# SUSITNA HYDROELECTRIC PROJECT

FEDERAL ENERGY REGULATORY COMMISSION
PROJECT No. 7114

# STAGED CONSTRUCTION PRE-FILING CONSULTATION PACKAGE

## MAIN TEXT

MAY 1985

ALASKA POWER AUTHORITY

# SUSITNA HYDROELECTRIC PROJECT

## STAGED CONSTRUCTION

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**PRE-FILING CONSULTATION PACKAGE**

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APPENDIX A PHYSICAL HABITAT SIMULATION EXHIBITS

# SECTION I

## I. INTRODUCTION TO THE THREE STAGE CONSTRUCTION PLAN

The Alaska Power Authority's (Power Authority) Application for License before the Federal Energy Regulatory Commission (FERC), submitted in February 1983, proposed that the construction of the Susitna River Hydroelectric Project be completed in two stages. The first stage called for construction of a facility at the Watana site with the dam built to an elevation of 2205 feet (see Figure II.1), followed by construction of a second facility at the Devil Canyon site, with the dam built to an elevation of 1463 feet (see Figure II.2).

At a meeting of the Power Authority Board on May 3, 1985, the Board confirmed its conclusion that this two-dam configuration optimizes the power development of the Susitna River, and on that basis the Power Authority is proceeding with its efforts to pursue FERC license authority necessary to permit construction of the Susitna Project. However, the Power Authority has also concluded that a number of benefits will be derived from a modification of the plan for construction of the project to provide for the completion of construction in three stages, rather than the two proposed in the February 1983 license application. Accordingly, the Power Authority has determined to amend its License Application to seek FERC approval of a construction plan that provides for construction in three stages: first, construction and operation of a facility at the Watana site with a dam elevation of 2025 feet; second, completion and operation of the Devil Canyon facility at the originally proposed dam elevation of 1463 feet; and third, further elevation of the dam at the Watana facility to the 2205 foot level proposed in the original License Application.

Although the three stage construction plan will not alter the character of the fully completed project, staging construction in three steps will accomplish certain desirable changes over the course of proiect development. Most importantly three stage construction would reduce the costs associated with construction time and materials in the initial stage of the project.

The development of Watana to its full height would result in concentration of expenditures in the early years of the project. Completion of Watana I at a 2025 foot crest elevation would substantially reduce the initial materials requirement and construction time. The result would be both a reduction in the required state contribution, and improved opportunity for private financing. Moreover, stretching out the pace of development of project energy and capacity would permit a better matching of load growth and capacity available, thereby ensuring greater flexibility in responding to future rates of system growth.

# SECTION II

# II. THREE STAGE PROJECT DESCRIPTION

## A. PROJECT LOCATION

As outlined in the FERC License Application maps and land descriptions, the Susitna Project will be located on the Susitna River approximately 120 miles northeast of Anchorage. The Watana Dam will be located at river mile 184 and the Devil Canyon Dam located at river mile 152. For a complete description of the project boundaries and locations of specific features, see Exhibit G of the February 1983 Application for License.

## B. WATANA - STAGE I

The Watana Initial Dam would be built to El. 2025 with a maximum normal reservoir elevation of 2000 (see Figure II.5). The internal zoning of the earthfill dam would include an inclined upstream impervious core. The inclination of the core would reduce the amount of shell material required for stability of the Stage III dam that would be submerged by the Stage I pool, and therefore placed during Stage I construction (see Figure II.6). When the dam is being raised, all the additional fill could then be placed in the dry during the seasonal drawdown of the reservoir. The raising of the Watana Dam involves no adverse effects on the safety of either the Stage I or Stage III dam, and no unusual construction operation is required during raising. An additional five feet of freeboard is added in Stage I to facilitate flood control with the small reservoir storage volume.

The spillway and approach channel excavation would be deepened by approximately 185 feet below that shown in the two stage project in order to accommodate the reservoir during Stage I (see Figure II.7). The rock excavated from these areas would be used in the construction of the dam and would minimize or eliminate the need for opening a quarry site during Stage I. The deeper excavation would be designed with suitable rock reinforcement and berms. The spillway in either concept would pass the potential maximum flood.

For Stage I, there would be one outlet facility structure and two power intake structures (see Figure II.9). The outlet facility, in conjunction with the four powerhouse units in Stage I, would be designed to discharge a 50-year flood before flow would be discharged over the spillway. The same criterion applies to the current two stage project.

The power house in Stage I would have four generating units. With the lower head available in Stage I, each unit would generate 130 MW for a total of 520 MW.

The construction schedule for Stage I has been shortened by one year over that which was planned for in the two stage project. The shortening of the schedule is a result of a decrease in the quantities of the fill material necessary for the Stage I construction.

## C. DEVIL CANYON - STAGE II

The Devil Canyon facility would be identical for either a two stage or three stage project.

## D. WATANA - STAGE III

The Watana Initial Dam would be raised to El. 2205 with a maximum normal reservoir elevation of 2185 (see Figure II.5). During seasonal drawdown when the Stage I reservoir elevation is below elevation 1925 (the elevation of the upstream berm) rockfill would be in the dry on the upstream side of the dam.

The concrete spillway ogee crest would be raised to El. 2135 and the spillway gates relocated to accommodate the higher ogee elevation (see Figure II.8).

The outlet facility structure and the two power intakes would be raised to El. 2201. A third power intake would be built in Stage III with an inlet at El. 2012 (see Figure II.10).

Two additional units would be added to the powerhouse bringing the total number of units to six. After completion of Stage III, the capacity of the powerhouse would increase from 520 MW to 1020 MW because of the increase in head on the four Stage I units and the addition of two more units at 170 MW each. This would be the same capacity as is currently planned for in the two stage project.

# LIST OF FIGURES

# WATANA DAM GENERAL PLAN
## 1983 LICENSE APPLICATION PROJECT

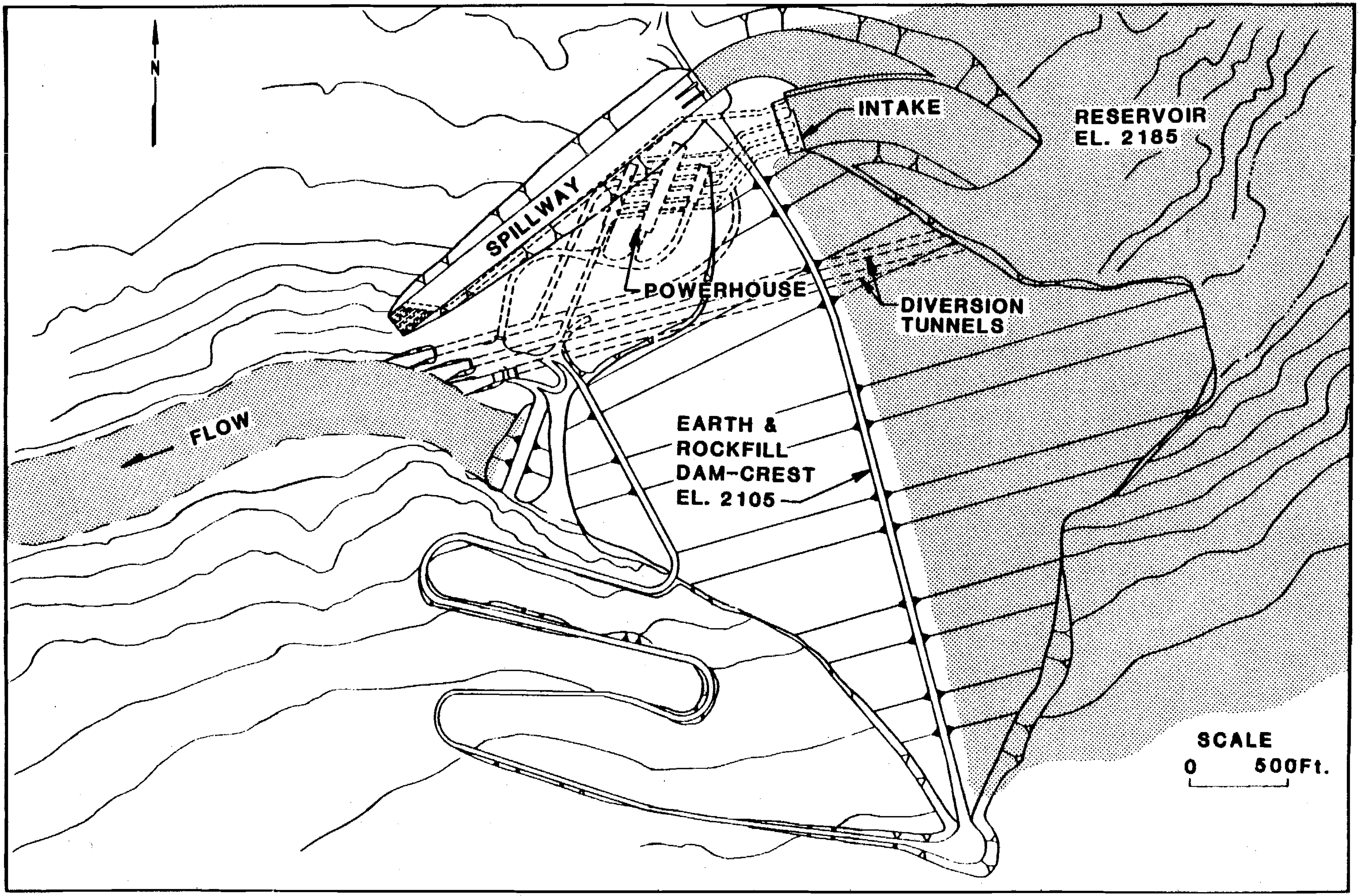



FIGURE II.1

# DEVIL CANYON DAM GENERAL PLAN

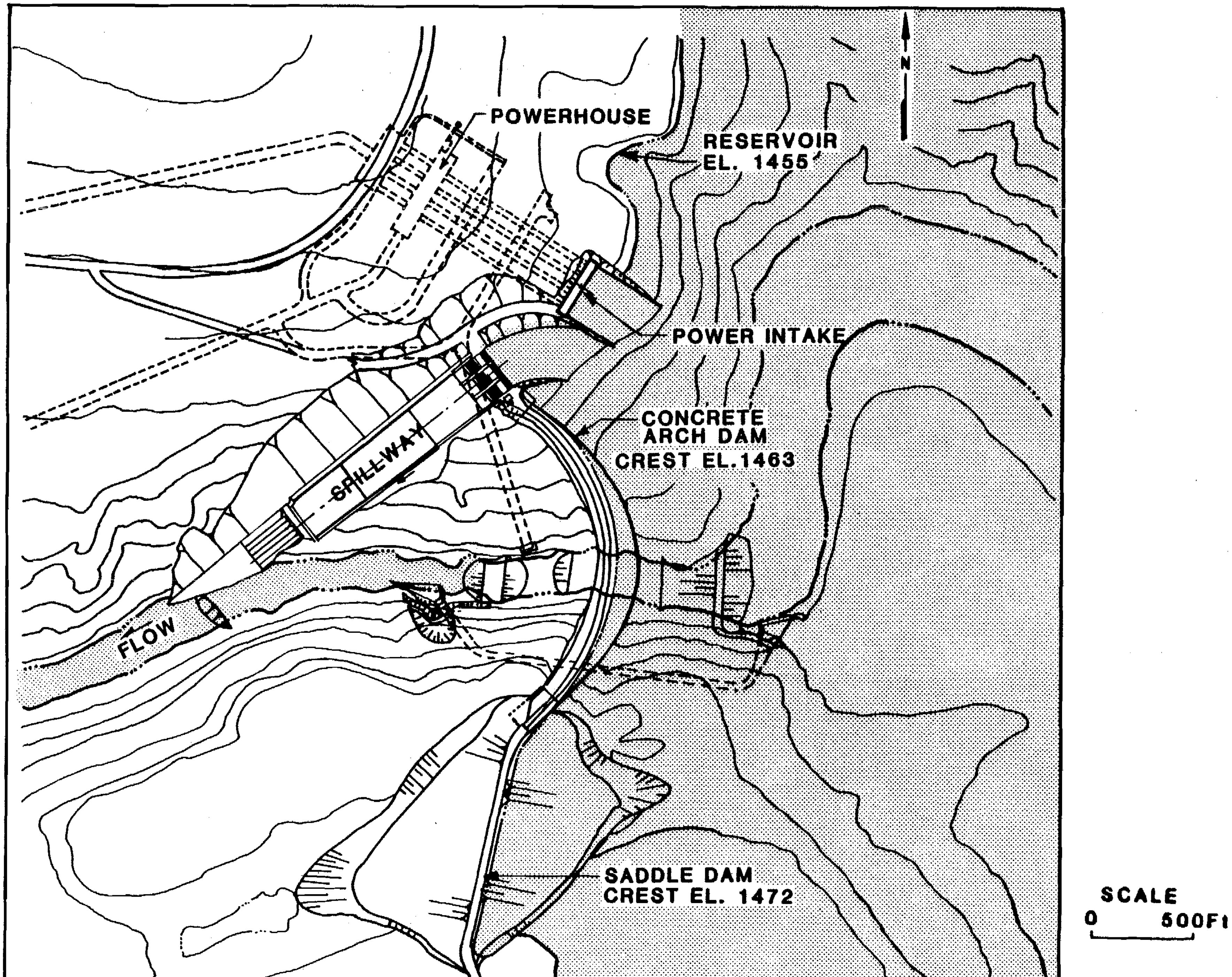



FIGURE II.2

# WATANA DAM GENERAL PLAN
## STAGED DAM CONSTRUCTION

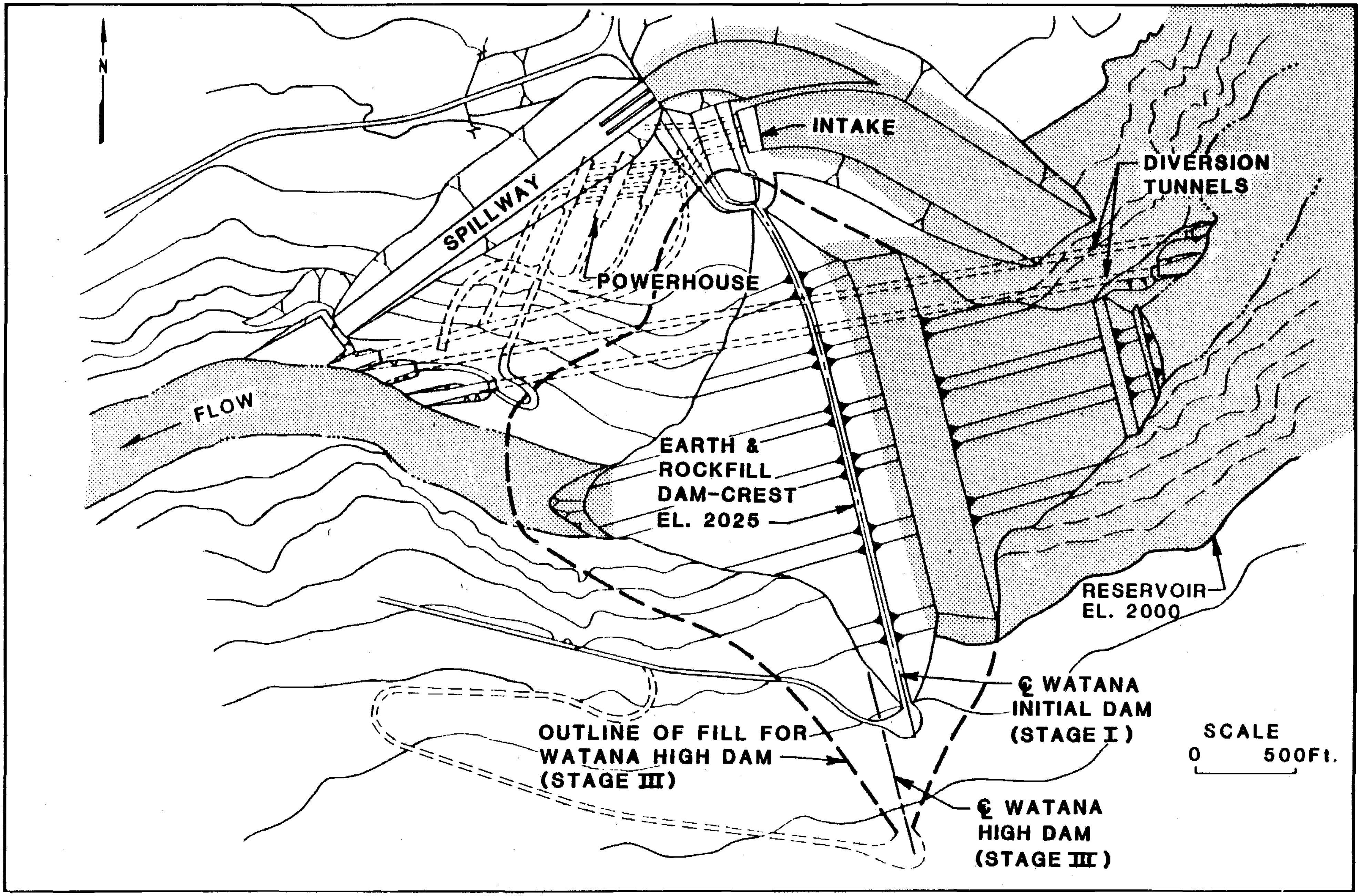



FIGURE II.3

# SUSITNA HYDROELECTRIC PROJECT
## TRANSMISSION LINES

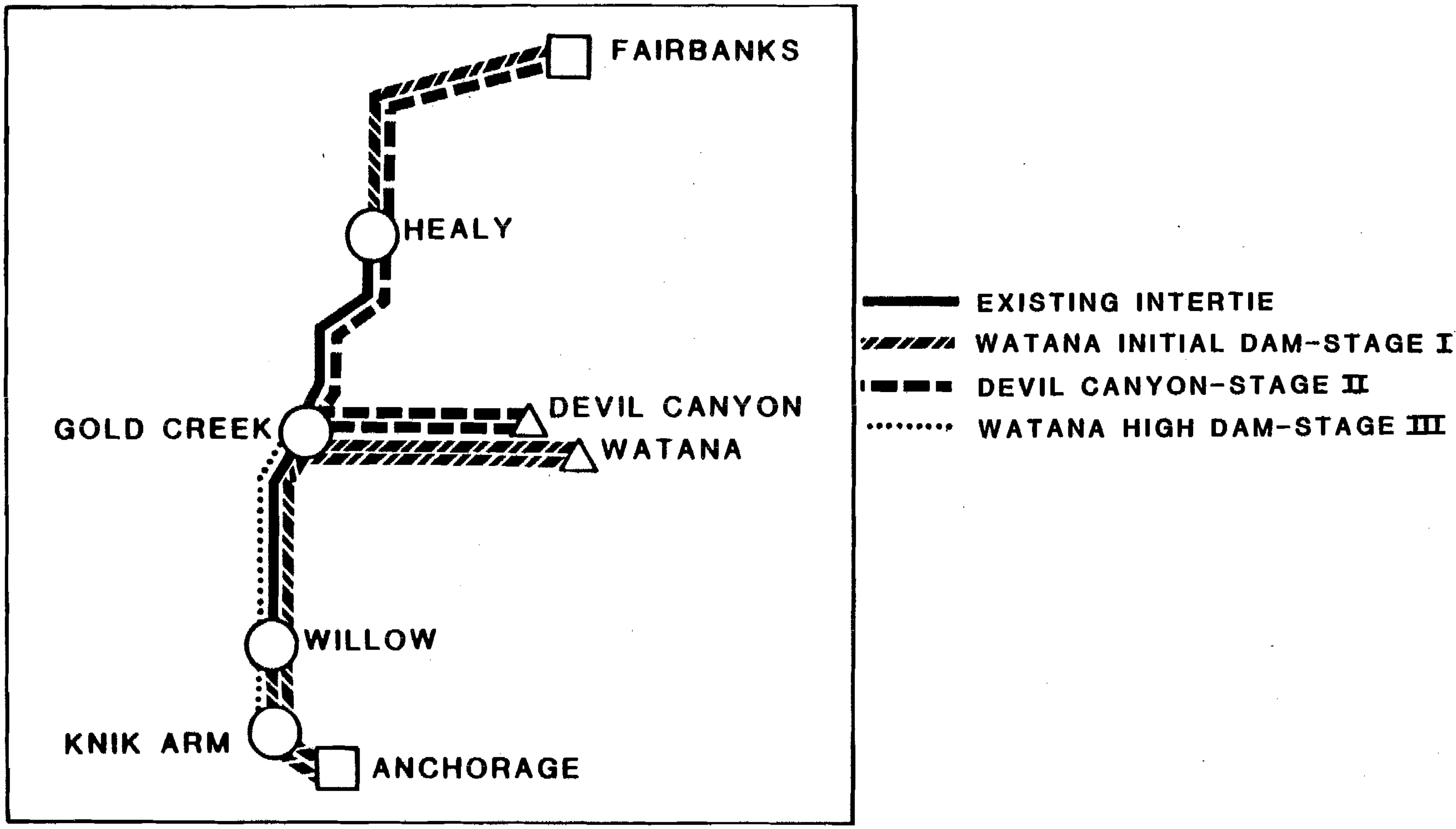
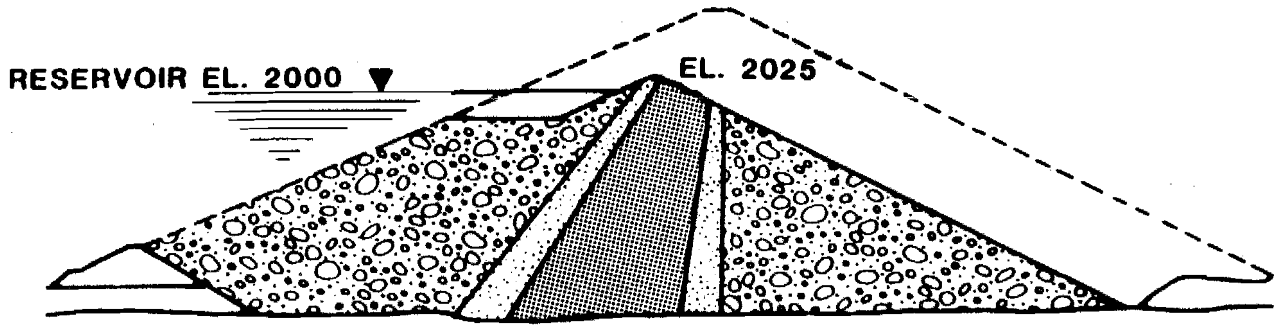
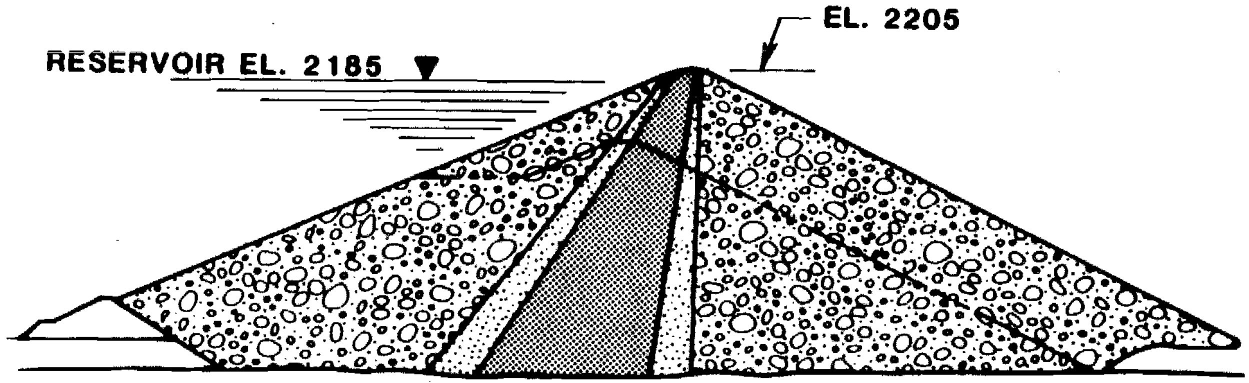



