment, rotary drill holes, Becker drill holes, bucket auger holes, backhoe pits, and dozer trenches will be used to expose in-place materials for examination and to obtain samples for testing. If necessary, vertical shafts will also be sunk at selected sites to study in-place permeabilities and soil temperatures. During the winter months data collected will be evaluated and organized for design use as described under activities FM-18 and 19.

Seasonal Constraint: Field work will be restricted to the months of June to September inclusive.

Cost: \$1,820,000

FOUNDATIONS AND MATERIALS

Activity Designation: FM-16

Activity: Conduct geophysical investigations - Watana

Description: This activity will study the presence, depth, and configuration of certain underground formations, using ground-level explosive charges which generate vibrations that strike formations of differing densities and are reflected back to ground-level sensors (a refraction seismic survey). The purpose is to obtain information about buried channels in glacial deposits on the left bank between the site and the margin of the outer valley.

Seasonal Constraint: June-August

Cost: \$93,000

FOUNDATIONS AND MATERIALS

Activity Designation: FM-17

Activity: Perform concrete studies - Watana

Description: Possible sources of concrete aggregate will be located. Each source will be sampled and tested to determine the suitability of the source. The most economical source of concrete aggregate for each structure will be determined, to provide for a concrete gravity dam alternative and appurtenant structures for both an earth rock-fill dam and a concrete dam. Preliminary mix designs will be completed to provide information on cement requirements. Thermal studies will be undertaken to determine cooling requirements for mass concrete. Sources of pozzolan will be investigated. Pozzolan is finely-ground material which may be used as a replacement for a portion of the cement in mass concrete, thereby reducing costs.

Seasonal Constraint: Field reconnaissance and sampling will be accomplished during the summer construction season.

Cost: \$265,000

FOUNDATIONS AND MATERIALS

Activity Designation: FM-18

Activity: Perform feature design for embankment dam, cofferdams, and diversion - Watana

Description: Under this activity, embankments will be designed to a degree consistent with the preparation of required cost estimates. Internal zoning and shape of the main dam embankment will be determined. The zoning will be somewhat dependent upon the quality of the foundation and abutments, the dam height selected and the quality and quantity of available construction materials, particularly the availability of fine-grained core material. Quality of materials will be a critical factor, and such characteristics as shear strengths under high confining pressures, permeabilities under high head, liquefaction potential, and settlement characteristics will be closely examined. Foundation permeabilities and fracture patterns will be evaluated, and the results of seismic and stability analyses reviewed. Consolidation and settlement studies will be undertaken, including a test fill if necessary to preclude internal fracturing in critical areas. Severe weather and icing conditions will be studied, and the data collected will be considered in design. A Board of Consultants of 3 to 5 members will be appointed to review the overall project scope, the geology, site selection, seismicity, and proposed specific design features. Board members selected will be geotechnical experts in the fields of geology, seismology, soil mechanics and structures. From time to time engineers with expertise in other disciplines may be included. Meetings will be held annually, and approximately three such meetings will be required during the design stage. This activity includes the cost of a complete seismicity study including determination of the design earthquake and a dynamic soils response analysis for the embankment.

Seasonal Constraint: None

Cost: \$910,000

FOUNDATIONS AND MATERIALS

Activity Designation: FM-19

Activity: Perform feature design for spillway, powerhouse, and outlet works - Watana

Description: Design of the underground features of the dam including diversion tunnels, draft tubes, and penstock tubes will require careful analysis of core borings drilled under activity FM-15. As rock cores are examined, rock quality and structure will be determined. Down-hole television cameras will be used in critical areas to determine attitude of structural features and the degree of support required for each facility. Concrete linings, steel berths, rock bolt systems, and mesh reinforced shotcrete will be considered and designed as necessary. Rock permeabilities will be determined and grout curtains designed.

Seasonal Constraint: None

Cost: \$410,000

FOUNDATIONS AND MATERIALS

Activity Designation: FM-20

Activity: Conduct site geology study - Devil Canyon.