FIGURE II.4

# WATANA DAM
## STAGED EMBANKMENT CROSS SECTIONS

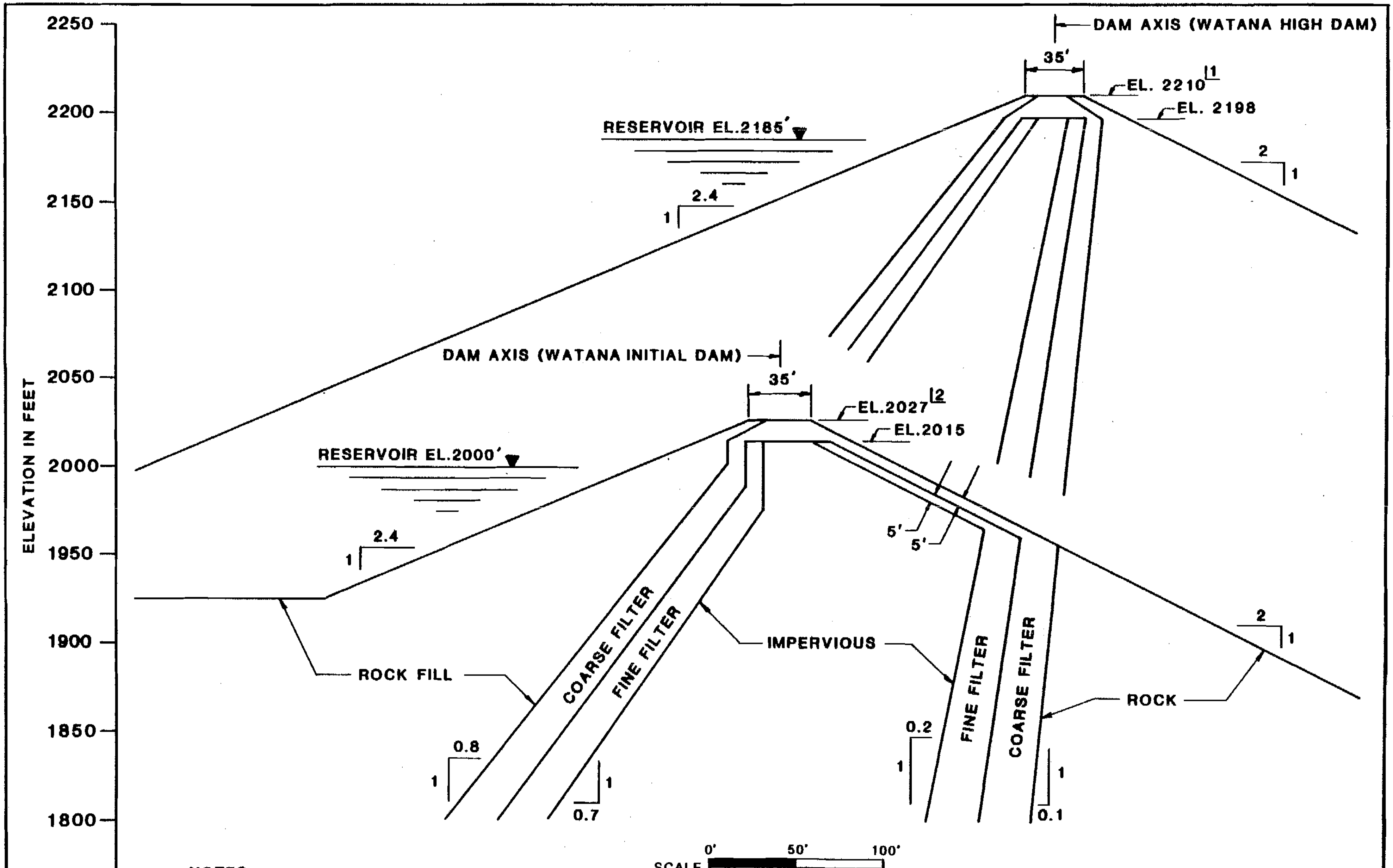



STAGE I - WATANA INITIAL DAM




STAGE III - WATANA HIGH DAM

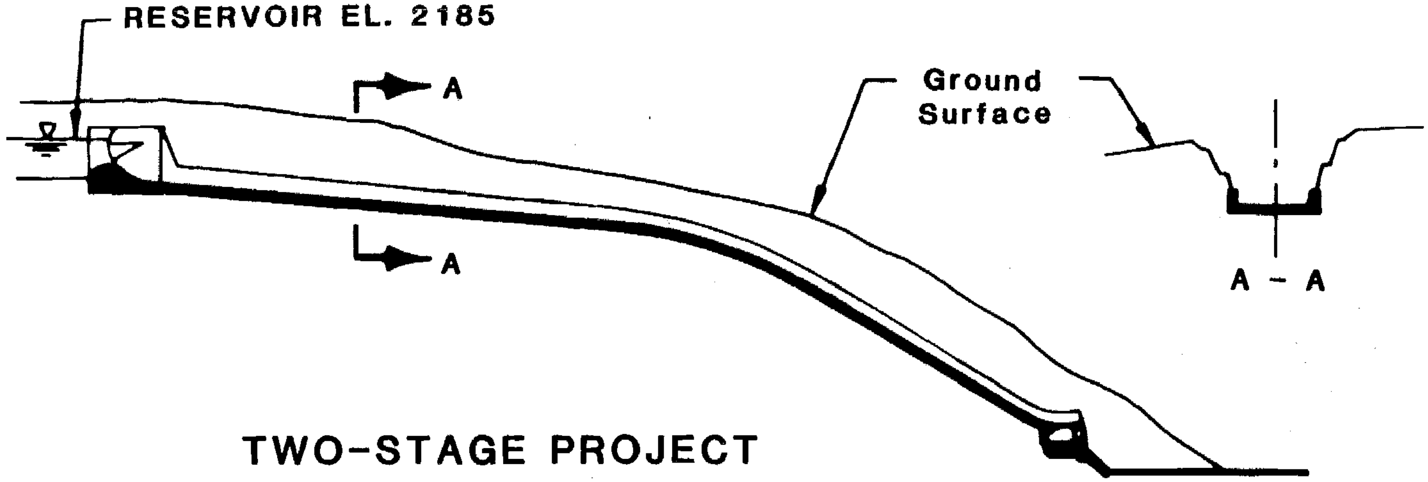
# WATANA DAM
## STAGED DAM - CREST DETAILS



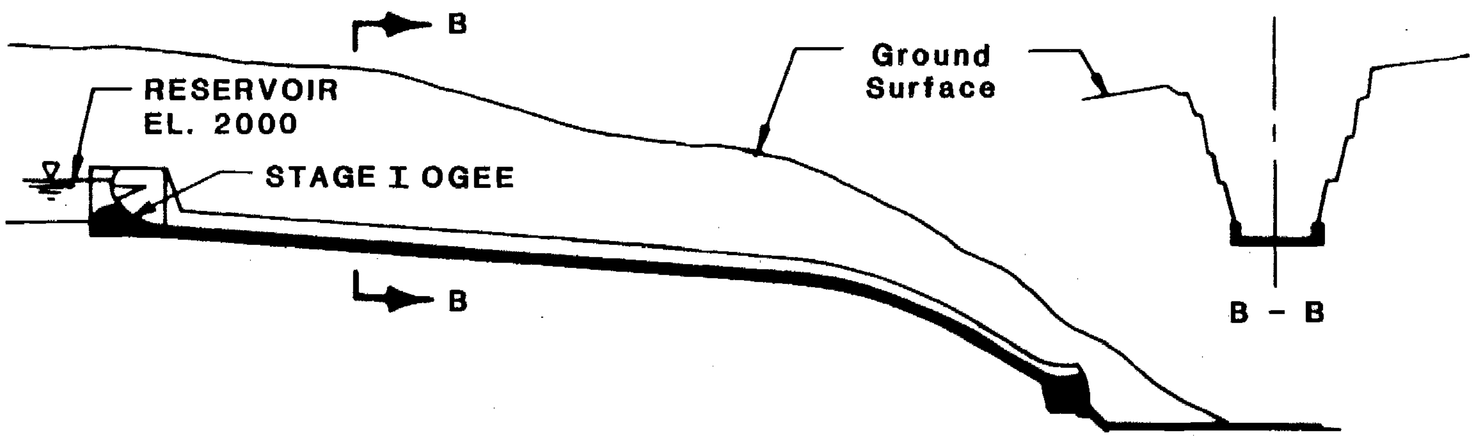

NOTES :
1.INCLUDES 5' SETTLEMENT OVERBUILD
2.INCLUDES 2' SETTLEMENT OVERBUILD

FIGURE II.6

# WATANA DAM
## SPILLWAY CROSS SECTIONS - SHEET I




TWO-STAGE PROJECT




THREE-STAGE PROJECT

FIGURE II.7

# WATANA DAM
## SPILLWAY CROSS SECTIONS - SHEET 2

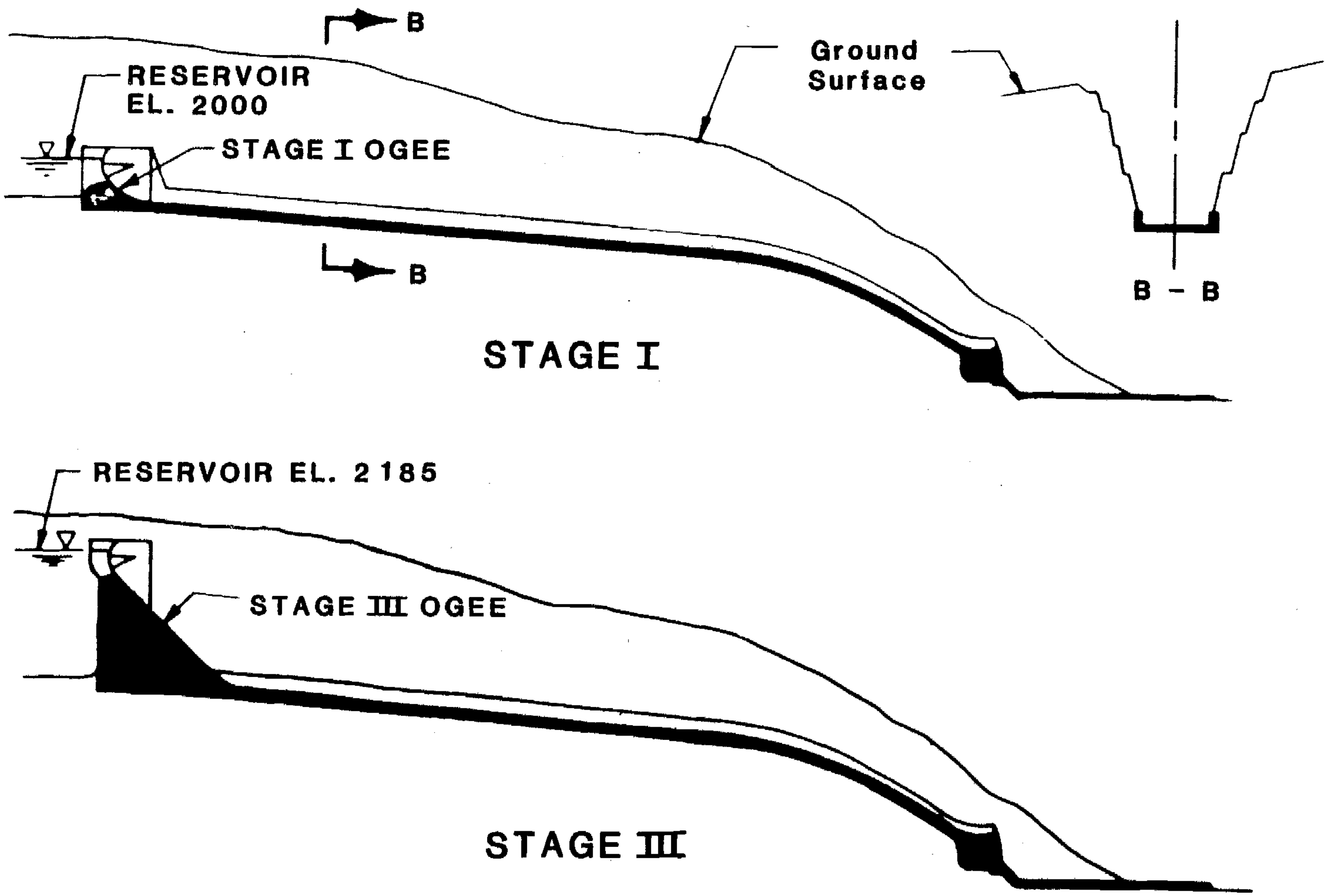
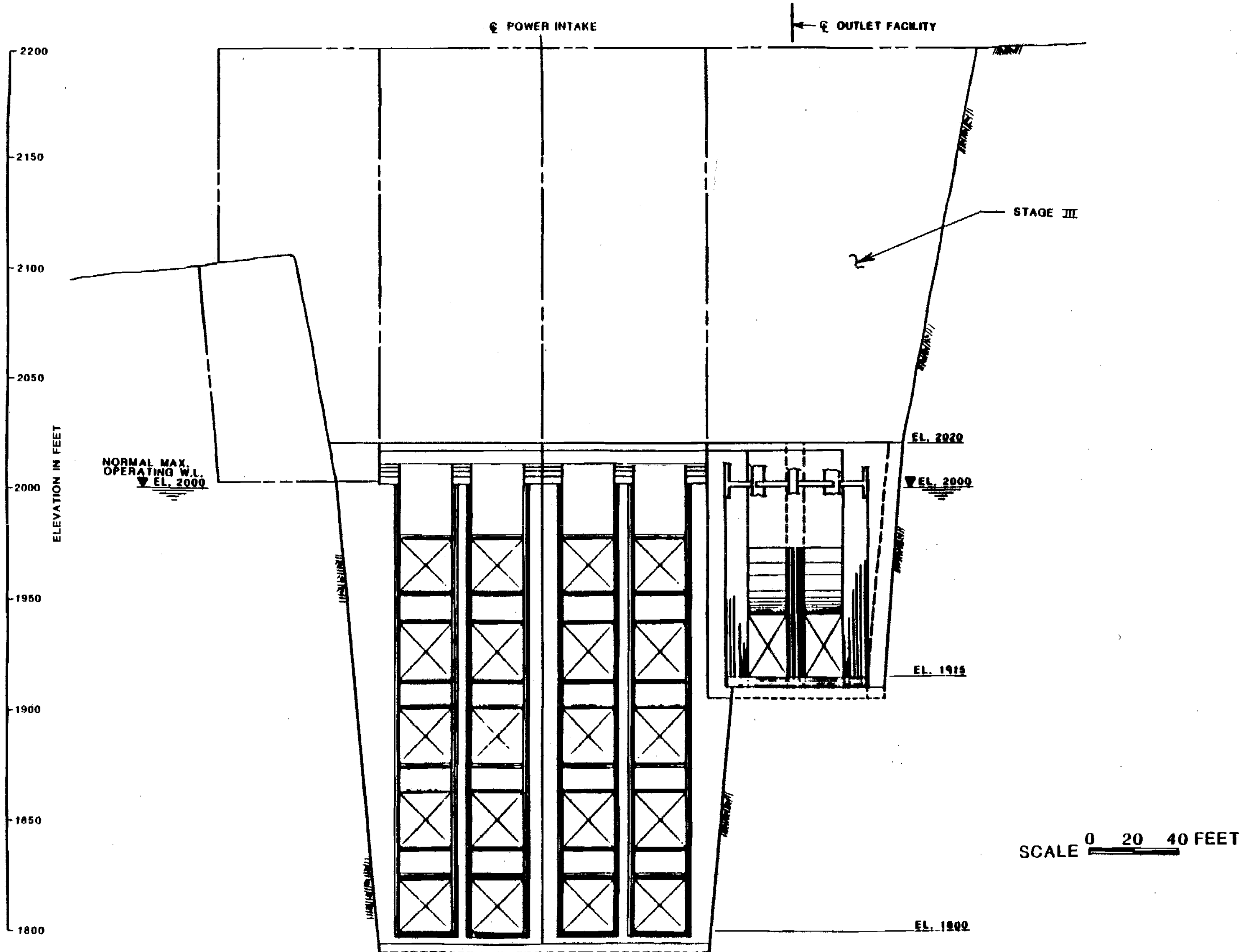



FIGURE II.8

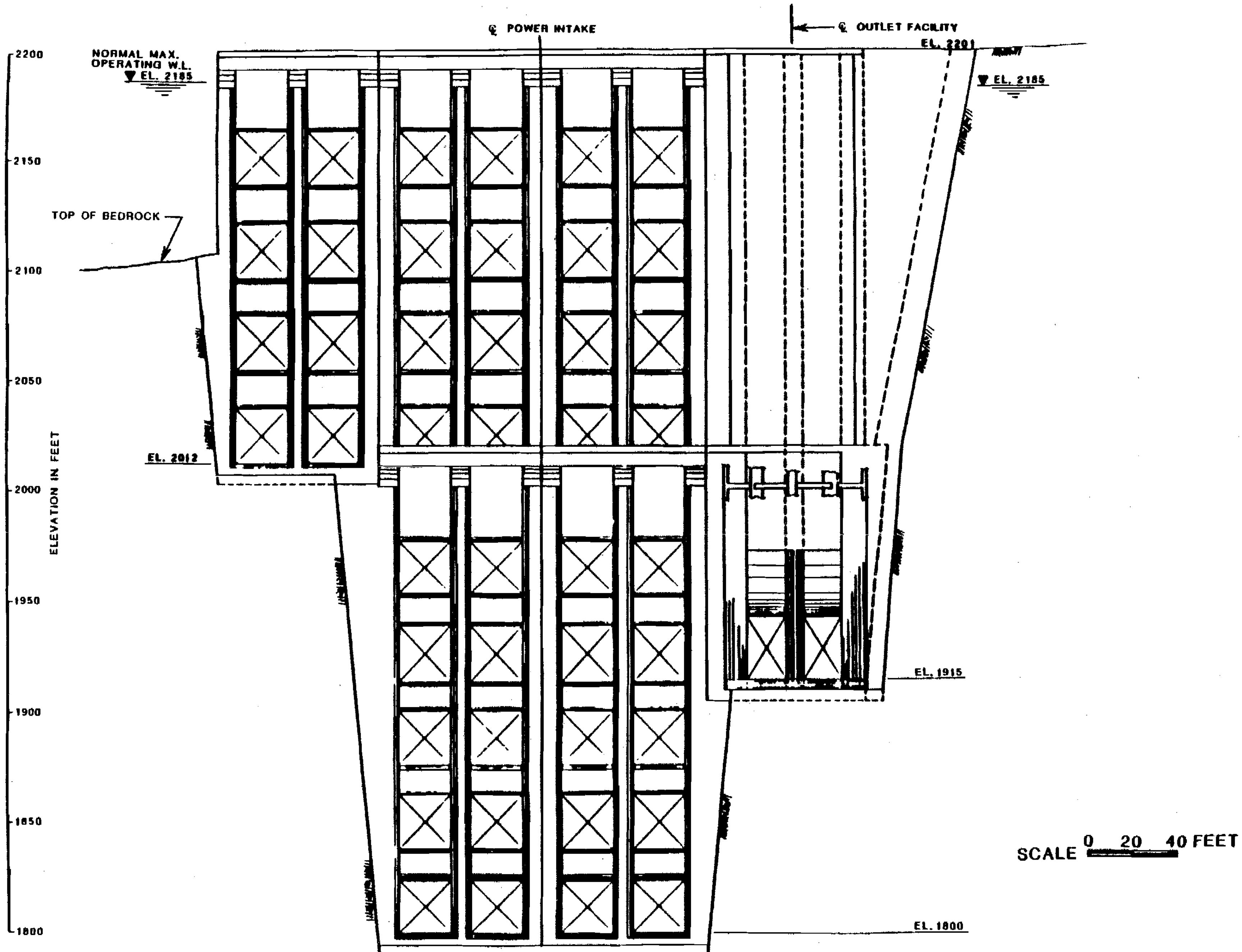
# WATANA DAM
## STAGE I INTAKE STRUCTURE




ELEVATION - LOOKING DOWNSTREAM

FIGURE II .9

# WATANA DAM
## STAGE III INTAKE STRUCTURE




ELEVATION - LOOKING DOWNSTREAM

FIGURE II.10

# SECTION III

## III. PROJECT CONSTRUCTION COST ESTIMATES AND SCHEDULE

Feasibility level costs of the Susitna project have been estimated based on the two stage project and on the three stage project. A cost comparison shows that development of the three stage project is more expensive than the two stage project, as shown below. However, Stage I-Watana of the three stage project is significantly less expensive than the Watana stage of the two stage project as indicated in Table III.1.