Description: Geologic mapping of Devil Canyon damsite was done in 1957 by Mr. Kachadoorian of the U.S. Geological Survey. This work, supplemented by the exploratory data obtained by the Bureau of Reclamation in 1957-58, is considered sufficient for the present study with the exception of the right abutment where no exploratory drilling has been done and of the river channel itself where there is a need to define the rock line in the river and to insure that no serious faulting exists in this critical area. As these necessary explorations proceed, three-dimensional relationships of shear zones and faults in the right abutment will be established, and their relationship to the theoretical shearing plane of the arch thrust in the abutment will be examined. If necessary an adit, or access tunnel, below the river will be used to examine the foundation for structure, rock quality and permeability.

Seasonal Constraint: Field work will be restricted to the June through September season.

Cost: \$35,000

FOUNDATIONS AND MATERIALS

Activity Designation: FM-21

Activity: Explore and test for site selection - Devil Canyon

Description: As outlined under activity FM-20, a need exists for core borings in the right abutment at Devil Canyon damsite to ensure structural adequacy of the supporting bedrock. An adit is also desirable beneath the channel invert (floor) to eliminate the possibility of faulting in this critical location.

Seasonal Constraint: Core drilling must be done during the frost-free season of June to September.

Cost: \$650,000

FOUNDATIONS AND MATERIALS

Activity Designation: FM-22

Activity: Evaluate for site selection and type of dam -
Devil Canyon

Description: The purpose of this activity is to evaluate the foundation conditions and adjust the position and/or configuration of the various structures to obtain optimum benefit with existing conditions. Work involved would include additional exploration and testing.

Cost: Included in activity FM-20 and 21.

FOUNDATIONS AND MATERIALS

Activity Designation: FM-23

Activity: Study rock and conduct in-situ testing - Devil Canyon.

Description: The purpose of this activity would be to evaluate the in-situ rock condition in the abutments of the main concrete structures and in the underground powerhouse structure. The testing required would include plate jacking tests in the exploratory adit. Other in-situ tests in boreholes in the damsite area may be deemed necessary after evaluation of preliminary core drilling.

Seasonal Constraint: Field work would be done during April - October period.

Cost: \$280,000

FOUNDATIONS AND MATERIALS

Activity Designation: FM-24

Activity: Investigate concrete aggregate - Devil Canyon.

Description: Exploration of the Cheechako Creek aggregate source will be undertaken to determine the quality of material available. A large composite bulk sample will be retrieved and forwarded to Troutdale, Oregon, for aggregate suitability tests and preliminary mix designs. The remainder of this aggregate will be retained for detailed design studies. In the unlikely event that the Cheekchako Creek source is inadequate in quantity or quality, additional sources will be investigated.

Seasonal Constraint: All field activities will be accomplished during the summer construction season.

Cost: \$85,000

FOUNDATIONS AND MATERIALS

Activity Designation: FM-25

Activity: Field reconnaissance - other sites.

Description: Field reconnaissance will be required to establish foundation suitability and material availability for any damsites considered under preliminary screening, with the exception of Devil Canyon, Watana, Vee and Denali where the required information is already at hand. The field studies will examine rock structure and quality, and the existence of any limiting factors as to heights and types of structures suitable to the site. The need for subsurface data will be considered and necessary explorations planned and located. Material sources will be obtained and preliminary samples obtained.

Seasonal Constraint: Field activity will be restricted to the June through September season.

Cost: \$8,000

FOUNDATIONS AND MATERIALS

Activity Designation: FM-26

Activity: Explore and test for site selection and type of dam - other damsites.

Description: Work performed under this activity will be the minimum necessary to provide foundation data demonstrating foundation suitability for purpose of preliminary screening. This information is already at hand for Devil Canyon, Watana, Vee and Denali. For other sites considered, explorations prior to screening will be limited to hand-dug test pits for embankment material and concrete aggregate sources during site reconnaissance. Samples of foundation rock will be obtained from the canyon walls. Testing will be limited to those tests necessary to confirm rock quality and to assure suitability of embankment materials and concrete aggregates.

Seasonal Constraint: Field work will be limited to the June through September seasons.

Cost: \$6,000

DESIGN (D)

THIS CATEGORY COMPRISES THE ACTIVITIES ASSOCIATED WITH THE PROJECT'S STRUCTURAL COMPONENTS. INITIAL ACTIVITIES PROVIDE THE CONCEPTUAL DESIGNS FOR PRELIMINARY SCREENING OF COMPETING ALTERNATIVES. MORE DETAILED DESIGN WORK IS THEN ACCOMPLISHED ON THE SELECTED PLAN FOR PURPOSES OF DETAILED FEASIBILITY ANALYSIS AND OF DETAILED DESIGN FOR THE PLAN'S INITIAL PHASE OF DEVELOPMENT.

PRELIMINARY SCREENING.

1. Make preliminary selection of potential damsites.
2. Conduct site inspection.
3. Determine types and heights of dams.
4. Determine powerhouse size and location.
5. Develop diversion scheme.
6. Develop water passages.
7. Estimate project costs.

DETAILED FEASIBILITY STUDIES (WATANA AND DEVIL CANYON).

8. Study dam type and height.
9. Study spillways.
10. Study outlet works.
11. Study water diversion and care.
12. Study powerhouse size, type and location.
13. Study power intake and conduit.
14. Estimate selected project cost.

DETAILED DAM ANALYSIS (WATANA SITE).

15. Study dam type and height.
16. Study spillways.
17. Study outlet works.
18. Study water diversion and care.
19. Study powerhouse size, type and location.
20. Study power intake and conduit.
21. Estimate selected project cost.

TRANSMISSION FACILITIES.

22. Conduct route studies.
23. Conduct transmission system study.
24. Conduct tower, hardware, and conductor studies.
25. Conduct foundation type studies.
26. Conduct substation studies.
27. Conduct switchyard studies.
28. Estimate transmission facilities cost.

DESIGN (cont.)

ACCESS ROADS.

29. Conduct route studies.
30. Conduct bridge studies.
31. Estimate selected route costs.

RESERVOIR CLEARING.

32. Conduct field survey.
33. Conduct marketability and disposal study.
34. Estimate clearing costs.

CONSTRUCTION AND PERMANENT CAMP FACILITIES.

35. Determine requirements.
36. Study locations and layouts.
37. Estimate camp costs.

OTHER HYDRAULIC CONSIDERATIONS.

38. Study upstream and downstream effects.
39. Determine model studies to consider.

DESIGN

Activity Designation: D-1

Activity: Make preliminary selection of potential damsites.

Description: A map and aerial photo study will be made of potential damsites within the Upper Susitna Basin. For those damsites which appear to be feasible, an analysis of pool elevation will be made to determine optimum pool elevation for the particular site. A determination of dam type best suited for the site will be made in conjunction with personnel from the Foundations and Materials Branch. This activity would be a part of the reformulation studies required to verify or supplement the existing feasibility study. The analysis will cover the various dam locations, layouts, and pool heights investigated with a recommendation for those sites to be investigated during the preliminary screening phase.

Seasonal Constraint: None

Cost: \$12,000

DESIGN

Activity Designation: D-2

Activity: Conduct site inspection.

Description: Some of the sites in activity D-1 will require on-site inspection to verify or expand information from the map and aerial photo studies. Inspections will provide field data required for recommendation or rejection of a site, and will be made in conjunction with personnel from the soils and materials branch to determine whether or not a site appears to be suitable for construction.

Seasonal Constraint: Would be made during summer.

Cost: \$28,000

DESIGN

Activity Designation: D-3

Activity: Determine types and heights of dams.