TABLE III.1
PROJECT COSTS
($ MILLION 1982)

| Stage | | Two Stage Project | Three Stage Project |
|---|---|---|---|
| I | Watana | $3,371 | $2,528 |
| II | Devil Canyon | 1,475 | 1,492 |
| | Subtotal | $4,846 | $4,020 |
| III | Raise Watana | -- | 1,270 |
| | Total | $4,846 | $5,290 |
| | Cost Differential | | +$444 |

Table III.2 includes a more detailed summary cost comprison of the two stage project versus the three stage project.

Major work efforts and milestone dates for the three stage project are outlined on the Project Schedule (see Figure III.1).

TABLE III.2

PROJECT COSTS
($ MILLIONS 1982)

| Item | Three Stage Project: Stage I Watana El. 2025 | Stage II Devil Canyon | Stage III Watana El. 2205 | Total - Stages I to III | Two Stage Proj.: Watana El. 2205 & Devil Canyon |
|---|---|---|---|---|---|
| Land & Land Rights | 32 | 22 | 19 | 73 | 73 |
| Powerhouse | 75 | 72 | 21 | 168 | 144 |
| Dam, Reservoir & River Diversion | 947 | 561 | 589 | 2,097 | 1,928 |
| Power Generation Equipment | 71 | 67 | 36 | 174 | 172 |
| Roads, Rail and Air Facilities | 191 | 119 | 51 | 361 | 332 |
| Electric Transmission Facilities | 294 | 113 | 118 | 525 | 487 |
| Construction Facilities & Misc. | 279 | 153 | 153 | 585 | 490 |
| Total Direct Costs | 1,889 | 1,108 | 987 | 3,984 | 3,626 |
| Contingency Allowance | 272 | 160 | 142 | 574 | 533 |
| Subtotal | 2,161 | 1,267 | 1,129 | 4,557 | 4,159 |
| Licensing, Engineering, & Administration | 367 | 225 | 141 | 733 | 687 |
| Total Project Cost | 2,528 | 1,492 | 1,270 | 5,290 | 4,846 |

# SUSITNA HYDROELECTRIC PROJECT

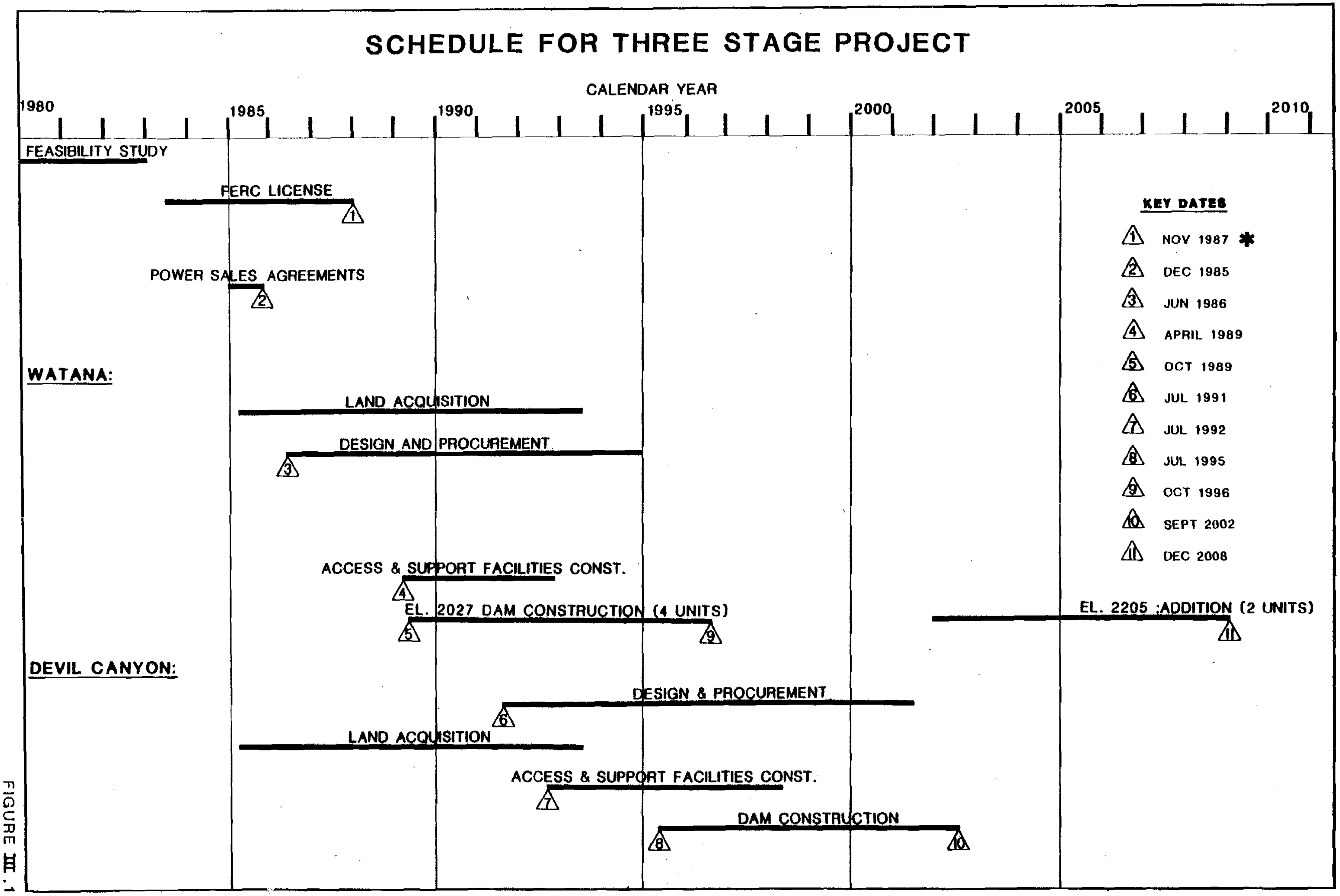



FIGURE III.1

✱ MOST RECENT FERC SCHEDULE DATE. APPLICANT ASSUMES THAT SOME MINOR BUT UNESTIMATED AMOUNT OF DELAY WILL OCCUR.

# SECTION IV

## IV. POWER AND ENERGY STUDIES

The economic feasibility of the Susitna Project depends upon the amount of generating capacity and energy that will be available for sale. For the two stage and the three stage projects, operation studies are performed to estimate the power and energy production capability of each stage of the Susitna Project.

Operation simulations are made using the Railbelt load forecast (discussed below) to establish the relation of system electrical demand to energy production from the project. In addition to meeting energy requirements, project operation is designed to meet monthly or weekly instream flow requirements.

### A. LOAD FORECAST

The load forecast for the Railbelt contained in the License Application was made by using a series of three econometric computer models: a petroleum revenue forecasting model operated by Alaska Department of Revenue (DOR); the Man-in-the Arctic Program (MAP) model operated by the Institute of Social and Economic Research (ISER); and the Railbelt Electricity Demand (RED) model operated by Battelle Northwest Laboratories. The petroleum revenue model produces State revenue forecasts based upon petroleum price forecasts. The MAP model converts these revenue projections into projections of state-wide economic conditions, including population, housing, and employment. The RED model then uses MAP model output, along with additional data, to produce an electrical energy and peak demand forecast for the Railbelt. The load forecasts are taken from Table B.117 of the License Application.

### B. RESERVOIR OPERATION PLAN

Project operation is designed to meet system energy requirements along with minimum monthly or weekly instream flow requirements. These flows are referenced to the Gold Creek gaging station. In the License Application Flow Regime C was used. For the present analyses, Flow Regime E-VI is used. The development of Flow Regime E-VI was discussed in the FERC submission of March 4, 1985.

For reservoir simulation, the energy generated is compared to the system energy demand. If the energy produced is greater than that which the system can use, energy production is reduced. This is done by decreasing the discharge through the powerhouse and increasing the storage or, if the reservoir is full, diverting the powerhouse discharge to the cone valves.

Prescribed minimum instream flow requirements at Gold Creek ensure that the project will release adequate flows for environmental purposes (e.g., Flow Regime E-VI). If the flow requirement is not met, more water is released through the downstream project powerhouse in order to meet the requirement. If the hydraulic capacity of the powerhouse is limiting, the shortfall is released through the cone valves.

Since the instream flow requirement may cause more energy to be generated than needed by the Alaska Railbelt, the powerhouse discharge could again be decreased. However, instead of reducing the total project outflow, discharge greater than that required for energy production is diverted from the powerhouse to the cone valves.

In the event that a flood could not be passed through the powerhouse and cone valves, because of limiting energy demand and hydraulic capacity, the reservoir is allowed to surcharge above the normal maximum water surface elevation. This surcharging is done to minimize spillway use and the potential for nitrogen saturation downstream.

## C. POWER AND ENERGY PRODUCTION

Based on the reservoir operation plan discussed above, and using Flow Regime E-VI, the power and energy production of the two stage and three stage projects were determined. With the three stage project the initial Watana Dam is about 180 feet lower than that proposed in the two stage project. This results in lower head and less flow regulation capability at Watana. The lower head reduces the Watana power output, while the reduced reservoir storage reduces both the Watana and Devil Canyon energy generation. After raising the Watana project (Stage III), the power and energy generation from the two concepts are identical. Table IV.1 provides a comparison of power and energy production for the two and three stage projects.

A distinct advantage of the three stage project is its ability to more closely match the expected Railbelt loads without developing excess capacity. Figures IV.1 and IV.2 demonstrate this effect. Figure IV.1 shows the relation between Railbelt peak power demand and installed capacity for the least-cost thermal alternative. Figure IV.2 shows the power demand and installed capacity relations for both the two stage and the three stage projects for the Susitna case. Excess reserve capacity exists with the Susitna Project during its early years. The reserve capacity more closely matches system requirements under the three stage project than the two stage project. This is especially true for the period 2002 through 2008.

TABLE IV.1

SUSITNA HYDROELECTRIC PROJECT
COMPARISON OF CAPACITY AND ENERGY
FOR THE
TWO AND THREE STAGE PROJECTS

| | Installed Capacity (MW) | Average Annual Energy (GWHR) |
|---|---|---|
| **Two Stage Project** | | |
| Watana High Dam | 1020 | 3500 |
| Devil Canyon | 600 | 3400 |
| | 1620 | 6900 |
| **Three Stage Project** | | |
| Stage I - Watana Initial Dam | 520 | 2470 |
| Stage II - Devil Canyon | 600 | 3120 |
| Stage III - Watana High Dam | 500 | 1310 |
| | 1620 | 6900 |

## SUSITNA HYDROELECTRIC PROJECT

### NON-SUSITNA ALTERNATIVE PEAK DEMAND AND CAPACITY

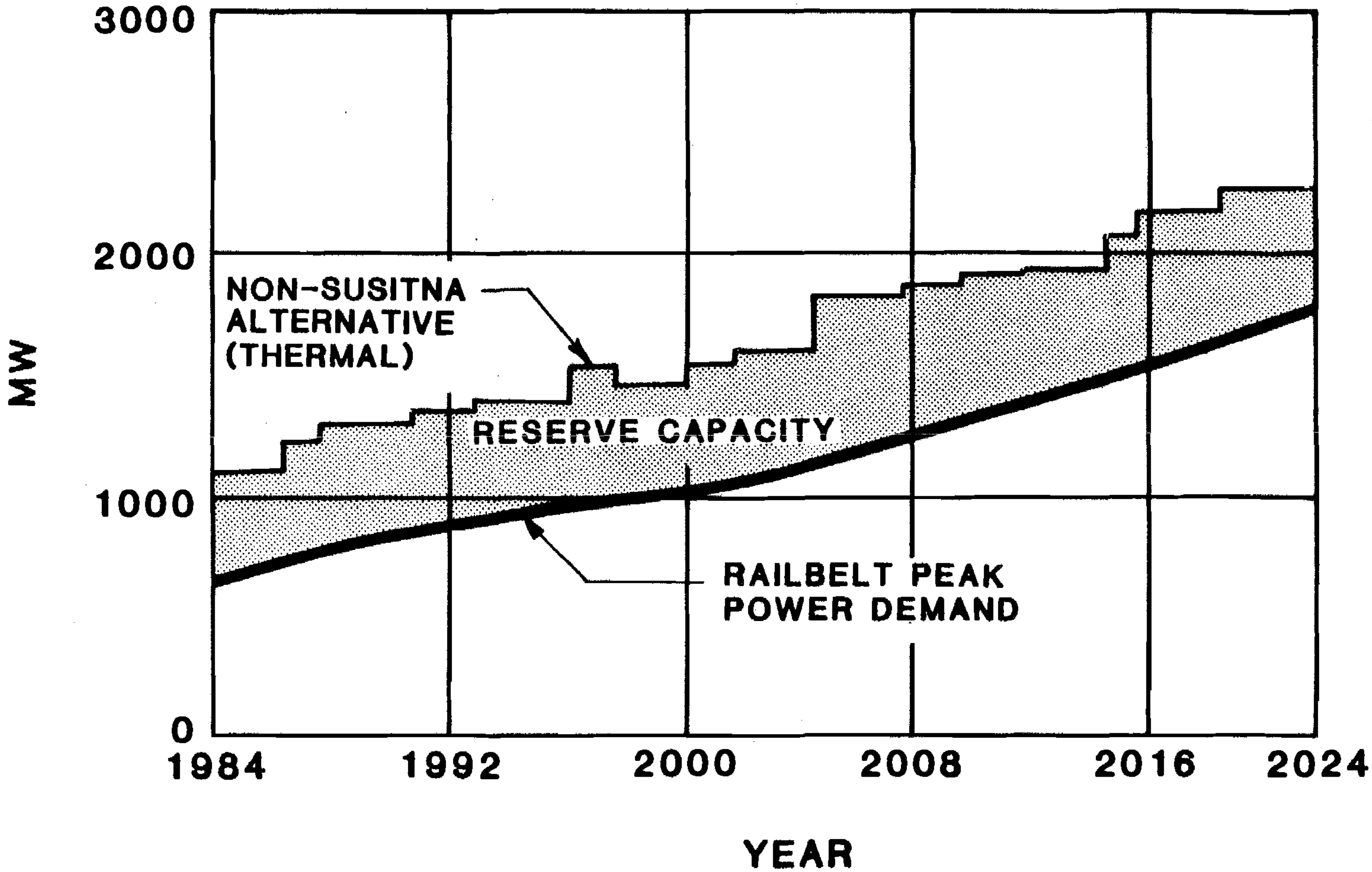



FIGURE IV.1

# SUSITNA HYDROELECTRIC PROJECT

## COMPARISON OF PEAK CAPACITIES AVAILABLE

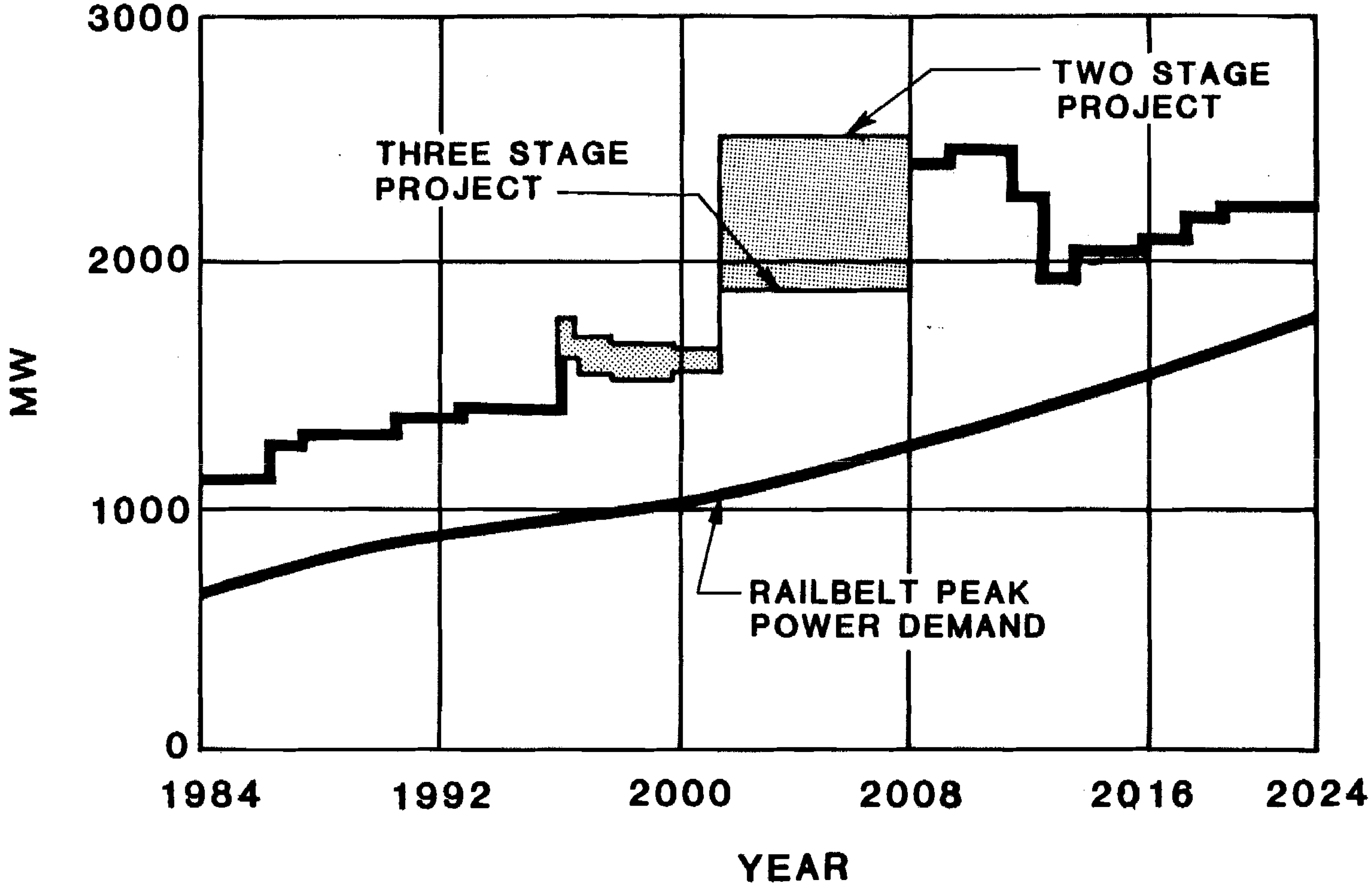



FIGURE IV.2

# SECTION V

## V. PROJECT ECONOMICS

The economic analysis compares the costs of alternative means of meeting the electrical demand of the Alaska Railbelt during the planning period 1993-2051. Load forecasts were developed and energy supply plans were formulated and compared over this planning period. For electric generation planning, a capacity expansion optimization model developed by General Electric (the Optimized Generation Planning [OGP] program) was used to develop alternative equivalent expansion plans.

### A. OPTIMIZATION OF DEVELOPMENT SCHEDULE

The Power Authority used the OGP program to develop alternative electric generation expansion plans for the period January 1993 to December 2020 to establish the least costly system for that period with and without the Susitna Project. In the With-Susitna case, Stage I was assumed to start operation in 1996. The optimum timing for Stage II and Stage III was selected by choosing the installation year which minimized total system costs. The analyses indicated that Devil Canyon should be on line in 2002 and Stage III on line in 2008. In this plan all of the Susitna Project's energy would be absorbed in the system by about the year 2015.

For purposes of evaluating Without-Susitna generating plans, several different plans were considered. Varying amounts of coal-fired and gas-fired thermal generation were added to the existing units to create these optional plans. The total costs for the alternatives include all costs of fuel and the O&M costs of the generating units. In addition, the costs include the annual investment costs of any plants and transmission facilities added during the period.

### B. COMPARISION OF SUSITNA AND THERMAL ALTERNATIVES

The With-Susitna and Without-Susitna expansion plan costs are used to assess the economic benefits of the Susitna Project. Benefits are based on the difference between the costs of the most feasible, least costly Without-Susitna plan and the With-Susitna plan. For the Susitna Project to be considered economically feasible, generally the benefit/cost ratio of the With-Susitna alternative over the Without-Susitna alternative should be greater than one.

The annual costs from 1993 through 2020 were developed by the OGP model, and then converted to a 1982 present worth figure. The long-term system costs (2021-2051) were estimated by extending the 2020 annual costs, with no load growth, and adjusting fuel prices to reflect any real fuel price escalation for the 30-year period. The selection of 2051 as the last year of the planning horizon recognizes the full 50-year economic life of the Devil Canyon Project, which is added to the With-Susitna expansion plan in 2002. This extended period of time is necessary to ensure that the full economic lives of hydroelectric plants are taken into account in the economic planning process.

Updated key variables and assumptions used in this analysis are summarized in Table V.I. The capital costs, and operation and maintenance costs of the alternatives have been revised since the Application for License and are estimated at 1982 price levels. Fuel costs have also been revised since the License Application and are at 1983 price levels. Costs incurred in future years reflect relative price changes only.

The cost estimate of the Susitna Project has been revised in accordance with the discussion presented in Chapter III, Table III.1.

Studies on fuel availability and price, construction costs, operation and maintenance costs, and heat rates of thermal units resulted in revisions to the type of plants which would be installed in the Without-Susitna alternative. The revised values are for fuel prices and thermal generating plant parameters shown in Tables V.2 and V.3.

The base year for the present worth analysis, or the year to which all costs are discounted for comparison, is 1982. The real discount rate, which was 3.0 percent in the License Application, was revised to 3.5 percent to reflect a change in financial parameters.

The net benefits and benefit/cost ratio of the least-cost thermal alternative compared to the two stage and three stage projects using the revised parameters are set forth in Table V.4.

TABLE V.1

SUSITNA HYDROELECTRIC PROJECT
STAGED CONSTRUCTION

ECONOMIC PARAMETERS

| | |
|---|---|
| Price level | - 1982 |
| Base Year Present Worth Analysis | - 1982 |
| Planning Horizon | - 1993-2020 by OGP-6<br>2021-2051 by extension |
| Discount Rate | - 3.5 percent |
| Fuel Prices | - Table V.2 |
| Thermal Generating Plant Parameters | - Table V.3 |
| Load Forecast | - per the License Application, July 1983, Table B.117 |
| Economic Life of Projects | |
| Coal-Fired Steam Turbines: | 30 years |
| Combustion Turbines: | 20 years |
| Combined Cycle Turbines: | 30 years |
| Hydroelectric Projects: | 50 years |
| Diesels: | 20 years |

TABLE V.2

SUSITNA HYDROELECTRIC PROJECT
STAGED CONSTRUCTION

FUEL PRICES
(1983 Price Level)

| | | Coal Price ($/MM Btu) | | Gas Price ($/MM Btu) | |
|---|---|---|---|---|---|
| Year | Oil Price ($/bbl) | Nenana Delivered | Beluga Minemouth | Cook Inlet Wellhead | North Slope Delivered |
| 1983 | 28.95 | 1.87 | - | 2.47 | - |
| 1985 | 26.30 | 1.91 | - | 2.25 | - |
| 1990 | 27.90 | 2.00 | - | 2.80 | - |
| 1995 | 32.50 | 2.09 | - | 3.39 | 4.00 |
| 2000 | 40.00 | 2.20 | 1.95 | 4.09 | 4.93 |
| 2010 | 60.00 | 2.43 | 2.40 | - | 7.37 |
| 2020 | 80.00 | 2.69 | 2.80 | - | 9.83 |
| 2030 | 90.00 | 3.00 | 3.35 | - | 11.00 |
| 2040 | 100.00 | 3.35 | 4.00 | - | 12.00 |
| 2050 | 110.00 | 3.76 | 4.75 | - | 13.00 |

TABLE V.3

SUSITNA HYDROELECTRIC PROJECT

THREE STAGE PROJECT

SUMMARY OF THERMAL GENERATING PLANT PARAMETERS/1982 $

| Parameters | Coal 200 MW | Combined Cycle 228 MW 3/ 4/ | Combustion Turbine 87 MW 3/ 4/ 5/ | Diesel 10 MW |
|---|---|---|---|---|
| Heat Rate (Btu/kWh) 3/ | 10,300 | 8,770 | 11,900 | 11,500 |
| Earliest Availability | 1992 | 1988 | 1985 | 1985 |
| O&M Costs | | | | |
| Fixed O&M ($/yr/kW) 3/ | 55.60 | 12.06 | 7.96 | 0.55 |
| Variable O&M ($MWh) 3/ | 3.89 | 0.60 | 0.53 | 5.38 |
| Outages | | | | |
| Planned Outages (%) | 8 | 7 | 3.2 | 1 |
| Forced Outages (%) | 5.7 | 8 | 8 | 5 |
| Construction Period (yrs) | 6 | 2 | 1 | 1 |
| Startup Time (yrs) | 3 | 2 | 1 | 1 |
| Unit Capital Cost ($/kW) 1/ | | | | |
| Beluga/Raibelt | 2,310 | 564 | 348 | 856 |
| Nenana | 2,450 | - | - | - |
| Unit Capital Cost ($/kW) 2/ | | | | |
| Belgua/Railbelt | 2,563 | 584 | 354 | 871 |
| Nenana | 2,718 | - | - | - |

Notes:

1/ As estimated without AFDC based on 33°F rating for combustion turbines.
2/ Including AFDC at 0 percent escalation and 3.5 percent interest, assuming an S-shaped expenditure curve.
3/ Based on 33°F rating for combustion turbines.
4/ Includes water injection for $NO_x$ control for combustion turbines. Actual net imput ISO is 217 MW and 237 MW (79 MW each) for combined-cycle and simple-cycle plants, respectively.
5/ All values reflect an assembly of three units (87 MW each) totalling 261 MW on a single site.

TABLE V.4

SUSITNA HYDROELECTRIC PROJECT
STAGED CONSTRUCTION

ECONOMICS ANALYSIS SUMMARY
($ million 1982)

| Case | Cumulative Present Worth Benefits | Cumulative Present Worth Costs | Net Benefits | Benefit/ Cost Ratio |
|---|---|---|---|---|
| A. Least-Cost Thermal | - | $8191 | - | - |
| B. Two Stage Project | $8191 | $5541 | $2650 | 1.5 |
| C. Three Stage Project | $8191 | $5716 | $2475 | 1.4 |

# SECTION VI

# VI. PROJECT FINANCING

The financing plan for the Susitna Project consists of two elements, rate stabilization funds and construction funds.

Rate stabilization funds are a contribution made by the State of Alaska to constrain utility rates so that increases in the early years of the project operation do not exceed rates that would be experienced under the thermal alternative of the Without-Susitna Plan. The Susitna Project provides a trade-off of higher initial capital cost, zero fuel cost and lower operation and maintenance cost against the lower initial capital costs, fuel costs and higher operation and maintenance costs of the thermal alternative of the Without-Susitna Plan over the long life of the project. The initial cost of energy with Susitna is higher than the thermal alternative because of the high initial investment cost. Rate stabilization funds are the means proposed by the Power Authority to subsidize electricity rates for Susitna until the rates required by the Without-Susitna alternative are equal to the With-Susitna costs. This crossover point of costs is anticipated to occur in 2005.

The construction funds are to be obtained from the sale of tax exempt revenue bonds. The bond proceeds will cover construction costs (including their escalation), interest during construction, licensing costs, financing costs, debt service reserves, working capital, and reserves and contingencies.

Building of the Susitna Project in three stages rather than two not only provides the means to better match the load requirements of the Railbelt utilities, but it also reduces required rate stabilization funds. With the Watana Initial Dam, fewer bonds are required to fund the construction of Stages I and II. When Watana is raised to its ultimate height in Stage III, inflation and real cost increases will act to increase the overall bonding requirements of the three stage project versus the two stage project.

The bond sizing analysis is based on the estimated construction cash flows and the assumptions listed on Table VI.1. The bond issue summary is shown in Table VI.2. It is important to note that the analysis is based on the bonds having tax-exempt status and therefore a lower interest rate.

As can be seen in Tables VI.3 and VI.4, the three-stage concept reduces rate stabilization from over $1.1 billion to approximately $600 million if interest earnings are retained in the fund and from $4.5 billion to $2.6 billion if they are not retained. The 1984 and 1985 Alaska Legislatures have made the initial deposits in this fund of 100 and 200 million dollars respectively for fiscal years 1985 and 1986. It is the Power Authority's intention in 1986 to obtain State legislation to retain the interest in the fund.

TABLE VI.1

BOND SIZING ASSUMPTIONS

- General Inflation Rate - 6.5 percent

- Bond Interest Rate - 10.0 percent

- Reinvestment Rates:

  - short-term - 9.0 percent
  - long-term - 11.0 percent

- Amortization Period - 35 years (level debt service)

- Bond proceeds will be used to fund construction costs (including their escalation), interest during construction, financing costs, licensing costs, debt service reserve, working capital, and reserve and contingency.

- First bonds issued after FERC license issued and all monies expended to date are reimbursed and deposited into the Rate Stabilization Fund.

TABLE VI.2

BOND ISSUE SUMMARY

($ MILLION - NOMINAL)

| Bond Size: | TWO STAGE PROJECT | THREE STAGE PROJECT |
|---|---|---|
| I WATANA | $12,300 | $ 8,600 |
| II DEVIL CANYON | 7,000 | 7,000 |
| SUBTOTAL | $19,300 | $15,600 |
| III RAISE WATANA | --- | 8,400 |
| TOTAL | $19,300 | $24,000 |
| **Annual Debt Service:** | | |
| I WATANA | $ 1,280 | $ 890 |
| II DEVIL CANYON | 720 | 720 |
| SUBTOTAL | $ 2,000 | $ 1,610 |
| III RAISE WATANA | --- | 870 |
| TOTAL | $ 2,000 | $ 2,480 |

TABLE VI.3

RATE STABILIZATION CONTRIBUTION

($ MILLION - NOMINAL)

| YEAR | TWO STAGE PROJECT | THREE STAGE PROJECT |
|---|---|---|
| 1985 | $ 100 | $100 |
| 1986 | 200 | 200 |
| 1987 | 200 | 200 |
| 1988 | 200 | 100 |
| 1989 | 200 | - |
| 1990 | 200 | - |
| 1991 | 40 | - |
| | $1,140 | $600 |

CONCLUSION: A total state contribution in the range of $500 to $750 million will meet rate stabilization needs for the three stage project.

TABLE VI.4

STATE CONTRIBUTION

COMPARISON OF PAY IN AND PAY OUT OF FUNDS

($ MILLION - NOMINAL)

| | TWO STAGE PROJECT | | THREE STAGE PROJECT | |
|---|---|---|---|---|
| FISCAL YEAR | CONTRIBUTION (PAY IN) | RATE STABILIZATION (PAY OUT) | CONTRIBUTION (PAY IN) | RATE STABILIZATION (PAY OUT) |
| 1985 | $ 100 | --- | 100 | --- |
| 1986 | 200 | --- | 200 | --- |
| 1987 | 200 | --- | 200 | --- |
| 1988 | 200 | --- | 100 | --- |
| 1989 | 200 | --- | --- | --- |
| 1990 | 200 | --- | --- | --- |
| 1991 | 40 | --- | --- | --- |
| 1992 | --- | --- | --- | --- |
| 1993 | --- | --- | --- | --- |
| 1994 | --- | --- | --- | --- |
| 1995 | --- | --- | --- | --- |
| 1996 | --- | --- | --- | 250 |
| 1997 | --- | 540 | --- | 270 |
| 1998 | --- | 550 | --- | 240 |
| 1999 | --- | 510 | --- | 220 |
| 2000 | --- | 450 | --- | 180 |
| 2001 | --- | 410 | --- | 150 |
| 2002 | --- | 740 | --- | 460 |
| 2003 | --- | 670 | --- | 420 |
| 2004 | --- | 550 | --- | 380 |
| 2005 | --- | 80 | --- | --- |
| | $1,140 | $4,500 | $600 | $2,570 |

# SECTION VII

# VII. ENVIRONMENTAL ANALYSIS

## A. INTRODUCTION AND FINDINGS

### 1. Background and Scope

Environmental analyses have been made for the three stage Susitna Project. These analyses considered the potential environmental effects of the following factors identified as the major differences from the two stage project:

- Smaller reservoir volume and reduced storage capacity for the Stage I Watana Reservoir.
- Decreased flow stability for Stage I, and to a lesser extent for Stage II, in comparison to Stage III and the two stage project.
- Lower downstream river temperatures (about 1°C) and greater ice cover development with resultant water level increases.
- Reduced area of inundated land for the Stage I Watana Reservoir which delays the loss of wildlife habitat and cultural resources due to inundation.
- Increased total time required for completion of the project would prolong construction-related impacts on wildlife, as well as socioeconomic impacts.

### 2. Findings

In general, analyses of the differences between the two stage and three stage projects reveal no significant impacts which would affect Susitna's overall environmental feasibility. As detailed below, there are both positive and negative differential impacts associated with the three stage project, most of which are judged to be insignificant. The major exception, increased overtopping flows into side slough salmon habitats in the middle river, is an impact already identified for the two stage project, albeit at reduced frequency. As such, it has already been accounted for in the project mitigation planning process and can be avoided by increasing the extent of slough habitat protection.

In addition, the smaller Stage I Watana Reservoir would result in less stable flows during late summer, autumn and early winter. This will result in some dewatering of side slough and side channel habitats not anticipated with the high Watana Dam and Reservoir. This represents a loss of project-related benefits but for the early years of project development only, as these flows would incrementally stabilize with the addition of Devil Canyon and raising of the Watana Dam.

The major effect the three stage project would have on wildlife and botanical resources would be to delay the inundation of some 17,000 acres of habitat by about 10 years. This would allow wildlife displaced by inundation to be somewhat more gradually absorbed into surrounding habitat areas. Perhaps more importantly, however, it would provide significantly more time to develop, test and refine wildlife mitigation and enhancement programs.

For cultural resources, delay in inundation of a number of sites also would allow more time for development and implementation of the mitigation program.

Socioeconomic effects of the three stage project include a build up of the construction workforce and a more prolonged construction period and more opportunity for local communities to grow to a size where project-related facilities and services could be easily utilized after construction is completed. Thus, the degree to which facilities and services are overbuilt is lessened, reducing, in turn, the financial burden incurred for under-utilized facilities.

## B. RESERVOIR AND RIVER PHYSICAL PROCESS ANALYSIS

### 1. Summary

Reservoir and river flows, temperatures and ice conditions have been simulated for the three stage project. Reservoir operations were simulated for the period 1950-1983 for all three stages. Case E-VI Environmental Flow Requirements were used, (APA, 1985). Temperature and ice simulations were made for Stage I and Stage II for hydrological and meteorological conditions represented by the period May 1981 through September 1982, which corresponds to a wet year followed by an average year. Simulated project operations for projected energy demands for 2001 (Stage I - low Watana only) and 2002 (Stage II - low Watana and Devil Canyon) were used in the temperature and ice model studies. The results of these simulations may be compared to simulations for Case E-VI for the two stage project (APA, 1985) and for Case C Flow Requirements for the two stage project (APA, 1984). Appendix A contains information which may be used to compare the two and three stage projects. Additionally, river flows and reservoir water levels have been estimated for filling of the reservoirs.

Appendix A, Exhibits A-11 to A-16 show high, average, and low exceedance level flows at Gold Creek for simulated reservoir operations for all three stages. For Stage I, because of the smaller reservoir storage volume, summer flows are approximately 4000 cfs higher and winter flows are approximately 2000 cfs lower, on the average, than the two stage project. For Stage II, because of the increased generating capacity, flows are generally similar to the two stage project, slightly lower in the summer and slightly higher in the winter. For Stage III, the three stage project is equivalent to the final two stage project and flows are similar.

Exhibits A-4 and A-5 show that summer water temperatures for the three stage project would be similar to the two stage project. Winter reservoir release temperatures would be approximately 1°C colder for Stages I and II of three stage project than for the two stage project. Therefore, the river ice cover is simulated to extend approximately five miles further upstream, and maximum water levels in the ice covered reaches average approximately two feet higher in the winter with the three stage project compared to the two stage project.

2. Discharge

Operation

Reservoir operation simulations were made for the three stage project using projected energy demands for:

1. 1996 and 2001 - Stage I,
2. 2002 and 2007 - Stage II, and
3. 2008 and 2020 - Stage III.

The resulting flows at Gold Creek for 97%, 50% and 6% exceedance levels are shown on Exhibits A-11 to A-16. Exhibits A-17 and A-18 show flows at Gold Creek for 2001 and 2002 projected energy demands, respectively, for:

1. 1964 - flood of record (June),
2. 1967 - large flood in August,
3. 1970 - second driest year,
4. 1981 - wet year used in temperature simulations, and
5. 1982 - average flow year used in temperature simulations.

Stage I of the three stage project has a smaller reservoir storage volume than the two stage project. Less water can be stored in the reservoir for winter operation and the reservoir operation plan for the three stage project attempts to take advantage of the required higher summer flows to generate energy. The result is that average summer flows are about 4000 cfs higher and average winter flows are about 2000 cfs lower than with the two stage project. Simulated reservoir operations for Stage I are summarized on Exhibits A.19 and A.20.

For Stage II, the generating capacity of the project is significantly increased. Winter flows are more stable in Stage II than Stage I, and average winter flows are about equal. Summer flows are less stable with Stage II than Stage I. Summer and winter flows for Stage II of the three stage project are similar to the two stage project for the same energy demands. Simulated reservoir operations for Stage II are shown on Exhibits A-21 and A-22.

The final stage of the two stage project and Stage III of the three stage project are similar and flows would be nearly identical throughout the year. Simulated reservoir operations for Stage III are summarized on Exhibits A-23 and A-24.

## Filling of Watana

### Stage I

Filling of Watana Reservoir would commence in the spring of 1995. During 1995 the dam crest would be raised from El. 1835 to El. 2025, the final Stage I crest level. During this period water would be impounded. The Case E-VI flow requirements would be met by releases through the low-level outlet works. Filling of the Stage I reservoir would require only one summer as opposed to three summers for the two stage project.

Filling of Watana Reservoir was simulated with the three flow sequences defined in the License Application (Table E.2.37, E.2.38) representing low, average, and high flows. The estimated water surface levels in the reservoir on November 1, 1995 for each of the three cases are shown in the following table.

Filling of Watana Reservoir
Water Levels on Nov. 1, 1995

| | |
|---|---|
| Low Flow Year | El. 1930 |
| Average Flow Year | El. 1955 |
| High Flow Year | El. 1970 |

The average monthly Gold Creek flows for the three cases are shown in the following table.

Filling of Watana Reservoir
Average Monthly Susitna River Flows at
Gold Creek During 1995

| | E-VI Requirement | Low Flow Year | Avg. Flow Year | High Flow Year |
|---|---|---|---|---|
| May | 4900 | 4900 | 4900 | 4900 |
| June | 8800 | 8800 | 8800 | 8800 |
| July | 9000 | 9000 | 11400 | 19400 |
| August | 9000 | 9000 | 12400 | 15200 |
| September | 6800 | 6800 | 6800 | 6800 |
| October | 5032 | 5032 | 5032 | 5032 |

The average monthly flows at Gold Creek during the first year of filling Watana Reservoir (three stage project) would be lower than for the first year of filling the two stage project. This is because the Stage I dam crest would be higher than the dam crest for the two stage project during this period and more water would be stored.

Winter flows during filling of the Watana Reserovir would be the same as natural since the reservoir water level would be held constant.

Generating units are scheduled to come on line in March, June, September and December of 1996. In all cases the reservoir water level will be sufficiently high by this time that the discharge can be made through the units. During the summer of 1996, flow will be passed through the operating units to generate power and the excess will be used to fill the reservoir. Flows during this period will be similar to with-project operational conditions.

Filling of Devil Canyon Reservoir

Devil Canyon Reservoir would be filled in the same manner as described in the License Application (p. E.2.148).

Filling of Stage III Watana Reservoir

During the summers of 2006 and 2007 the Watana dam would be raised from El. 2025 to El. 2210. The multi-level power intake would be raised prior to the year 2006 so that raising of the maximum reservoir water level may begin in 2006 and progress upward as work on the dam fill and spillway crests allows. Placement of fill on the upstream face of the dam will begin in the spring of 2006 when the normal water level is below the berm on the upstream face of the dam (El. 1925). The fill will progress rapidly and by the end of the 2006 construction season the dam crest will be near El. 2100.

During the period when the water level in the reservoir is being allowed to rise above El. 2000, water in excess of environmental and power requirements will be stored in the reservoir to the extent possible. Under normal operating conditions this water is released through the cone valves. Thus in 2006 and 2007, summer flows will be less than for normal operation. The Case E-VI flow requirements will be observed at all times during raising of the water level to its Stage III maximum level.

3. Reservoir Temperature

Operation

Reservoir temperature simulations are presented in Exhibit A-1 for Stage I, 2001 energy demands, and in Exhibit A-2 for Stage II, 2002 energy demands. These may be compared to Exhibits G-1 and H-1 of the Alaska Power Authority report on the E-VI Alternative Flow Regime (APA, 1985) for similar hydrology and meteorology. Hydrological and meterological conditions for the period May 1981 through September 1982 were used in the model runs. Based on previous simulations (APA, 1984) it is believed that the simulations for 2001 and 2002 would be representative of expected outflow temperatures for other years in Stage I and Stage II, respectively (i.e. 1996, the first year of Stage I operation and 2007, the last year of Stage II operation). Minor differences would occur because of the increased energy demand between 1996 and 2001 and between 2002 and 2007. Summer outflow temperatures would be expected to be slightly warmer for 2007 than 2002 because there would be more energy generation and less water released through the cone valves.

Reservoir temperature simulations were made using the "inflow temperature matching" policy described in the License Application of February 1983 (p. E-2-114). In Stages I and II, Watana powerhouse would have four units. Each unit would be served by the multi-level intake with five levels of ports spaced between El. 1800 and El. 1980. In general, the uppermost level of this intake, below the water level, would be operated. In Stage III, the Watana dam would be raised and two additional units would be installed. These two units would be served by multi-level intakes with four levels of ports spaced between El. 2000 and El. 2170. An additional four levels of intake ports to the first four units would be constructed between El. 2000 and El. 2170. The first four units would have the ability to withdraw water over a range from El. 1800 to El. 2170. The intake to the Watana cone valve outlet works will be at El. 1930. This is approximately 100 feet lower than in the two stage project.

The Devil Canyon multi-level intake and intakes to the cone valves would be similar to the two stage project. Simulations were made to determine the effect on downstream river temperatures if the multi-level intake were modified by reducing the size of the current proposed intake shutters and inserting a level of shutters in between the upper and lower levels. These simulations are included in this document.

Temperature simulations were not made for Stage III, since Stage III is the same as the final stage of the two stage project for which simulations have been made previously (APA, 1984). A check was made to determine that flows and reservoir water levels for Stage III were similar to the two stage project. There are very minor differences in flows resulting from different turbine and generator characteristics. However, these differences were not felt significant enough to warrant re-simulating conditions for 2020. Exhibit A-3 presents the results of simulations made for the two stage project for projected energy demands for 2020.