Description: The feasible sites will be further explored during this activity to develop a recommended type of dam and a most economical height for each site. Different combinations of dams will be considered at this stage. At this point a determination will be made whether the site is most suitable for a concrete gravity dam, gravity arch, arch, earthfill, rockfill, etc. During this period there may be a requirement for a site visit to some sites. The selection of dam type and height will be a multi-discipline determination with input from various sections and branches. The selected type will then be further studied to determine the shape, layout, preliminary stability, etc., in sufficient detail to allow a cost estimate to be made as a basis for recommendation of the selected plan to be developed in detailed feasibility studies.

Seasonal Constraint: Would require some field investigation in summer.

Cost: \$34,000

DESIGN

Activity Designation: D-4

Activity: Determine powerhouse size and location.

Description: This activity will size and locate powerhouses at the preliminary damsites to be investigated during the screening process. Studies will be in sufficient detail to allow a cost estimate to be prepared which will in turn support a recommendation for the selected project to be investigated during detailed feasibility studies.

Seasonal Constraint: None

Cost: \$25,000

DESIGN

Activity Designation: D-5

Activity: Develop diversion scheme.

Description: A scheme for river diversion during construction will be developed for each damsite under consideration. This activity will study each site to determine which type of scheme would be most suitable for the particular site. The following types of diversions would be considered: tunneling, diversion through a low section of dam, diverting the river via a coffer-dam and building one side of the dam. Preliminary detail will be developed to allow an estimate for recommending a selected plan to be further developed during detailed feasibility studies.

Seasonal Constraint: None

Cost: \$25,000

DESIGN

Activity Designation: D-6

Activity: Develop water passages.

Description: This will be a study to determine the type, location, number and size of spillways, sluices, outlet works and water quality conduits. These items must be sized and located to minimize adverse impact on water quality and erosion downstream of the dams. This study will also address the type of gate required for each water passage. Preliminary detail will be prepared for a cost estimate to serve as a basis of recommending a selected plan for further study during detailed feasibility studies.

Seasonal Constraint: None

Cost: \$40,000

DESIGN

Activity Designation: D-7

Activity: Estimate project costs.

Description: This activity will be a construction estimate (including contingencies) of all the features of each dam considered under the preliminary dam selection. The estimate must be in sufficient detail to allow a clear-cut decision to be made on what system of dams to recommend for further study in detailed feasibility studies.

Seasonal Constraint: None

Cost: \$17,000

DESIGN

Activity Designation: D-8

Activity: Study dam type and height.

Description: This activity will consist of planning studies and preliminary design of dams at Devil Canyon and Watana as the assumed dams that will be studied in detail for feasibility. Devil Canyon will be investigated as a concrete arch. A brief investigation of a concrete gravity section will be made at Watana to reconfirm the selection of an embankment section. These studies will be of sufficient scope to allow completion of a detailed feasibility analysis.

Seasonal Constraint: None

Cost: \$90,000

DESIGN

Activity Designation: D-9

Activity: Study spillways.

Description: This activity will be a hydraulic and structural study of alternative spillway designs for Devil Canyon and Watana dams. Spillway geometry, gates, piers, walls, energy dissipater, etc., will be sized for estimating and selection of a recommended scheme. The recommended schemes will be further studied to develop detailed hydraulic design and to allow preparation of preliminary design drawings, including layout, plans, elevations and sections, and monolith stability. (See activity D-16.) Preliminary design of bridges, piers, gates, stoplogs, and hoists will be done. Design will be sufficient for completion of a detailed feasibility analysis.

Seasonal Constraint: None

Cost: \$68,000

DESIGN

Activity Designation: D-10

Activity: Study outlet works.

Description: This activity will be a hydraulic and structural study of alternative outlet works designs for Devil Canyon and Watana dams. Intakes, gates, bulkheads, sluices, tunnels, air vent, energy dissipater, etc., will be sized and estimated to arrive at a selected scheme. Preliminary design drawings will be prepared to include layout, plans, elevations, and sections. Tower section stability will be checked. Preliminary design of tower, gates, bulkheads, trashracks and outlet structure will be prepared. This design will be adequate for a detailed feasibility study. (See activity D-17 for detailed studies for Watana.)