The Stage I reservoir outflow temperatures are similar to those for the two stage project in the summer periods. Winter outflow temperatures are approximately 1°C to 1.5°C colder than for the two stage project. This is because:

1. Higher summer flows with Stage I also remove warm water from the reservoir leaving less heat in the reservoir for winter.

2. The reservoir ice cover forms about two weeks later on Stage I of the three stage project than on the first stage of the two stage project. The reservoir ice cover provides an insulating layer and prevents further near surface mixing of reservoir waters thereby minimizing heat loss from the reservoir to the atmosphere. The late formation of an ice cover results in increased wind mixing of the reservoir and colder winter outflows for Stage I of the three stage project. The ratio of surface area to volume of Stage I (three stage project) is about 30% higher than for Stage I (two stage project).

Reservoir temperature simulations for Stage II were made for three different alternatives:

1. Devil Canyon Reservoir drawdown between El. 1455 and El. 1405 using the presently proposed multi-level intake for Devil Canyon power house. This intake has two levels of ports at El. 1425 and El. 1375.

2. Devil Canyon Reservoir drawdown between El. 1455 and El. 1405, using a modified multi-level intake for Devil Canyon. The intake would be modified by inserting a third level of ports at El. 1400 and slightly modifying the geometry of the other two levels of ports.

3. Devil Canyon Reservoir drawdown between El. 1455 and El. 1446, using only the upper level of the presently proposed multi-level intakes at Devil Canyon.

The results of the reservoir temperature simulations for all three cases are presented in Exhibits A-2a to A-2c. The initial simulation for alternative 1 above indicates that the summer outflow temperatures for Devil Canyon Reservoir may be up to 2°C colder in mid to late June than for the two stage project as presented in Appendix H of the E-VI Alternative Flow Regime Report (APA, 1985). This results when the Devil Canyon water level drops below the minimum submergence level for the upper level ports. The lower level ports, located deeper and in colder water, are then opened and outflow temperatures are reduced.

Alternatives 2 and 3 were then simulated to attempt to increase the outflow temperatures. Alternative 3 is similar to the policy adopted for the two stage project and the E-VI Flow Regime (APA, 1985 pp 3-34, 3-35). The simulated summer outflow temperatures for this policy are similar to those for the two stage project. Alernative 2 results in somewhat more variability of temperatures than Alternative 3 but, in general, the temperatures are similar to the two stage project. River temperature and ice simulations described later were made for all three alternatives. Evaluations of aquatic assessments are based on Alternative 2.

Winter outflow temperatures for Stage II are approximately the same for all three alternatives for the winter of 1981-82 and are approximately 0.2°C to 1.0°C colder than for the two stage project. Because the Stage II flows are similar to the two stage project 2002 flows, the cause of the differences may be the late formation of an ice cover on the Watana Reservoir.

The Devil Canyon Reservoir forms an ice cover in the same period as before, which is in early December. The ratio of surface area to volume at Devil Canyon is about 40% higher than at low Watana indicating weather forcing conditions may have greater influence there.

Reservoir temperature simulations for Stage III would be similar to the two stage project. Simulations were made for Case C flow requirements (APA, 1984 Volume 6 Exhibit AH, AI, AR and AS). The simulations made for the Case E-VI Flow Requirements (APA, 1985) for 2001 and 2002 energy demands indicated that Case E-VI and Case C outflow temperatures would be similar.

Filling of Watana Stage I

Reservoir temperature simulations were not made for the year of filling for the three stage project. As noted in the License Application (p. E-2-85) and in the Power Authority's comments on the Draft Environmental Impact Statement (Volume 6) the temperatures in the reservoir would be a composite of the inflow temperatures and the outflow temperatures would be an average of the existing river water temperatures. Simulations carried out for the first summer of filling of the two stage project Watana Reservoir are shown in the Power Authority's comments on the DEIS (Volume 6, Exhibit N). It is believed that temperatures during the first summer of filling the Stage I Watana Reservoir would be similar to these.

During 1996, the reservoir would be stratified and the outflow releases would generally be made through the powerhouse, thus reservoir outflow temperatures would be similar to operational conditions.

## Filling of Devil Canyon Reservoir

Devil Canyon Reservoir would be filled in the same manner as described in the License Application for the two stage project. Reservoir outflow temperatures would be similar to the outflow temperatures for Watana Stage I since the reservoir will be filled quickly.

## Filling of Watana Stage III

Reservoir water levels would increase over a period of two years as the dam crest is raised and the spillway is raised. Multi-level intakes near the water level surface would always be available to allow selective withdrawal of water. Reservoir temperature stratification would be generally similar to the periods before and after raising of the crest. Although summer outflows may be somewhat reduced, outflow temperatures are expected to be similar to conditions before and after raising.

During this period there would be fewer releases through the cone valves as the water in excess of environmental and power requirements is stored to increase water level. Therefore outflow temperatures may be warmer than for normal operation.

4. River Temperature

## Operation

River temperature simulations were made for Stage I and Stage II using the reservoir outflow temperatures discussed above. Results are shown for Stage I in Exhibit A-4 and for Stage II using the three alternative drawdown and intake policies on Exhibits A-5a to A-5a.

River temperatures for Stage I are similar to those for the two stage project in the two summers simulated. For a short period in June of 1982 the river temperatures would be up to 2°C warmer with Stage I than in the two stage project. River temperatures are generally 1°C to 1.5°C colder in winter because of the colder outflow temperatures from the reservoir. Thus, the 0°C isotherm in winter is further upstream than with the two stage project.

Summer river temperatures for Stage II for the 50-foot drawdown and the 3-level intake at Devil Canyon are also similar to the two stage project. Temperatures for the 9-foot drawdown are similar to those for the 50-foot drawdown with the 3-level intake. Temperatures for the 50-foot drawdown with the 2-level intake are slightly colder in June than for the other two alternatives.

Filling of Watana Stage I

River temperature simulations were not made for filling. River temperatures during the year of filling Watana would follow the same trends as described for reservoir outlet temperatures.

Since the powerhouse would begin operating in the spring of 1996, river temperatures during the summer of 1996 would be similar to operational conditions. Temperatures during this period would be significantly warmer than for the second summer of filling the two stage project.

Filling of Devil Canyon Reservoir

Water temperatures during filling of the Devil Canyon Reservoir would be similar to temperatures during operation as explained under reservoir temperatures.

Filling of Watana Stage III

Water temperatures during filling of Watana Stage III would be similar to operational conditions prior to and after raising of the crest as explained under reservoir temperatures. Because of reduced cone valve discharges, temperatures in July and August may be warmer than for normal operation.

5. River Ice

## Operation

River ice simulations were made for Stages I and II using the previously referenced reservoir and river temperature simulations and results are shown in Exhibits A-7 and A-8, respectively. Exhibits A-9 and A-10 are comparisons of the simulations for staged construction and the two stage project.

The simulations for Stage I show maximum progression of the ice front would be three miles further upstream than with the two stage project. Maximum water levels for staged construction would be similar to the two stage project downstream of RM 113, up to four feet higher between RM 115 and RM 124, similar between RM 124 and RM 132 and up to seven feet higher between RM 132 and Rm 137. One additional slough would be subject to overtopping. Maximum water levels are simulated to overtop the slough 11 upstream berm by about one foot for less than a week.

The simulations for Stage II for the three different Devil Canyon intake policies are all similar because outflow temperature and discharges are also similar. The maximum upstream extent of the ice front is seven miles further upstream with staged construction than the two stage project. Maximum water levels in the reach downstream of RM 132 are approximately 2-3 feet higher with the three stage project. Sloughs 8A and 9 are simulated to be overtopped with the three stage project and not with the two stage project.

## Filling of Watana Stage I

River ice simulations were not made for the first winter of filling of Stage I Watana Reservoir. However, reservoir releases and temperatures during the winter would be similar to those for the two stage project. River ice conditions for the winter of filling the two stage project (Alaska Power

Authority Comments on the DEIS - Volume 8, Exhibits F and G) are believed to be representative of conditions during filling of Stage 1 Watana.

Filling of Devil Canyon Reservoir

River ice conditions during filling of Devil Canyon Reservoir would be unchanged from the two stage project and would be similar to those for operation of Devil Canyon Reservor.

Filling of Watana - Stage III

River ice conditions during raising of the Watana Dam would be similar to conditions prior to and after raising since multi-level intakes will be available for the whole range of reservoir water levels and temperature stratification will be similar.

6. Nitrogen Saturation

The three stage project contains flood storage capacity at Watana and cone valve outlet works at Watana and Devil Canyon reservoirs. The flood storage volume and cone valve capacities are similar to the two stage project. The purposes of these features are to store and release most flood flows without using the project spillways. This minimizes the potential for gas concentrations exceeding detrimental levels in the river downstream of the project. The thirty-four years of historic streamflows were routed through the project reservoirs for all three stages. Tables VII.B.1 to VII.B.6 show the simulated cone valve operations. In all cases the flows were routed through the project using only the turbines and cone valve outlet works. Downstream gas concentrations would thus be similar to the two stage project.

## 7. Suspended Sediment and Turbidity

Model studies of suspended sediment in the Watana and Devil Canyon Reservoir are being made. The DYRESM model has been modified to include a suspended sediment simulation routine. Model studies are being made for Stage I, II and III. Suspended sediment concentrations for Stages I and II would be somewhat higher than for Stage III and the two stage project due to the smaller surface area and volume of the Stage I Watana Reservoir. Summer suspended sediment concentrations would be markedly lower than for natural conditions, and winter concentrations would be higher than natural conditions.

## REFERENCES CITED

Alaska Power Authority, 1985 Susitna Hydroelectric Project, Case E-VI Alternative Flow Regime, prepared by Harza-Ebasco Susitna Joint Venture.

Alaska Power Authority, 1984, Before the Federal Energy Regulatory Sustina Hydroelectric Project Commission, FERC Project No. 7114.

## LIST OF TABLES

TABLE VII.B.1

SUSITNA HYDROELECTRIC PROJECT
WATANA CONE VALVE OPERATION
THREE STAGE PROJECT, STAGE I
1996 SIMULATION

| Year | Week of First Release | Week of Maximum Release | Duration of Release Weeks | Maximum Release cfs | Powerhouse Flow cfs | Total Release ac-ft |
|---|---|---|---|---|---|---|
| 1951 | Sept 2 | Sept 2 | 4 | 11,842 | 9,832 | 355,000 |
| 1952 | Aug 12 | Aug 12 | 5 | 6,521 | 9,040 | 278,000 |
| 1953 | Aug 12 | Aug 26 | 6 | 8,022 | 9,497 | 321,000 |
| 1954 | Aug 26 | Aug 26 | 2 | 6,696 | 9,510 | 114,000 |
| 1955 | July 29 | Aug 26 | 8 | 24,000 | 9,561 | 1,065,000 |
| 1956 | July 15 | July 22 | 10 | 17,582 | 8,571 | 1,378,000 |
| 1957 | Aug 5 | Aug 12 | 8 | 8,520 | 9,048 | 685,000 |
| 1958 | Aug 5 | Aug 12 | 4 | 8,734 | 9,049 | 297,000 |
| 1959 | Aug 19 | Aug 26 | 4 | 23,726 | 9,564 | 608,000 |
| 1960 | Sept 9 | Sept 9 | 3 | 7,056 | 10,058 | 201,000 |
| 1961 | Aug 5 | Aug 5 | 5 | 13,291 | 8,923 | 528,000 |
| 1962 | July 1 | July 22 | 11 | 16,094 | 8,565 | 1,603,000 |
| 1963 | July 15 | July 22 | 9 | 18,192 | 8,573 | 1,212,000 |
| 1964 | July 1 | July 8 | 9 | 14,343 | 8,595 | 901,000 |
| 1965 | Aug 5 | Aug 12 | 7 | 16,165 | 9,082 | 785,000 |
| 1966 | Aug 19 | Aug 26 | 3 | 5,122 | 9,484 | 145,000 |
| 1967 | July 22 | Aug 12 | 8 | 24,000 | 9,049 | 1,456,000 |
| 1968 | July 22 | July 29 | 6 | 9,442 | 8,882 | 465,000 |
| 1969 | -- | -- | - | -- | -- | -- |
| 1970 | -- | -- | - | -- | -- | -- |
| 1971 | Aug 5 | Aug 12 | 6 | 24,000 | 9,101 | 976,000 |
| 1972 | July 15 | July 15 | 10 | 10,863 | 8,537 | 964,000 |
| 1973 | Aug 22 | Aug 22 | 3 | 2,188 | 9,532 | 1,584,000 |
| 1974 | -- | -- | - | -- | -- | -- |
| 1975 | July 22 | July 29 | 9 | 11,375 | 8,890 | 769,000 |
| 1976 | -- | -- | - | -- | -- | -- |
| 1977 | July 15 | July 29 | 9 | 10,644 | 8,887 | 717,000 |
| 1978 | -- | -- | - | -- | -- | -- |
| 1979 | July 22 | July 29 | 6 | 12,836 | 8,896 | 641,000 |
| 1980 | July 29 | July 29 | 6 | 18,303 | 8,926 | 707,000 |
| 1981 | July 29 | Aug 12 | 7 | 24,000 | 9,078 | 1,408,000 |
| 1982 | Sept 16 | Sept 16 | 2 | 6,979 | 10,275 | 114,000 |
| 1983 | Aug 19 | Aug 26 | 3 | 13,207 | 9,521 | 373,000 |

TABLE VII.B.2

SUSITNA HYDROELECTRIC PROJECT
WATANA CONE VALVE OPERATION
THREE STAGE PROJECT, STAGE I
2001 SIMULATION

| Year | Week of First Release | Week of Maximum Release | Duration of Release | Maximum Release | Powerhouse Flow | Total Release |
|---|---|---|---|---|---|---|
| | | | Weeks | cfs | cfs | ac-ft |
| 1951 | Sept 2 | Sept 16 | 4 | 4,375 | 11,363 | 195,000 |
| 1952 | Aug 19 | Sept 2 | 3 | 4,697 | 10,864 | 117,000 |
| 1953 | Aug 26 | Sept 2 | 3 | 3,201 | 10,857 | 92,000 |
| 1954 | -- | -- | - | -- | -- | -- |
| 1955 | Aug 5 | Aug 26 | 6 | 23,509 | 10,637 | 900,000 |
| 1956 | July 15 | July 22 | 10 | 16,607 | 9,546 | 1,139,000 |
| 1957 | Aug 12 | Aug 26 | 7 | 7,243 | 10,561 | 470,000 |
| 1958 | Aug 12 | Aug 12 | 2 | 6,009 | 10,082 | 142,000 |
| 1959 | Aug 26 | Aug 26 | 2 | 22,276 | 10,636 | 450,000 |
| 1960 | Sept 9 | Sept 9 | 3 | 6,054 | 11,165 | 155,000 |
| 1961 | July 28 | Aug 5 | 5 | 13,144 | 9,939 | 484,000 |
| 1962 | July 1 | July 22 | 11 | 15,120 | 9,539 | 1,510,000 |
| 1963 | July 15 | July 22 | 9 | 17,217 | 9,548 | 1,053,000 |
| 1964 | July 1 | July 8 | 9 | 13,373 | 9,565 | 717,000 |
| 1965 | Aug 12 | Aug 12 | 6 | 11,766 | 10,121 | 531,000 |
| 1966 | -- | -- | - | -- | -- | -- |
| 1967 | July 29 | Aug 12 | 7 | 24,000 | 10,087 | 1,211,000 |
| 1968 | July 22 | July 29 | 6 | 8,435 | 9,889 | 334,000 |
| 1969 | -- | -- | - | -- | -- | -- |
| 1970 | -- | -- | - | -- | -- | -- |
| 1971 | Aug 5 | Aug 12 | 6 | 24,000 | 10,145 | 822,000 |
| 1972 | July 8 | July 15 | 11 | 10,178 | 9,505 | 841,000 |
| 1973 | -- | -- | - | -- | -- | -- |
| 1974 | -- | -- | - | -- | -- | -- |
| 1975 | July 22 | July 22 | 9 | 11,817 | 9,529 | 644,000 |
| 1976 | -- | -- | - | -- | -- | -- |
| 1977 | July 22 | July 29 | 6 | 9,637 | 9,894 | 547,000 |
| 1978 | -- | -- | - | -- | -- | -- |
| 1979 | July 22 | July 29 | 6 | 11,827 | 9,905 | 487,000 |
| 1980 | July 22 | July 29 | 7 | 18,215 | 9,935 | 646,000 |
| 1981 | July 29 | Aug 12 | 7 | 24,000 | 10,120 | 1,310,000 |
| 1982 | -- | -- | - | -- | -- | -- |
| 1983 | Aug 19 | Aug 26 | 3 | 12,142 | 10,586 | 290,000 |

TABLE VII.B.3

SUSITNA HYDROELECTRIC PROJECT
DEVIL CANYON CONE VALVE OPERATION
THREE STAGE PROJECT, STAGE II
2002 SIMULATION

| Year | Week of First Release | Week of Maximum Release | Duration of Release | Maximum Release | Powerhouse Flow | Total Release | Maximum Watana Release During Period |
|---|---|---|---|---|---|---|---|
| | | | Weeks | cfs | cfs | ac-ft | cfs |
| 1950 | Aug 12 | Aug 19 | 3 | 7,224 | 9,438 | 192,000 | 16,096 |
| 1951 | Aug 5 | Sept 2 | 8 | 18,670 | 9,584 | 991,000 | 24,000 |
| 1952 | July 22 | July 29 | 10 | 31,395 | 3,135 | 1,142,000 | 24,000 |
| 1953 | July 15 | July 29 | 10 | 14,870 | 9,135 | 1,146,000 | 20,931 |
| 1954 | July 29 | Aug 5 | 8 | 14,462 | 9,161 | 1,062,000 | 23,280 |
| 1955 | July 15 | Aug 26 | 10 | 35,491 | 700 | 1,736,000 | 24,000 |
| 1956 | July 1 | July 15 | 13 | 23,898 | 6,283 | 2,327,000 | 24,000 |
| 1957 | July 15 | July 22 | 11 | 15,793 | 8,788 | 1,444,000 | 22,198 |
| 1958 | July 29 | July 29 | 5 | 26,020 | 3,371 | 876,000 | 24,000 |
| 1959 | July 29 | Aug 19 | 7 | 38,000 | 430 | 1,841,000 | 24,000 |
| 1960 | Aug 5 | Sept 9 | 9 | 16,303 | 10,283 | 1,039,000 | 22,570 |
| 1961 | July 8 | Aug 5 | 12 | 15,895 | 9,166 | 1,402,000 | 23,083 |
| 1962 | June 24 | June 24 | 14 | 20,975 | 8,161 | 2,362,000 | 24,000 |
| 1963 | July 8 | July 15 | 10 | 33,185 | 2,222 | 2,288,000 | 24,000 |
| 1964 | June 24 | July 8 | 11 | 16,189 | 8,820 | 1,318,000 | 22,938 |
| 1965 | July 15 | Aug 12 | 12 | 20,500 | 8,211 | 1,558,000 | 24,000 |
| 1966 | July 29 | July 29 | 8 | 15,626 | 9,153 | 823,000 | 22,511 |
| 1967 | July 15 | Aug 12 | 10 | 38,000 | 0 | 2,636,000 | 24,000 |
| 1968 | July 1 | July 8 | 11 | 16,504 | 8,821 | 1,172,000 | 22,504 |
| 1969 | -- | -- | -- | -- | -- | -- | 5,751 |
| 1970 | Aug 12 | Aug 19 | 4 | 9,464 | 9,446 | 237,000 | 16,486 |
| 1971 | July 29 | Aug 5 | 7 | 38,000 | 0 | 1,891,000 | 24,000 |
| 1972 | Jun 24 | July 8 | 13 | 15,443 | 8,818 | 1,619,000 | 22,096 |
| 1973 | Aug 12 | Aug 26 | 4 | 12,510 | 9,750 | 415,000 | 20,593 |
| 1974 | Sept 2 | Sept 2 | 2 | 5,574 | 10,012 | 91,000 | 13,395 |
| 1975 | July 8 | July 8 | 12 | 20,910 | 7,526 | 1,602,000 | 24,000 |
| 1976 | Aug 5 | Aug 12 | 4 | 11,185 | 9,301 | 277,000 | 19,534 |
| 1977 | July 1 | July 15 | 12 | 15,230 | 8,775 | 1,338,000 | 21,740 |
| 1978 | Aug 12 | Aug 12 | 4 | 6,412 | 9,295 | 164,000 | 14,572 |
| 1979 | July 15 | July 22 | 8 | 25,737 | 5,131 | 1,204,000 | 24,000 |
| 1980 | July 8 | July 15 | 11 | 26,498 | 5,087 | 1,641,000 | 24,000 |
| 1981 | July 15 | Aug 12 | 10 | 38,000 | 0 | 2,876,000 | 24,000 |
| 1982 | July 22 | Sept 16 | 10 | 14,207 | 10,505 | 875,000 | 21,010 |
| 1983 | July 29 | Aug 5 | 8 | 16,221 | 9,167 | 980,000 | 22,829 |