Seasonal Constraint: None

Cost: \$66,000

DESIGN

Activity Designation: D-11

Activity: Study water diversion and care.

Description: This activity will make hydraulic and structural studies of river diversions using tunnels, cofferdams, tailrace tunnels, etc. It will include preliminary design of selected scheme including closure methods, structure size, channels, tunnel, etc. The design will be adequate for a detailed feasibility study. (See activity D-18 for detailed studies for Watana.)

Seasonal Constraint: None

Cost: \$62,000

DESIGN

Activity Designation: D-12

Activity: Study powerhouse size, type, and location.

Description: This activity will look at Devil Canyon and Watana dams with reference to powerhouse layout and arrangement, powerhouse type, turbine studies and tailrace studies. Tailrace studies will determine size, setting, type, lining, tunnel length, surge tank size and location, closure structures and bulkhead handling. Turbine studies will look at type selection, size, setting and number of units. Powerhouse type selection will involve comparative studies of above- and below-ground locations. A preliminary cost estimate will be prepared. The design studies will be of sufficient detail for a detailed feasibility study.

Seasonal Constraint: None

Cost: \$100,000

DESIGN

Activity Designation: D-13

Activity: Study power intake and conduit.

Description: This activity will investigate the power intake and conduits for Devil Canyon and Watana dams. The study will include the penstocks from power intake structure to the gates or valves, upstream of the powerhouse, the intake structure and bridge, selective withdrawal system, power bellmouths and emergency gates. This study will arrive at a recommended design, and be of sufficient detail to allow a preliminary cost estimate for a detailed feasibility study.

Seasonal Constraint: None

Cost: \$200,000

DESIGN

Activity Designation: D-14

Activity: Estimate selected project cost.

Description: This activity will provide a preliminary cost estimate of the selected plan for Devil Canyon and Watana dams based on preliminary designs and studies outlined in previous activities (D-8 thru D-13).

Seasonal Constraint: None

Cost: \$16,000

DESIGN

Activity Designation: D-15

Activity: Study dam type and height (Watana)

Description: This study assumes that Watana will be an embankment dam. A brief investigation will be made of a concrete gravity dam to reconfirm that an embankment dam is the best alternative at this site. The remainder of design efforts will be in conjunction with F&M design of the embankment dam. Should the concrete dam study show it to be the best alternative, then the design funds for the embankment dam would be transferred to study the concrete one.

Seasonal Constraint: None

Cost: \$50,000

DESIGN

Activity Designation: D-16

Activity: Study spillway. (Watana)

Description: This activity will provide a detailed hydraulic and structural design study of alternative spillway designs. Spillway geometry, gates, piers, walls, energy dissipater, etc., will be selected and sized for cost estimating purposes. The scheme will be further studied to develop detailed hydraulic design and to allow preparation of preliminary design drawings, including layout, plans, elevations and sections, and monolith stability. Preliminary design of bridges, piers, gates, stoplogs, and hoists, etc., will be done with a detailed cost estimate. Model studies will be required to verify design.

Seasonal Constraint: None

Cost: \$406,000

DESIGN

Activity Designation: D-17

Activity: Study outlet works. (Watana)

Description: This activity will provide a hydraulic and structural detailed design of alternative outlet works. Intakes, gates, bulkheads, sluices, tunnels, air vent, energy dissipater, etc., will be selected and sized. The scheme will be developed to provide a refined hydraulic and structural design. Preliminary design drawings will be prepared to include layout, plans, elevations, and sections. Tower section stability will be checked. Preliminary design of tower, gates, bulkheads, trashracks and outlet structure will be prepared to provide a detailed cost estimate. The selected hydraulic design will be modeled to verify the design.