TABLE VII.B.4

SUSITNA HYDROELECTRIC PROJECT
DEVIL CANYON CONE VALVE OPERATION
THREE STAGE PROJECT, STAGE II
2007 SIMULATION

| Year | Week of First Release | Week of Maximum Release | Duration of Release Weeks | Maximum Release cfs | Powerhouse Flow cfs | Total Release ac-ft | Maximum Watana Release During Period cfs |
|---|---|---|---|---|---|---|---|
| 1950 | June 3 | Aug 19 | 15 | 13,106 | 3,556 | 701,000 | 10,414 |
| 1951 | June 3 | Sept 2 | 18 | 24,654 | 3,600 | 1,761,000 | 15,663 |
| 1952 | June 10 | July 29 | 18 | 27,142 | 4,273 | 1,916,000 | 23,665 |
| 1953 | May 20 | July 29 | 17 | 18,870 | 4,217 | 1,756,000 | 13,869 |
| 1954 | May 13 | Aug 19 | 16 | 20,040 | 3,583 | 1,674,000 | 12,684 |
| 1955 | May 20 | Aug 26 | 17 | 31,346 | 3,447 | 2,257,000 | 24,000 |
| 1956 | May 20 | July 15 | 18 | 25,216 | 4,238 | 3,128,000 | 20,360 |
| 1957 | May 27 | Aug 26 | 18 | 15,872 | 3,791 | 2,137,000 | 14,799 |
| 1958 | June 3 | Aug 5 | 11 | 23,004 | 3,993 | 1,129,000 | 22,021 |
| 1959 | May 13 | Aug 26 | 19 | 35,768 | 3,445 | 2,325,000 | 24,000 |
| 1960 | June 3 | Sept 9 | 18 | 22,621 | 3,965 | 1,677,000 | 13,802 |
| 1961 | May 13 | Aug 5 | 19 | 21,073 | 3,988 | 2,089,000 | 15,718 |
| 1962 | June 3 | July 22 | 18 | 21,934 | 4,229 | 3,238,000 | 18,472 |
| 1963 | May 27 | July 15 | 15 | 30,095 | 4,402 | 2,711,000 | 24,000 |
| 1964 | June 3 | July 8 | 17 | 20,485 | 4,524 | 2,231,000 | 16,628 |
| 1965 | May 27 | Aug 12 | 16 | 24,882 | 3,829 | 2,364,000 | 17,501 |
| 1966 | May 27 | Aug 19 | 17 | 17,692 | 3,574 | 1,427,000 | 10,955 |
| 1967 | May 27 | Aug 12 | 15 | 34,841 | 3,889 | 3,012,000 | 24,000 |
| 1968 | May 20 | July 15 | 15 | 20,087 | 4,360 | 1,837,000 | 15,284 |
| 1969 | July 1 | Aug 19 | 8 | 2,303 | 5,294 | 114,000 | -- |
| 1970 | June 24 | Aug 19 | 6 | 13,132 | 3,568 | 534,000 | 6,938 |
| 1971 | June 24 | Aug 12 | 15 | 31,453 | 3,847 | 2,347,000 | 24,000 |
| 1972 | May 20 | July 8 | 18 | 19,741 | 4,520 | 2,362,000 | 15,774 |
| 1973 | June 3 | Aug 26 | 14 | 18,874 | 3,386 | 927,000 | 11,833 |
| 1974 | May 27 | Aug 26 | 15 | 7,942 | 0 | 474,000 | 4,497 |
| 1975 | May 20 | July 15 | 20 | 22,586 | 4,371 | 2,427,000 | 17,692 |
| 1976 | May 27 | Aug 12 | 14 | 13,442 | 3,809 | 621,000 | 16,171 |
| 1977 | May 20 | July 15 | 21 | 19,645 | 4,360 | 2,165,000 | 15,301 |
| 1978 | Aug 5 | Sept 2 | 7 | 7,002 | 3,514 | 430,000 | 6,437 |
| 1979 | June 3 | July 22 | 19 | 26,622 | 4,246 | 1,913,000 | 21,484 |
| 1980 | July 1 | July 29 | 15 | 27,193 | 4,247 | 2,286,000 | 21,088 |
| 1981 | June 3 | Aug 12 | 14 | 33,300 | 3,877 | 3,042,000 | 24,000 |
| 1982 | June 10 | Sept 16 | 16 | 20,434 | 4,278 | 1,593,000 | 13,244 |
| 1983 | May 27 | Aug 26 | 20 | 21,886 | 3,398 | 1,749,000 | 15,464 |

**TABLE VII.B.5**

**SUSITNA HYDROELECTRIC PROJECT**
**DEVIL CANYON CONE VALVE OPERATION**
**THREE STAGE PROJECT, STAGE III**
**2008 DEMAND**

| Year | Week of First Release | Week of Maximum Release | Duration of Release Weeks | Maximum Release cfs | Powerhouse Flow cfs | Total Release ac-ft | Maximum Watana Release During Period cfs |
|---|---|---|---|---|---|---|---|
| 1950 | June 10 | Aug 26 | 11 | 8,375 | 0 | 447,000 | 4,953 |
| 1951 | June 3 | Sept 2 | 18 | 21,714 | 4,260 | 1,301,000 | 17,911 |
| 1952 | June 17 | Aug 5 | 16 | 18,134 | 4,438 | 1,554,000 | 15,663 |
| 1953 | July 1 | July 29 | 14 | 18,041 | 4,545 | 1,671,000 | 15,465 |
| 1954 | Aug 5 | Aug 19 | 8 | 19,299 | 4,324 | 1,316,000 | 14,290 |
| 1955 | July 1 | Aug 26 | 14 | 28,063 | 4,295 | 2,131,000 | 24,000 |
| 1956 | May 20 | July 22 | 15 | 24,950 | 4,504 | 2,735,000 | 21,734 |
| 1957 | May 27 | Aug 26 | 17 | 15,694 | 4,259 | 2,058,000 | 17,043 |
| 1958 | June 3 | Aug 5 | 12 | 27,210 | 3,154 | 1,402,000 | 24,000 |
| 1959 | May 20 | Aug 26 | 12 | 35,217 | 2,828 | 2,048,000 | 24,000 |
| 1960 | July 1 | Sept 9 | 14 | 22,578 | 4,008 | 1,616,000 | 15,518 |
| 1961 | June 17 | Aug 5 | 14 | 20,616 | 4,445 | 2,263,000 | 17,497 |
| 1962 | June 10 | July 22 | 17 | 21,665 | 4,498 | 3,115,000 | 19,669 |
| 1963 | July 8 | July 15 | 14 | 28,525 | 4,602 | 2,684,000 | 24,000 |
| 1964 | June 3 | July 15 | 19 | 19,024 | 4,577 | 1,847,000 | 17,922 |
| 1965 | July 22 | Aug 12 | 12 | 24,283 | 4,428 | 2,060,000 | 19,488 |
| 1966 | June 3 | Aug 19 | 14 | 16,948 | 4,318 | 1,125,000 | 12,734 |
| 1967 | July 1 | Aug 12 | 12 | 32,359 | 4,455 | 2,702,000 | 24,000 |
| 1968 | July 1 | July 15 | 12 | 19,869 | 4,578 | 1,699,000 | 16,658 |
| 1969 | July 1 | Aug 19 | 10 | 4,154 | 3,443 | 355,000 | -- |
| 1970 | -- | -- | -- | -- | -- | -- | -- |
| 1971 | July 1 | Sept 2 | 11 | 17,226 | 4,233 | 787,000 | 12,550 |
| 1972 | May 27 | July 8 | 15 | 19,582 | 4,679 | 2,413,000 | 17,106 |
| 1973 | June 3 | Aug 12 | 14 | 8,398 | 0 | 725,000 | 14,275 |
| 1974 | July 1 | Aug 19 | 11 | 4,557 | 3,636 | 277,000 | -- |
| 1975 | July 1 | July 22 | 16 | 20,167 | 4,493 | 1,970,000 | 16,921 |
| 1976 | June 17 | Aug 12 | 13 | 8,915 | 0 | 482,000 | 9,979 |
| 1977 | May 27 | July 29 | 17 | 16,838 | 4,534 | 1,878,000 | 14,384 |
| 1978 | July 29 | Aug 19 | 8 | 9,603 | 4,298 | 651,000 | 8,813 |
| 1979 | June 3 | July 29 | 17 | 20,325 | 4,542 | 1,697,000 | 22,945 |
| 1980 | July 8 | July 29 | 14 | 26,881 | 4,559 | 2,417,000 | 23,072 |
| 1981 | June 3 | Aug 15 | 16 | 32,951 | 2,956 | 3,290,000 | 24,000 |
| 1982 | July 1 | Sep 16 | 15 | 20,718 | 3,994 | 1,647,000 | 17,654 |
| 1983 | June 3 | Aug 26 | 20 | 21,011 | 4,273 | 1,832,000 | 17,243 |

TABLE VII.B.6

SUSITNA HYDROELECTRIC PROJECT
DEVIL CANYON CONE VALVE OPERATION
THREE STAGE PROJECT, STAGE III
2020 SIMULATION

| Year | Week of First Release | Week of Maximum Release | Duration of Release | Maximum Release | Powerhouse Flow | Total Release | Maximum Watana Release During Period |
|---|---|---|---|---|---|---|---|
| | | | Weeks | cfs | cfs | ac-ft | cfs |
| 1950 | -- | -- | -- | -- | -- | -- | -- |
| 1951 | -- | -- | -- | -- | -- | -- | -- |
| 1952 | -- | -- | -- | -- | -- | -- | -- |
| 1953 | -- | -- | -- | -- | -- | -- | -- |
| 1954 | -- | -- | -- | -- | -- | -- | -- |
| 1955 | Aug 26 | Sept 2 | 5 | 11,857 | 5,653 | 420,000 | 8,653 |
| 1956 | Aug 5 | Aug 12 | 8 | 17,910 | 6,046 | 1,210,000 | 12,222 |
| 1957 | -- | -- | -- | -- | -- | -- | -- |
| 1958 | -- | -- | -- | -- | -- | -- | -- |
| 1959 | Sept 2 | Sept 9 | 5 | 6,411 | 6,938 | 195,000 | 2,362 |
| 1960 | -- | -- | -- | -- | -- | -- | -- |
| 1961 | -- | -- | -- | -- | -- | -- | -- |
| 1962 | Aug 5 | Aug 26 | 8 | 16,449 | 5,760 | 1,210,000 | 11,424 |
| 1963 | Aug 12 | Aug 19 | 7 | 15,820 | 5,905 | 728,000 | 12,613 |
| 1964 | Aug 26 | Sept 9 | 3 | 4,455 | 6,034 | 114,000 | 1,238 |
| 1965 | Sept 23 | Sept 23 | 2 | 11,276 | 7,213 | 230,000 | 7,403 |
| 1966 | -- | -- | -- | -- | -- | -- | -- |
| 1967 | Aug 12 | Aug 19 | 7 | 22,674 | 5,925 | 1,103,000 | 16,270 |
| 1968 | Sept 2 | Sept 9 | 2 | 4,335 | 6,136 | 121,000 | -- |
| 1969 | -- | -- | -- | -- | -- | -- | -- |
| 1970 | -- | -- | -- | -- | -- | -- | -- |
| 1971 | Aug 26 | Sept 2 | 5 | 15,801 | 5,658 | 508,000 | 9,902 |
| 1972 | May 27 | Sept 9 | 6 | 11,943 | 5,269 | 422,000 | 5,984 |
| 1973 | -- | -- | -- | -- | -- | -- | -- |
| 1974 | -- | -- | -- | -- | -- | -- | -- |
| 1975 | Aug 26 | Sept 9 | 5 | 13,114 | 5,272 | 572,000 | 5,976 |
| 1976 | -- | -- | -- | -- | -- | -- | -- |
| 1977 | Sept 9 | Sept 16 | 3 | 7,984 | 5,206 | 254,000 | 1,533 |
| 1978 | -- | -- | -- | -- | -- | -- | -- |
| 1979 | -- | -- | -- | -- | -- | -- | -- |
| 1980 | Sept 16 | Sept 16 | 3 | 4,933 | 6,962 | 142,000 | 1,419 |
| 1981 | Aug 12 | Aug 19 | 7 | 29,582 | 5,959 | 1,244,000 | 22,420 |
| 1982 | -- | -- | -- | -- | -- | -- | -- |
| 1983 | -- | -- | -- | -- | -- | -- | -- |

## C. AQUATIC/FISHERIES ANALYSIS

### 1. SUMMARY

Effects of the physical changes presented in the preceding section were preliminarily assessed relative to selected aquatic resources. The assessment focused on chinook salmon rearing as it might be affected by predicted changes in discharge, temperature, ice processes, and gas supersaturation. The evaluation emphasized comparison between the staged construction project and the two stage project with general comparisons between both construction concepts and natural or pre-project conditions.

Differences in discharge between the two construction concepts were greatest for Stage I of the three stage project, and resulted in higher summer and lower winter flows than those for Stage I of the two stage project.

In an average year, the differences in flow between the two projects were considered to be beneficial for rearing chinook salmon because of higher Stage I flows of the three stage project relative to Stage I of the two stage project. During dry years, both the two and three stage projects met current minimum flow criteria for chinook rearing.

Only during wet years was it expected that Stage I of the three stage project flows would exceed maximum Case E-VI flow constraints to a greater extent than the two stage project. These high flows, however, were still less than natural flows for the same period.

Three stage project temperature effects were essentially the same as those associated with the two stage project, especially with regard to spring and summer temperatures. Both the two and three stage projects resulted in consistently cooler river temperatures in May and warmer temperatures in October when compared to natural temperatures.

River ice simulations indicated that the ice front would progress further upstream with Stage I of the three stage project than with Stage I of the two stage project, resulting in overtopping of certain productive side sloughs, with potentially negative effects. Methods to protect side sloughs from overtopping due to altered ice problems are included in mitigation plans.

Gas supersaturation was not expected to be a problem under the three stage project because of proposed use of cone valves to eliminate spillway operation. The three stage project flow simulations indicated that spillway utilization would not occur under estimated extremes in reservoir inflow and all excess or required releases would be handled through the cone valves.

## 2. Introduction

### Background

The three stage project described earlier in this transmittal are characterized by initial construction of low Watana Dam (elevation 2,000 ft above MSL) resulting in a reservoir of significantly lesser volume than the originally proposed Watana Dam constructed to an elevation of 2,185 ft. The resultant change in reservoir volume was expected to affect both the thermal characteristics in the reservoir and the downstream temperature and discharge regimes. The three stage project was also expected to affect downstream ice processes and dissolved gas concentrations.

### Objectives

The objectives of the assessment were:

- o To demonstrate the general nature of changes in downstream temperature, discharge, ice, and gas saturation which might result from the three stage project as opposed to both natural conditions and conditions related to the two stage project;

- To preliminarily assess those changes in terms of effects on aquatic resources and to alter the reservoir operations and design specifications to minimize negative aquatic effects; and

- To assess, on a preliminary basis, the magnitude of aquatic effects expected to result from the three stage project.

Assessments of aquatic effects were not conducted at the same level of detail seen in other Susitna aquatic studies. However, the assessments were based on computer simulation of reservoir operations, reservoir temperature, downstream temperature, discharge and ice. Criteria for biological effects were drawn from literature sources or Susitna-specific data wherever possible. To a large extent, this preliminary assessment is methodologically similar to the assessment used in the Case E-VI flow constraints submittal (HESJV 1985).

3. Format for Assessment

Throughout this transmittal, our intention has been to provide a comparison of the three stage project with the two stage project described in the License Application and with natural conditions. Prior to development of the three stage project, the most recent analyses of project effects on aquatic life was presented to FERC staff in a compendium of reports documenting development of the Case E-VI flow constraints (HESJV 1985). These reports documented both the rationale behind and the aquatic effects of a set of downstream flow constraints designed to retain 75 percent of natural (pre-project) chinook salmon rearing through flow regulation.

4. Assessment Methods

a. Approach

The overall aquatic assessment approach was to 1) produce comparable simulations of the downstream Susitna River discharge and temperature regimes associated with natural (pre-project), two stage project, and three stage project, and 2) to assess effects of those flow and temperature conditions using available aquatic studies information and relationships.

To the extent possible, this assessment was to demonstrate differences between the two stage project construction sequence and the three stage project. Where possible, comparisons were made with an effort toward holding all factors (demand level, number of generating units, temperature regulation, maximum drawdown level, number of intake shutters) constant while allowing only Watana Dam height to vary. Following are more detailed sections describing methods used to simulate discharge and temperature and those used to assess aquatic effects.

b. Discharge Simulation

Discharge simulations are described in the Section VII.B on flow, temperature, and gas saturation studies. These simulations were based on mean weekly discharges predicted for a 34-year operating period and flow indexed to the Gold Creek gage site (Susitna RM 132). The historic 34-year sequence of weekly flows were used to represent the preproject or "natural" discharge conditions. Simulations of project discharges involved superimposition of various reservoir operating criteria on the natural flow regime at the damsite(s).

Discharges related to the two stage project construction sequence and operation under the Case E-VI flow constraints were presented in HESJV (1985). In general, Case E-VI flow constraints require, for the period June through September, minimum flows of 9,000 cfs during normal runoff years, (8,000 cfs during low-flow years) and maximum June through September discharges of 35,000 cfs. Case E-VI winter flow constraints call for 2,000 cfs weekly minimum flows and 16,000 cfs maximum flows. Transitional flow requirements were established for October and May corresponding to the transition in reservoir operation from storage to drawdown and vice versa.

Actual discharge simulation cases are described in the foregoing chapter on reservoir and river flow, temperature ice and gas saturation studies. The flow conditions analyzed in the aquatic assessment are summarized in Table VII.C.1.

c. Temperature Simulations

Detailed discussion of both reservoir and instream temperature simulation modeling are presented in Section VII.B. In general, only instream temperature was considered in this assessment. Reservoir temperature simulations were important, however, to serve as a basis for instream temperature simulation.

The temperature simulation process involved first configuring the DYRESM reservoir temperature simulation model (HESJV 1984) as desired to predict weekly release temperatures below one or both dams. These release temperatures were then input to the SNTEMP instream temperature model (AEIDC, 1984) and weekly downstream temperatures were predicted.

Both the DYRESM and SNTEMP models required hydrologic and meteorologic data as input. Both were calibrated using available data for the time period from summer (May) 1981 through fall (October) 1982. Therefore, the temperature simulations differed from flow simulations in that they reflected only a two-summer, one-winter period and not a 34-year forecast period.

The model was used to predict downstream Susitna River temperatures under 1981-82 meteorologic-hydrologic conditions, with either natural streamflows or those expected under two stage or three stage projects. All SNTEMP simulations were performed initially for each river mile (RM) between

TABLE VII.C.1

DISCHARGE SIMULATIONS ANALYZED IN ASSESSMENT

OF THE THREE STAGE SUSITNA PROJECT

| DEMAND YEAR | TWO STAGE PROJECT | THREE STAGE PROJECT |
|---|---|---|
| 1996 | X | X |
| 2001 | X | X |
| 2002 | X | X |
| 2007 | | X |
| 2008 | | X |
| 2020 | X | X |

the mouth of Devil Canyon (RM 150) and Talkeetna (RM 100). To reduce the analytic complexity, temperatures were only analyzed for aquatic effects at RM 150, 130, and 100.

d. Aquatic Resources Selection

Habitat characteristics and seasonal habitat uses by the evaluation fish species were evaluated in order to develop a rationale for establishing environmental flow requirements for planning project operation. The general approach was to find the most important species/habitat combinations, based on density of fish and frequency and duration of use, which are most sensitive to mainstem flow. This process and its results were also reviewed to avoid overlooking a less sensitive habitat used by other evaluation species that would be adversely affected by project operation (APA 1985).

Once the most sensitive species/habitat combinations were defined, an evaluation of the combinations was conducted in consultation with resource agencies to prioritize the combinations. The purpose of the prioritization was to select those species/habitat combinations for which adverse effects could be avoided most easily and economically by flow allocation. For potentially adverse effects to those species/habitat combinations which could not be avoided by allocation of flow constraints, structural measures to rehabilitate adversely affected combinations have been proposed. Throughout the assessment of impacts, refinements to the flow allocation will be made to avoid adverse effects to the principal species/habitat combinations. Any refinements to the flow constraints will also be evaluated in terms of the potential effects to all evaluation species.

In the assessment of the Case E-VI flow constraints (HESJV 1985) it was concluded that direct streamflow effects of Susitna project operations would be most pronounced on chinook salmon juveniles during the months of June through September. At that time, it was considered that, while chum and sockeye salmon side-slough access was affected by mainstream Susitna discharge, maintenance of significant spawning habitat could not be ensured by project-related flows during the spawning period. Therefore, structural modification of selected sloughs was proposed for mitigation of project effects on side-slough access and spawning. Overwintering of juvenile chinook salmon and incubation of chum and sockeye salmon embryos in side slough habitats were also considered important in the assessment of flows during the winter months. These combinations are considered generally in relation to flow and ice process.

Temperature effects were similarly assessed only during the summer months, again with chinook salmon juvenile rearing as the primary target resource. Chinook salmon which reared in mainstem or side-channel habitats were expected to be most vulnerable to temperature impacts, especially as they might affect growth rates.

Temperature effects were also assessed on pink salmon adults which immigrated through affected main-channel habitats during periods of expected lower water temperature in June and July. Additionally, outmigrating chinook salmon could encounter colder mainstem water as they left rearing tributaries.

## 5. Assessment Criteria

### a. Discharge

Discharge effects of the three stage project were assessed relative to the Case E-VI flow constraint ranges. That is, if a particular stage produced discharges which were either above or below the specified range in the Case E-VI constraints, it was assumed that the Case E-VI criterion of retaining 75 percent of the natural chinook salmon rearing in Middle Susitna side-sloughs and side-channels was not met. Chum salmon spawning was assessed subjectively by focusing on flows during the August to early September period and assuming that Case E-VI constraints for rearing would protect side-channel spawning as well.

### b. Temperature

Instream temperature effects were assessed only for the period during which the river was expected to be ice-free. For rearing chinook salmon, predicted temperatures at RM 150, 130, and 100 were subjectively evaluated.

Temperature effects to the principal evaluation species were evaluated primarily by noting significant monthly temperature differences between the two and three stage projects. Significant differences were discussed in terms of the anticipated effects on the pertinent life stages of the evaluation species. As in other assessments, comparisons were made of temperatures associated with natural, two stage project, and three stage project conditions.

## 6. Results and Discussion

### a. Flow

Median Flows. Median (50th percentile exceedance) flows for the three stage project remained within the bounds of the Case E-VI flow constraints for all demand years from 1996 to 2020 (Exhibits A-11 through 16).