Seasonal Constraint: None

Cost: \$498,000

DESIGN

Activity Designation: D-18

Activity: Study water diversion and care. (Watana)

Description: This activity will make hydraulic and structural detailed-design studies of river diversions using tunnels, cofferdams, tailrace tunnels, etc. It will include hydraulic design of the selected scheme including closure methods, structure size, channels, tunnel, etc. Sufficient detail will be developed to allow a detailed cost estimate to be made. A hydraulic model study will be made to verify hydraulic design.

Seasonal Constraint: None

Cost: \$393,000

DESIGN

Activity Designation: D-19

Activity: Study powerhouse size, type, and location. (Watana)

Description: Detailed studies will look at powerhouse layout and arrangement, powerhouse type, turbine studies and tailrace studies. Tailrace studies will determine size, setting, type, lining, tunnel length, surge tank size and location, closure structures and bulk-head handling. Turbine studies will look at type selection, size, setting and number of units. Powerhouse type selection will involve comparative studies of aboveground and underground locations. A detailed cost estimate will be prepared.

Seasonal Constraint: None

Cost: \$200,000

DESIGN

Activity Designation: D-20

Activity: Study power intake and conduit. (Watana)

Description: This activity will extend findings of hydropower study for designing conduits and penstocks. It will include the power conduits and penstocks from power intake structure to the gates or valves, upstream of the powerhouse, the intake structure and bridge, selective withdrawal system, power bellmouths, and emergency gates. This study will be quite extensive because of the high dam under consideration. The study will arrive at a design of sufficient scope for a detailed cost estimate.

Seasonal Constraint: None

Cost: \$720,000

DESIGN

Activity Designation: D-21

Activity: Estimate selected project cost. (Watana)

Description: This activity will provide a detailed cost estimate of the selected plan for Watana Dam based on detailed designs and studies outlined in activities D-15 through D-20.

Seasonal Constraint: None

Cost: \$18,000

DESIGN

Activity Designation: D-22

Activity: Conduct route surveys.

Description: The transmission corridors are somewhat set by existing facilities and terrain features. Map and aerial photo studies will be made to narrow down the routes. Then a field reconnaissance by civil, structural, materials, and electrical engineers will be made to define problem areas. Clearing studies will be required, as well as a study of possible markets for timber. The selected route would have a road parallel to, and as close as possible to the line to minimize construction costs. Close attention will be given to possible areas of high wind, rime ice buildup, and drifting or creeping snow. Some areas of the corridor may require fitting the lines into a narrow canyon already having a river, highway and railroad. Route selection will have to include consideration of tower location, conductor slope, dangerous trees, foundation locations and maintenance access.

Seasonal Constraint: Field work would be completed over 2 summers.

Cost: \$250,000

DESIGN

Activity Designation: D-23

Activity: Conduct transmission system study.

Description: This study will be to reconfirm the type of transmission system running from the dams to both Fairbanks and Anchorage. The study will consider the location of project headquarters, remote operation, dispatch centers, operation and maintenance, line voltage, number of lines, and circuitry. A direct current system would be evaluated at some point in the study.

Seasonal Constraint: None

Cost: \$36,000

DESIGN

Activity Designation: D-24

Activity: Conduct tower, hardware, and conductor studies.

Description: Present planning calls for lines of different capacity to Fairbanks and Anchorage. When the route is fairly well located, a study of towers, hardware, and conductor can be made. Depending on route location, there could be a change in tower type, as the line will traverse different types of terrain. Conductor type is dependent upon tower spacing and loads. At the beginning of this study, the loads would be the first item to be determined. Such things as design wind, snow, icing, span factor, etc., would be determined. Towers to be considered would be self-support or guyed and probably steel or aluminum. Coloration of the metal will be considered to develop a scheme which is aesthetically acceptable. The color treatment might vary depending on the area being traversed. Hardware would be compatible with the towers and conductor.

Seasonal Constraint: Some site visits in summer.

Cost: \$55,000