Two distinct discharge patterns were recognized. The pattern during the Watana only (Stage I of two stage project) stage in both 1996 and 2001 reflecting generally higher in the summer and lower in the winter discharges for the three stage project relative to the two stage project (Exhibits A-11 and A-12). These higher summer flows were considered to be beneficial to chinook salmon rearing, which has generally been shown to relate positively to discharges up to about 20,000 cfs (ADF&G 1984).

Further, the higher median flows in August and September would be considered more favorable than those of the two stage project in terms of maintaining access conditions without mitigation into certain side-sloughs. In either case, mitigation measures are designed to alleviate any potential access problems.

The second discharge pattern was that seen under both the three stage and two stage projects under 2002 through 2007 demand conditions (Exhibits A-13 through A-15). In both of these simulations, the Case E-VI flow requirements were consistently met. Summer flows increased rapidly to approximately 20,000 cfs beginning in July or August (depending on reservoir volume). Discharge remained at greater than 20,000 cfs throughout late summer until flow to the reservoirs decresed with the onset of winter flow conditions.

The 2002 flow pattern with Stage II of the three stage project was generally indistinguishable from the flows in 2002 for Stage II of the two stage project in terms of effects on aquatic resources. The July increase in discharge for both projects occurred before most salmon spawning activity occurred in sloughs. Discharges were nearly identical during the remainder of the year that habitat differences between the two projects could not be discerned using currently available assessment tools.

Comparisons between the two stage and three stage projects under 2020 demand levels indicated that no discharge regime differences were distinguishable (Exhibit A-16). In both cases, the discharge patterns reflected extreme discharge regulation, and resulting flows which remained consistently within the Case E-VI constraints.

Dry year flows. Comparison of flows between two stage project and three stage project for the 97th percentile exceedance level (dry year flow) reflected the effects of decreased reservoir inflow and the requirement to release water during the summer months to meet the Case E-VI 9,000 cfs requirement. Only in the 1996 and 2001 demand simulations were summer flows met without forced reservoir releases (Exhibits A-11 and 12). In all 2002, 2007, and 2008 flow simulations, the two stage and three stage projects were almost identical with respect to discharge levels, except for some smoothing and slightly higher levels of the early winter flows with the three stage project (Exhibits A-13 through 15). In dry years, it was concluded that the three stage project would be either indistinguishable or slightly superior to the two stage project in terms of potential effects on aquatic resources.

Wet year flows. Among all flow comparisons performed for the three stage project, Case E-VI constraints were not met (or exceeded) only during the wet year (6th percentile exceedance) simulations. Here, the reduced storage of the low Watana Dam resulted in summer flows greater than the 35,000 cfs maximum constraint in many cases (See Exhibits A-11c, 12c, 13c, and 14c). Once Watana Dam is raised to El. 2185 in 2008 (Stage III of the three stage project), Case E-VI maximum flow constraints were met consistently.

The two stage project flows for the 2002 demand level also exceeded the Case E-VI maximum flow constraint. Three factors modify these findings: first, the wet year simulations were of a water year composed entirely of wet weekly periods, and, therefore, represented more runoff than is likely to occur; second, even under these extreme conditions, flows of this magnitude would only occur about twice every thirty-four years; third, these high flows are still lower than the natural middle Susitna flows during the summer months. High flow effects of the staged construction project will be the object of reservoir operation refinements as the effects of the three stage project are further developed.

b. Temperature

General temperature effects. Instream temperatures at river miles 150, 130, and 100 were predicted to compare effects of the two stage project and the three stage project. As discussed in Section VII.B, the temperature simulations were made assuming 1981-82 hydrologic and meteorologic conditions.

Temperature differences between the two stage and three stage projects were greatest during winter and summer months at River Mile 150 (Exhibits A-4 and 5). Stage II (2002) simulations at this river mile indicated early summer temperatures 1.5 to 2.0°C lower and early winter temperatures 1.0 to 2.0°C higher with the three stage project than with the two stage project (Exhibit A-5). During the remaining months and at more downstream locations, the differences between three stage and two stage projects were more irregular and became more difficult to assess. Both projects reduced temperatures relative to natural during May, June and July and increased temperatures relative to natural in September and October.

Effects of these temperature changes on juvenile chinook rearing were generally considered to be highly similar for both two stage and three stage projects. As growth rate models are developed, summer temperature effects on rearing chinook salmon will be assessed.

<u>Other Potential Temperature Effects</u>. Other effects to evaluation species attributable to temperature are comparable to those discussed in other Susitna project reports by AEIDC (1984). These include 1) delay of juvenile salmon outmigration from the system because of cooler water during the spring, 2) early emergence of fry from spawning due to warmer water during the winter, and 3) cooler water temperatures during adult salmon inmigration period possibly leading to changes in timing of spawning. Except for the winter incubation temperatures, these effects are identical for both the two stage and three stage projects, and are in both cases somewhat speculative.

c. River Ice

Results of ice studies described in Section VII.B indicated that, through Stages I and II of the three stage project, river ice would extend further upstream than with the two stage project. Further, because of increased winter flows resulting from the Stage I and Stage II reservoir and generation characteristics, water surface elevation increases due to ice formation ("staging") would be greater at certain locations than with the two stage project. Staging results in overtopping of side-sloughs and side-channels and is characterized as having negative environmental effects, especially in sloughs or side-channels which are used for incubation or rearing. Overtopping under three stage project conditions is expected to be greater within the middle (RM 124-135) reaches of the Middle Susitna River than with the two stage project (Exhibits A-9 and 10).

Staging and subsequent overtopping of sloughs were addressed as a potential problem in the Case E-VI assessment submittal (HESJV 1985). It was proposed in both that paper and the report on mitigation practices (HESJV 1984) that berms be constructed to protect the upstream beaching points of sloughs 8a, 9, 11 and 21. To protect against overtopping of sloughs expected under Stage I and Stage II of the three stage project conditions, berms would need to be constructed to prevent overtopping of the sloughs during the winter months, ranging from 1 to 4 feet higher. This increase in height is considered within feasibility limits of berm construction practices.

d. Nitrogen Supersaturation

Based on the engineering conclusion that the majority of three stage project dishcarge regime flows, even under flood conditions, would not require use of the project spillway, the associated nitrogen supersaturation levels would not differ from those of the two stage project. As Stage I nitrogen concentrations would depend somewhat on discharge-related turbulence in Devil Canyon, the exact Middle Susitna nitrogen concentrations could not be predicted. However, the generally lower peak flows resulting from either the two stage or three stage projects could be expected to reduce nitrogen concentrations below those associated with natural conditions. Nitrogen saturation problems directly attributable to project spillway operation are not expected within the simulated range of project operations.

e. Suspended Sediment and Turbidity

As discussed in Section VII.B, suspended sediment concentrations during Stage I and Stage II were expected to be higher than will ultimately result from the Stage III Watana Reservoir. However, this is not expected to reduce the fisheries resource benefits in the Susitna River resulting from the project.

As was the case for the two stage project, turbidity would be increased in winter in comparison to the natural state. However, as was the case of the two stage project, the reduced turbidity during the open water season will be a net benefit. Summer turbidity will be high enough to provide cover for rearing juvenile chinook slamon. Turbidity levels will not exceed the preferred maximum of 200 NTU's as often and will be of shorter duration than for natural conditions. At the same time, the euphotic zone will be increased over natural conditions. This increase in the euphotic zone in turn would increase the primary and secondary production and availability of food for both resident and anadromous fish.

7. Mitigation

The major difference in the potential effects between the three stage and two stage projects requiring modification of the mitigation plans currently being considered is the increased staging due to ice processes. The major modification to the mitigation plans would be to increase the height of the berms at the upstream ends of sloughs selected for habitat enhancement or protection. The basic mitigation plan, therefore, would be the same for the three stage project as that described for the two stage project (WCC 1984).

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## D. WILDLIFE/BOTANICAL ANALYSIS

### 1. Summary

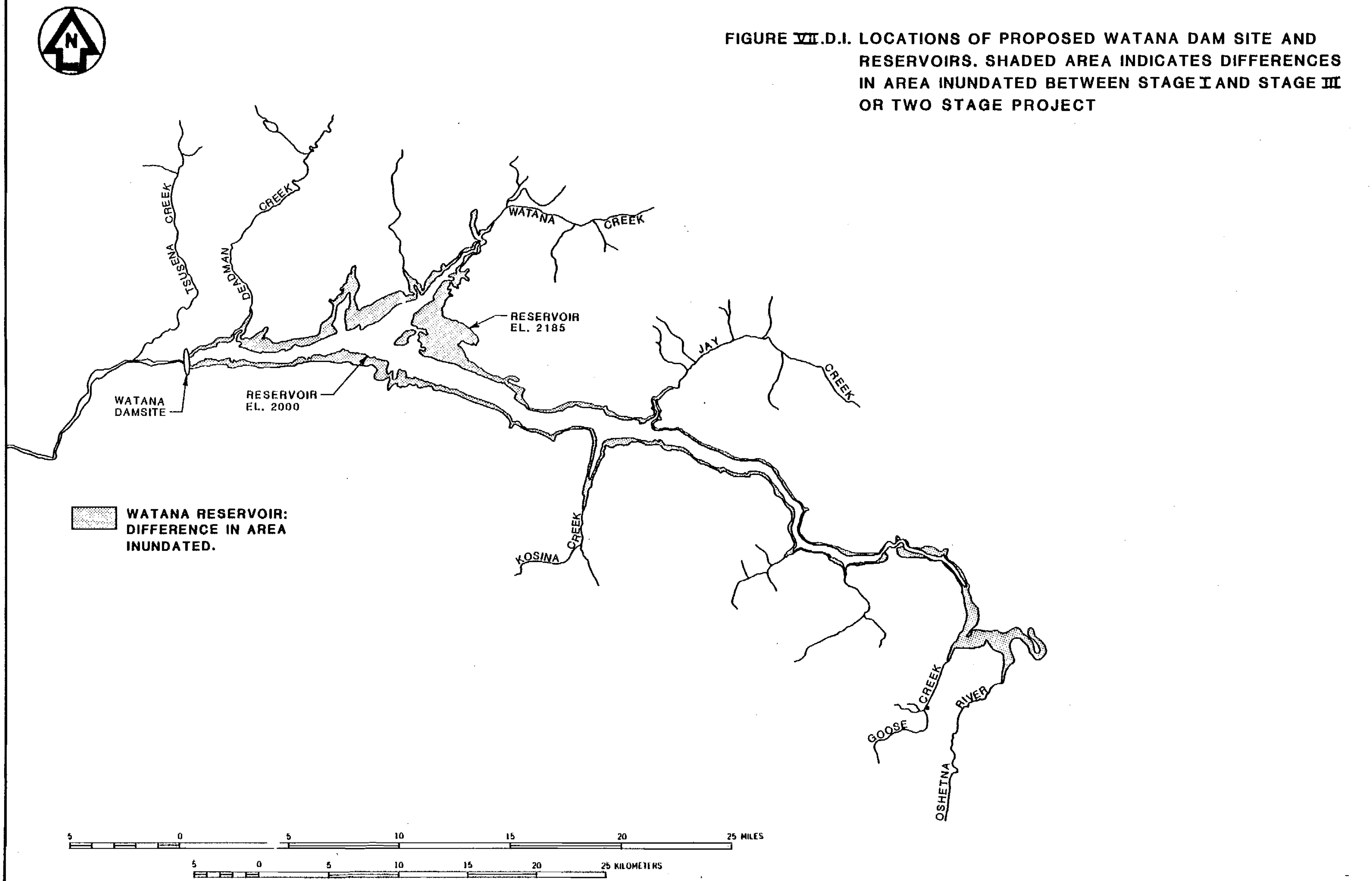
On the basis of this preliminary consideration of all the positive and negative aspects of the three stage project, the net effect would be positive from the standpoint of wildlife and botanical resources. The slight potential for the development of Borrow Site F, a high quality wildlife habitat area (which would eventually be rehabilitated), is not considered to outweigh the benefits of: 1) delayed habitat loss, 2) more time for local wildlife populations to adapt to the habitat loss and movement restrictions caused by the reservoirs, and 3) more time to refine and implement required mitigation programs. The following sections describe changes in habitat loss, borrow site impacts, big game movement impacts, downstream effects, other schedule-related effects, and mitigation which would result from the three stage project.

### 2. Delayed Habitat Loss

#### a. Vegetation

One of the major advantages of a three stage project would be that 17,000 acres of habitat which would be inundated by the Watana High Dam (Stage III) would be preserved for roughly ten years (see Figure VII.D.1). Much of this land area consists of the forested, gentler-sloping portions of the proposed impoundment zone, which represent higher quality habitat for most wildlife species than the steeper canyon walls. Extensive tracts bordering both sides of the Watana Creek confluence on the north side of the impoundment, and bands of land on both sides of the impoundment between Watana and Deadman creeks, represent about half of the 17,000 acres. These areas provide valuable wildlife habitat, particularly for moose, black bear, and marten.

FIGURE VII.D.I. LOCATIONS OF PROPOSED WATANA DAM SITE AND RESERVOIRS. SHADED AREA INDICATES DIFFERENCES IN AREA INUNDATED BETWEEN STAGE I AND STAGE III OR TWO STAGE PROJECT



On north facing slopes black spruce predominates, with interspersed vertical bands of tall shrubs. South facing slopes have greater areal extent and a more diverse flora. White spruce is among the dominant overstory species and woodland black spruce and open mixed forest types are abundant. Birch shrub and mixed low shrub habitats are also present especially in the area near the mouth of Watana Creek. Compared to the vegetation which is to be inundated by stages I and III combined, the band of vegetation between El. 2000 and 2185 contains: proportionally more open white spruce, wet sedge-grass, birch shrub, and mixed low shrub types; about equal proportions of woodland spruce, open black spruce, and open tall shrub types; and proportionally less birch shrub, mixed shrub, closed tall shrub, and willow shrub vegetation types.

b. Moose

When compared to the two stage project, the three stage project would have a positive impact on local moose populations by delaying for roughly ten years the loss of several vegetation types important to moose. On a year-round basis elevations ranging from 2000 to 2200 were used by moose in the project area more than expected based on availability (Ballard, et al. 1984a). In the Watana impoundment zone, much of the vegetation between El. 2000 and 2185 is woodland black spruce, open black spruce, and woodland white spruce. These three habitat types are preferred (in relation to their availability) by moose in the study area (Ballard, et al. 1984a).

It is also likely that the three stage project would reduce the possibility that moose displaced by Watana impoundments will overbrowse areas adjacent to the impoundment during any severe winters occurring soon after filling. Higher densities of moose may occur in areas near the impoundment for several years after filling until moose numbers are reduced to carrying capacity. The incremental nature of Watana impoundment filling under the three stage project plus the approximately ten year lag between Stage I and III fillings should reduce this concentration and allow the vegetation to recover between high density years.

Another minor although positive effect of the three stage project upon moose would be the creation of an island east of Watana Creek. This area, estimated to be about 240 acres, will be surrounded by water as the Stage I Watana dam fills to its maximum pool elevation of 2000. Vegetation on the island is approximately 50 percent woodland black spruce with the remainder consisting of equal amounts of birch shrub and low shrub. Female moose often use islands as calving areas to avoid predators. This newly formed habitat would be available to local moose for approximately ten years.

c. Caribou

Delayed loss of habitat between El. 2000 and 2185 is not expected to have any significant positive or negative impacts to the Nelchina caribou herd. The proposed impoundment zone is a small portion of total caribou habitat in the Nelchina Range and is generally of poor quality (Pitcher 1984).

d. Dall Sheep

A positive impact of the three stage project to Dall sheep would be the delayed inundation of portions of the Jay Creek mineral lick. The Jay Creek lick soil is currently exposed in several areas mostly between El. 2200 and 2400 (Tankersley 1984). Sheep do occasionally utilize areas of the lick below El. 2185. Delayed inundation of the lick would preserve these low priority lick sites below El. 2185 for approximately ten years.

e. Black Bear

In the vicinity of Watana reservoir, acceptable spring, summer and denning habitats for black bear are largely limited to the impoundment zone and immediate vicinity. Black bear commonly use spruce habitats throughout the year and adjacent shrubland habitats during the August berry season (Miller and McAllister 1982). The three stage project would delay the loss of vegetation in a band from El. 2000-2185 in the impoundment zone. Much of this vegetation is spruce habitat with bands of shrub habitat interspersed.

Prolonging the availability of these habitats for black bear will also delay possible interspecific competition with brown bear and the increased predation by brown bears which could result as black bear are forced out of their favored spruce forest habitat to higher elevations. Depending on how close the habitats between El. 2000 and 2185 are to carrying capacity for black bear, the three stage project may also reduce the levels of intraspecific and interspecific competition.

In the project area black bear den sites tend to be found in steep terrain along the mainstem Susitna or its tributaries (Miller and McAllister 1982). Twenty-six dens used at least once by radio-collared black bear have been identified in the vicinity of the Watana impoundment. Fifteen of these would be inundated by the Watana High Dam. The three stage project would prolong the availability of five of these den sites.

f. Brown Bear

The three stage project would delay the loss of early spring green-up habitat which is utilized by many bears after emergence from winter hibernation and by a few bears throughout the year. These habitats are the first to be cleared of snow in the spring and provide bears with a forage base of overwintered berries and early spring vegetation. Nutritionally, early spring is probably the most critical period for bears.

Predation on moose calves by brown bear is very common in early spring (Miller and McAllister 1982). Any reduction in moose populations could have an effect on bears. The delayed loss of moose habitat is therefore another positive aspect of the three stage project as it pertains to brown bears.

g. Wolf

About four wolf packs would lose portions of their territories due to the development of the Watana High Dam. The three stage project would delay this impact for about half of the packs for an additional ten years. This delayed loss of area would postpone some of the increased interpack strife which is anticipated to result as packs readjust territory boundaries due to the loss of territory area.

Any delay in loss of habitat for moose would also affect wolves in the project area. The majority of the wolves' diet in this area is moose and any decrease in prey numbers would likely be reflected in both wolf density and distribution (Ballard, et al. 1984b). Therefore, another positive effect of staged construction on wolves would be the ten year delay in loss of moose habitat between El. 2000 and 2185.

h. Wolverine

No significant difference is expected between the FERC License and staged concepts. During Stage I, carrying capacity for wolverine would be reduced as a result of decreased winter habitat and food supply, and shifts in home range boundaries. This would largely be due to inundation of forested habitats. Some areas of the habitats would remain unflooded until Stage II filling about ten years later.

i. Other Furbearers

Stage I effects would likely affect fewer animals then either the FERC License Concept or Stage III.

Marten are largely restricted to those portions of the basin with coniferous or mixed forests, although some use is also made of shrublands. This is largely due to the distribution of their preferred food items (predominantly microtine rodents and fruits), and use of red squirrel middens for resting sites (Gipson, et al. 1982, 1984). Based on location data from radio-collared marten, about two-thirds of the marten predicted displaced by completion of either construction concept would be displaced by Stage I of the three stage project, and the remainder by Stage III (Gipson, et al. 1984). The band from El. 2000 to 2185 is generally the "shoulder" area where the steep canyon sides are leveling off to the more level uplands. Forests and woodlands in this band are currently used by marten to a large extent (S.W. Buskirk, project biologist, University of Alaska, 1982 pers. comm.), hence the incremental loss with Stage III. This assumes, however, that marten using these areas do not require lower elevation forested habitat as well for continued presence.

Other furbearers (including beaver, muskrat, mink, otter, coyote, red fox, and lynx) would not be significantly affected differently under the three stage project than they would be under the two stage project. These species either occur far enough from the impoundment to be unaffected by changes in inundations or occupy the riparian forest habitat which would be inundated during Stage I and would occur little additional loss during Stage III. Mink and otter may benefit from a shorter reservoir length and less inundation of tributary streams for about ten years.

j. Raptors

Five of the 12 golden eagle (GE) nesting locations upstream of the Watana damsite (GE-4,5,6,8,9) would be inundated by the Watana High Dam and one nesting location, GE-2, would be partially lost. Staging of the project would prevent the partial loss of location GE-2 for an additional ten years.

Three of seven bald eagle (BE) nesting locations upstream of the Watana damsite (BE-3,4,5) would be inundated by Stage III and one nesting location, BE-2, could be impacted whenever a maximum flood occurs. Staging would eliminate any threat of flooding to nest BE-2 for an additional ten years.

Ten common raven nesting locations would be inundated by the Watana High Dam. Staging would delay inundation of four of these nests for about ten years.

k. Other Wildlife

Since most waterfowl species use lake habitats and very few lakes would be affected by the project, effects on waterfowl are minimal for either project. Some breeding species utilize riverine sandbars, islands, and shorelines, and would be adversely affected due to loss of habitat. About 85 percent of the total (100 percent) riverine habitat loss for these species would occur as a result of Stage I, with the remaining 15 being lost in Stage III.

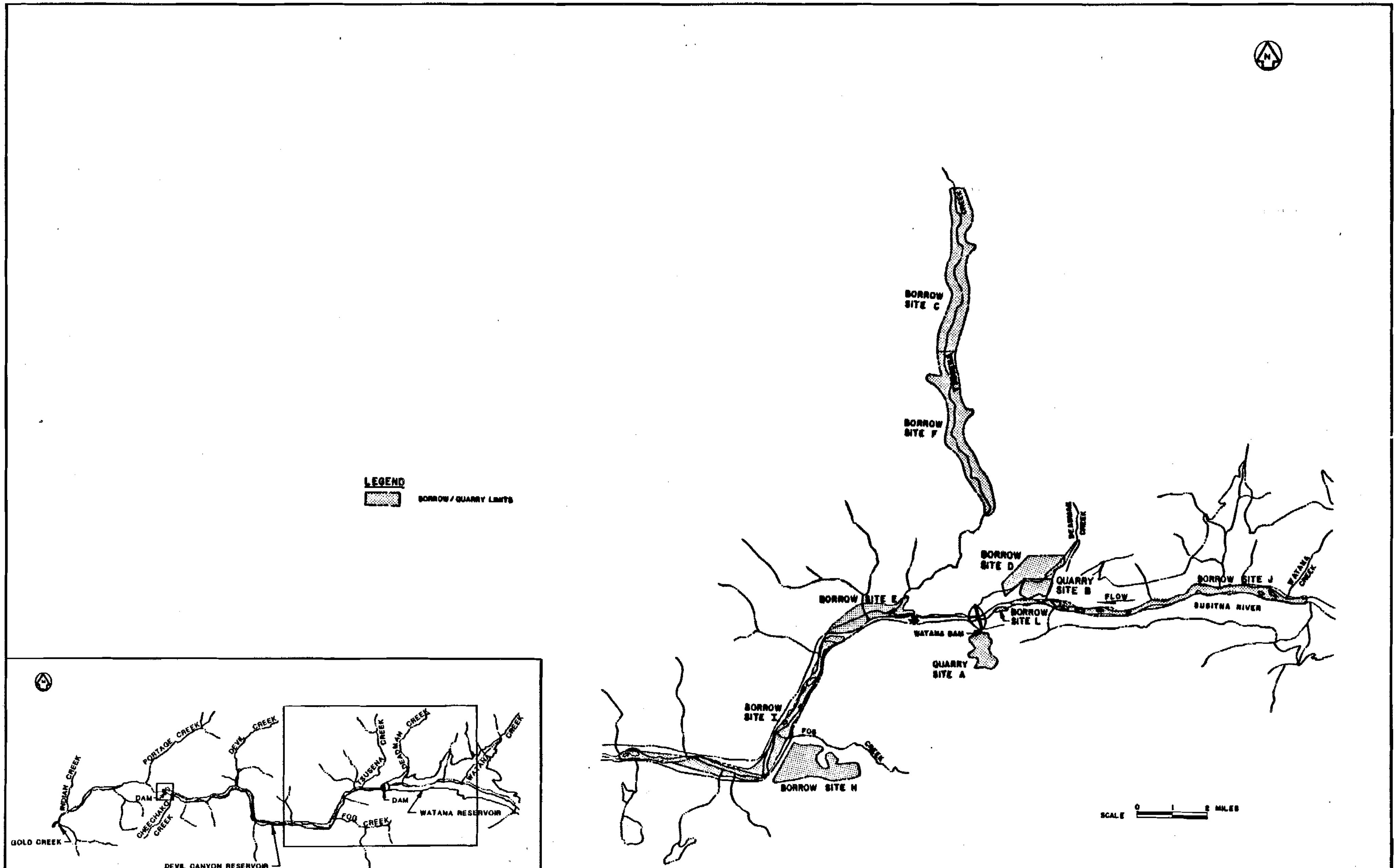
Other bird species most affected by the project would be those which rely on forested habitats such as spruce grouse, hairy woodpecker, brown creeper, Swainson's thrush, yellow-rumped warbler, and northern waterthrush. Some species may use the shrublands resulting from reservoir clearing and borrow site rehabilitation but this would be temporary due to filling and succession. In general, the only anticipated differences between the three stage and two stage projects would be about a ten year delay in the loss of 17,000 acres including some productive breeding habitat.

Small mammals would temporarily benefit from staged construction due to a delay in loss of habitat.

3. Borrow Area Impacts

Borrow Site E (see Figure VII.D.2), a primary source for materials for Watana Dam in the two stage project and for Stage I of the three stage project, would be partially inundated by the Devil Canyon reservoir during Stage II construction, slightly increasing the likelihood that Borrow Site F would need to be used during Stage III. Current plans call for continuing to use Site E. Use of Site F is considered unlikely for either the two stage or three stage project.

The three stage project would reduce the amount of material required from Quarry Site A because all quarry material for Stage I would be obtained through excavation of the deeper spillway required for the staged construction concept. Although the habitat value of this area is not high, the general level of disturbance and habitat loss in the total project area would be less.




WATANA
BORROW SITE MAP

FIGURE VII .D.2

4. Big Game Movement Impacts

The three stage project would have a positive impact in terms of big game movements across the impoundment zone. Under the current two stage project reservoir widths at maximum pool elevation (2185 ft) would range from less than 0.1 to 4.2 miles. The reservoir length would be approximately 48 miles. Under the staged concept plan, Stage I reservoir widths would range from less than 0.1 mile to about 3 miles, with a typical width of less than 0.7 mile. Reservoir length with the Stage I dam would be about 40 miles. Big game attempting to cross the impoundment zone during Stage I operation would face less of a barrier than under Stage III dam operation.

Wildlife may become habituated to the impoundment during Stage I operation, or may alter their movement patterns to avoid lengthy crossing. If this subtle yet positive impact were to occur, animals might be better suited to deal with the more extensive impacts of the Stage III impoundment zone. Another positive impact would be that the monitoring of animal movements which would be possible during Stage I could be used to aid in prediction or mitigation of impacts realized during Stage III.

5. Downstream Effects

As a result of the proposed project's construction and operation, flows in the Susitna River downstream of the Devil Canyon Dam would be altered. These altered flows are expected to affect plant establishment and successional patterns along the river. Early successional plant areas appear to last up to about 15 years from the time of the last major disturbance. The vegetation in early successional sites five to 15 years after stabilization of the substrate is mainly willow and balsam poplar, plant species especially useful to wildlife. Fifteen to 40 years after reduction of downstream flows and the stabilization of the river floodplain, mid-successional plant communities become established. These communities by then have developed into tall shrubs or trees (McKendrick, et al. 1982).

The twelve year time span between the completion of Stages I and III of the staged concept construction schedule would allow the floodplain exposed as a result of the changes in flow due to the completion of Stage I to develop a well advanced early successional plant community. The six year time span between the completion of Stage II and Stage III would allow the floodplain exposed as a result of changes in flow due to the completion of Stage II to establish an early successional plant community. After the completion of Stage III, an additional amount of floodplain would be available for the establishment of an early successional plant community. The establishment of three phases of early successional plant communities, each of a different age and at a different stage of plant development, would result in a floodplain community of higher diversity than would occur under the two stage project. This increase in plant species and age diversity would be, over the life of the project, of more benefit to wildlife than would be derived under the two stage project.

6. Other Schedule-Related Effects

One potential disadvantage of the three stage Susitna project is the expansion of the construction period in the vicinity of the Watana damsite. This expansion would increase the length of the period that wildlife populations are exposed to construction-related disturbance and mortality factors.

The most recent work force estimates for the two stage project for Watana assume ten years of concentrated construction activity on Watana beginning in 1989 and ending in 1997. Under the three stage project, construction activity would start in 1989 and end in 1996 for Stage I-Watana, a total of eight years. In 1992, the focus of construction activity would be shifted 26 miles downstream to the Devil Canyon damsite. In the year 2002 construction would begin on the Stage III Watana project. This period of construction would last 6 years, to 2008. The total construction period for the two stage project is 15 years, while that for the three stage project is about 20 years.

It should be noted that the level of disturbance during Stage III development would be less than during Stage I development due to the reduced magnitude of the construction effort, and the presence of an existing infrastructure and support facilities developed during earlier stages. As it is presently understood, the Denali Highway-Watana access road would be closed during Stage I and the Watana-Devil Canyon segment would be closed during Stage II. If the Denali Highway-Watana segment is closed during Stage III, all wildlife species would benefit from decreased public access. It is also likely that road access to the south side of the Susitna River would not be possible until Stage III is completed. This would likely delay any secondary development on the south side of the river.

A more subtle, but real, advantage of the staged development approach is that data collected and experience gained through the monitoring of construction and operation effects and mitigation success during Stages I and II would permit refinements to construction, operation, and mitigation plans during Stages II and III so that the ultimate impacts on wildlife and botanical resources would be lessened.

7. Mitigation

There would be no significant differences in mitigation measures required for the three stage project as compared to the two stage project. The longer construction period would result in greater temporary effects, and could require somewhat greater temporary rehabilitation measures. However, this might well be offset by the knowledge gained during mitigation for Stage I, when applied to Stages II and III mitigation. This knowledge could include efficacy of proposed mitigation measures and methods as well as delineating actual project effects upon target species.

The extended construction schedule would cause corresponding extensions in the rehabilitation, mitigation, and monitoring schedules. For example, post-Stage I monitoring of caribou crossing the Watana reservoir might add to our understanding of mitigation needs for Stage III.

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## E. CULTURAL RESOURCES ANALYSIS

### 1. Summary

The primary effects of the three stage project on cultural resources would be to reduce, at least initially, the number of archeological sites impacted through construction and reservoir flooding, and to allow more time for study and implementation of mitigation plans. Both are significant positive benefits from the cultural resources standpoint. Since staging does not alter the schedule or design of the Devil Canyon Dam and Reservoir, its effect is essentially neutral.

### 2. Borrow Areas

Staging of the Watana Dam construction would make a greater difference to cultural resources, though on balance the effects are positive. As the construction schedule in Stage I would be speeded up for a completion date of 1996 instead of 1997, there would be somewhat less time available in which to implement mitigation plans. However the scaled-back construction of Stage I would require less borrow, resulting in less damage due to removal of fill. This is particularly important in Borrow Area F (the Tsusena Creek area), which contains a total of eight recorded archeological sites (see Table VII.E.1).

TABLE VII.E.1

SITES AFFECTED BY THE TWO STAGE PROJECT

| | |
|---|---|
| Borrow Areas: | |
| A | None* |
| B | None* |
| C | TLM 054, 055, 078, 081, 084, 085, 086, 087, 088, 094, 095, 096, 097, 201, 211, 213 |
| D | None* |
| E | TLM 022, 023, 258<br>Adjacent to E: 024, 035 |
| F | TLM 176, 188, 202, 203, 209, 210, 212, 214<br>Adjacent to F: 164 |
| G | None* |
| H | None* |
| I | TLM 034, 178, 259 |
| J | TLM 080<br>Adjacent to J: 043, 058, 063, 177, 200, 229, 230, 233 |
| K | TLM 030 |
| L | None* |
| Devil Canyon Reservoir | TLM 023, 034, 178, 252, 253, 258, 259<br>Adjacent to Devil Canyon Reservoir: 022, 024, 027, 029, 030, 118 |

*None: No recorded archeological sites

3. Inundation Areas

The Stage I impoundment level of El. 2000 of the three stage project would result in inundation of 49 recorded archeological sites (see Table VII.E.2). This is one-third fewer than would be flooded permanently by a reservoir level of El. 2185 in the two stage project. The 24 sites between El. 2000 and El. 2185 contours would be available for study for a much longer period under the staged concept than in the two stage project. Staging would allow additional time for implementation of mitigation plans for these 24 sites, as Stage III construction is not scheduled for completion until 2008.

Under the two stage project, the maximum and minimum pool levels would be El. 2201 and 2075, respectively. Reservoir fluctuations during the year could result in two types of adverse impacts on affected sites: 1) cyclical wetting and drying, which could damage organic remains present, and 2) erosion, which could damage or destroy the site. Under the three stage project, the Stage I maximum and minimum pools would be El. 2020 and 1875. Thus, the three stage project would expose fifteen more sites to cyclical wetting and drying and erosion than would the two stage project. On the positive side, the three stage project provides an opportunity to study the effects of immersion on unexcavated sites since during Stage III construction the reservoir level would be lowered to approximately El. 1875 for about six months. This information would be particularly valuable, since controlled data on reservoir effects on archeological resources are scarce.

A final consideration concerns how the three stage project would affect sites adjacent to but outside the actual project area. Adjacent sites are defined as those located within one-half mile of a project boundary. Though not affected directly, these sites could be subject to impacts due to ancillary construction activity, improved access, greater likelihood of erosion, and increased traffic. The lower Stage I Watana reservoir level would reduce the reservoir perimeter temporarily leaving more archeological sites outside the one-half mile zone. It should be noted, however, that the

TABLE VII.E.2

SITES AFFECTED BY THE THREE STAGE PROJECT

STAGE I (El. 2000 Reservoir Level)

TLM 033, 040, 043, 050, 058, 062, 063, 065, 072, 075, 077, 079, 080, 102, 104, 115, 194, 199, 200, 216, 220, 221, 222, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 238, 239, 240, 241, 242, 243, 246, 247, 248, 249, 250, 256, 257 (N=49).

STAGE III (El. 2000 - 2185 Reservoir Level)

TLM 039, 048, 059, 060, 061, 119, 126, 169, 171, 173, 174, 175, 182, 184, 196, 204, 206, 215, 217, 218, 223, 237, 244, 251 (N=24).

ADJACENT SITES (Within 1/2 Mi. of El. 2185 Reservoir Level)

TLM 026, 031, 032, 038, 042, 047, 049, 064, 073, 074, 076, 120, 121, 122, 123, 124, 125, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 139, 140, 141, 142, 143, 145, 147, 148, 159, 165, 166, 167, 177, 183, 185, 189, 190, 195, 198, 207, 219 (N=48).

SITES OUTSIDE THE ONE-HALF MILE ZONE, STAGE I (El. 2000 Reservoir Level)

TLM 026, 032, 038, 042, 049, 073, 074, 076, 120, 122, 159, 189, 195, 198, 207 (N=15).

SITES ADJACENT TO WATANA CONSTRUCTION AREA

TLM 016, 018, 160, 165, 166, 167, 172, 192, 197 (N=9) adjacent distance is arbitrarily defined, so that factors such as topography may be more significant. Nevertheless, approximately 15 adjacent sites would fall outside the one-half mile zone for an El. 2000 reservoir level. This represents 31 percent of the sites defined as adjacent in the two stage project.

4. Mitigation

Mitigation techniques employed for the three stage project would be essentially identical to those used for the two stage project. Implementation, however, would vary. Data recovery (excavation) is expected to be a principal mitigation technique under either project. However, the degree to which it would be utilized and the actual sites involved would be different. Preservation in place, where it involves construction of protective barriers for sites at or near the impoundment margin, may not be considered in the case of the Stage I Watana impoundment because these sites would eventually be flooded by the Stage III reservoir.

The three stage project would permit the details of the mitigation plan (research and excavation strategy) for sites located in the area between the Stage I and Stage III maximum pools to be developed or the basis of information recovered from sites excavated within the Stage I impoundment. This would insure the best scientific use of these resources.

## F. SOCIOECONOMICS ANALYSIS

### 1. Summary

Through the year 2002 there are no significant differences between the two stage and three stage projects for average yearly employment, project-induced population, population immigration, or the magnitude of community facility and services demand. Nor are there notable differences in the type or magnitude of socioeconomic mitigation measures needed to reduce the effects of these impacts. The primary difference is that the three stage project increases the duration of employment impacts, population impacts, and demand for facilities and services.

### 2. Employment and Population

In general, the three stage project would allow a more gradual increase in project employment but reach the same peak yearly average (about 2,000) in 1995. The three stage project would extend the length of employment by five years, through the year 2007. The highest yearly average for these five years would be about 1,000 in the year 2005 (see Table VI.F.1).

Extending the period of employment has the positive effect of providing jobs for a longer time and decreasing the year-to-year variation in employment. Associated (secondary) economic activities are also extended for affected communities.

Population increases generated by the project generally follow the same pattern as project-induced employment. The magnitude and duration of population impacts would therefore follow the trends of employment impacts. The duration of impact would be longer by five years under the three stage project.

## 3. Community Facilities and Services

Impacts on demand for facilities and services are a consequence of population impacts. Since the magnitude of population impacts are similar in both the two and three stage projects, impacts on community facilities and services are likely to be similar through the year 2002. The major difference would be that impacts would occur more gradually and last longer for the three stage project. Facility and service demand levels from 2002 until 2007 would be well below peak demand for either the two stage or three stage projects.

Prolonging the duration of project-induced demand would have one positive effect. Namely, it would delay or reduce any excess capacity of facilities that would be built to meet the peak demand. Since most communities in the impact area have steadily increasing baseline populations, any facilities constructed to serve peak project-related demand would eventually be needed after project construction ends. The period of excess capacity, between the time peak project demand ends and baseline demand catches up, produces a financial burden for maintenance and operation costs for underutilized facilities. The three stage project would reduce this financial burden for some communities by extending the period of economic activity for their residents.

## 4. Mitigation

If a worker transportation program is not adopted by the Power Authority, community aid mitigation programs would be similar for both the two stage and three stage projects. The three stage project would cause the aid programs to extend, at reduced levels for five additional years. With an air/bus worker transportation program, the need for community aid programs would be reduced equally for either project.

TABLE VII.F.1

YEARLY AVERAGE WORK FORCE

| | TWO STAGE PROJECT | | | THREE STAGE PROJECT | | | |
|---|---|---|---|---|---|---|---|
| | Watana | Devil | Total | Stage I | Stage II | Stage III | Total |
| 1988 | -0- | -0- | -0- | -0- | -0- | -0- | -0- |
| 1989 | 700 | -0- | 700 | 376 | -0- | -0- | 376 |
| 1990 | 1,227 | -0- | 1,227 | 666 | -0- | -0- | 666 |
| 1991 | 866 | -0- | 866 | 744 | -0- | -0- | 744 |
| 1992 | 849 | 77 | 926 | 822 | 77 | -0- | 899 |
| 1993 | 1,160 | 118 | 1,278 | 1,058 | 118 | -0- | 1,176 |
| 1994 | 1,416 | 203 | 1,619 | 1,225 | 203 | -0- | 1,428 |
| 1995 | 1,752 | 342 | 2,094 | 1,733 | 342 | -0- | 2,075 |
| 1996 | 1,295 | 355 | 1,650 | 1,206 | 355 | -0- | 1,561 |
| 1997 | 603 | 747 | 1,350 | 142 | 747 | -0- | 889 |
| 1998 | 97 | 885 | 982 | -0- | 885 | -0- | 885 |
| 1999 | -0- | 795 | 795 | -0- | 795 | -0- | 795 |
| 2000 | -0- | 932 | 932 | -0- | 932 | -0- | 932 |
| 2001 | -0- | 492 | 492 | -0- | 492 | -0- | 492 |
| 2002 | -0- | 107 | 107 | -0- | 107 | 304 | 411 |
| 2003 | -0- | -0- | -0- | -0- | -0- | 555 | 555 |
| 2004 | -0- | -0- | -0- | -0- | -0- | 741 | 741 |
| 2005 | -0- | -0- | -0- | -0- | -0- | 1,015 | 1,015 |
| 2006 | -0- | -0- | -0- | -0- | -0- | 943 | 943 |
| 2007 | -0- | -0- | -0- | -0- | -0- | 547 | 547 |
| 2008 | -0- | -0- | -0- | -0- | -0- | -0- | -0- |

## G. RECREATION RESOURCES

### 1. Summary

The primary effect of the three stage project on the proposed recreation plan would be a potential delay in the construction and public use of recreation facilities to be located near the Watana damsite. Futhermore, proposed project recreation sites and recreation development plans of Native groups located south of the Susitna River could also be delayed since access across Watana Dam would be disrupted during Stage III construction. Moreover, boating access to the portion of Watana reservoir near the Watana damsite may be restricted during the Stage III construction period.

Some short-term benefits would occur as a result of staging. Approximately 17,000 additional acres of land would be available for recreation use as a result of a lower Watana reservoir during Stages I and II, and downstream boaters may benefit from increased flow releases. These benefits would last close to completion of Stage III.

### 2. Resource Use

The three stage project would not result in any appreciable changes in effects on recreation resources in the project area. Construction of Stage III would extend the time by approximately 6 years that construction workers would remain in the area. Thus, the use of area resources by construction workers would be extended, particularly fishing of nearby lakes and streams. However, the highest yearly average number of workers for Stage III would only be about half the number estimated for the construction of Watana Dam under the two stage project.

The three stage project would result in some short-term resource benefits as compared to the two stage project. First, construction of Stage I would result in approximately 17,000 acres adjacent to the Watana reservoir to be available for backcountry hiking and hunting due to the lower reservoir level. Second, grayling areas near tributary mouths such as the Oshetna River also would not be inundated until Stage III and therefore would be available for fishing. Third, because there would be less reservoir storage capacity, summer flow releases during Stage I would be greater than they are for the two stage project. This may benefit downstream boaters, particularly during August and September when flows are naturally low.

### 3. Recreation Plan Phasing

The recreation plan proposed for the two stage project would be developed in five phases. Phases One and Two would occur during Watana construction and operation; Phases Three and Four would be developed during Devil Canyon construction and operation. A fifth phase is also presented, which proposes sites to be constructed if adjustments are needed in Phases One through Four. Thus, phased development provides flexibility in responding to changes in recreation demand or to unexpected impacts to area resources. Phasing of the recreation plan as proposed for the two stage project assumes that the Watana access road would be open to the public after Watana construction and the Devil Canyon access road would be open after construction of Devil Canyon.1/

Assuming public access after completion of each stage, the three stage project would not change the number of facilities proposed for the recreation plan. However, it could change the timing and location of facilities proposed near Watana Dam in Stage II of the two stage project plan. The Watana Dam visitor center and trails would either be relocated to the north side of the dam in Phase Two or would be constructed after completion of

1/ The policy regarding public access after completion of project stages and before completion of all construction has not yet been determined.

Stage III, since the area around Watana Dam would be closed to the public for Stage III construction. Boat access to and from both reservoirs near the Watana damsite would also likely be restricted during Stage III construction.

Construction of Stage III may also delay development of recreation sites proposed south of the Susitna River in Phase Five since access across Watana Dam would be disrupted until the completion of Stage III. Development plans of Native landowners for areas south of Susitna River could also be delayed for the same reason.

Recreation facilities proposed for the construction work force would not change since total work force estimates for the three stage project are not expected to be significantly different than those for the two stage project (see Table VI.F.1). The three stage project, however, would require the proposed worker recreational facilities to remain in service for a longer period of time, which would increase operation and maintenance costs.

4. Mitigation

The recreation plan proposed for the two stage project serves as mitigation for recreation-related impacts of the project. Changes in the recreation plan that may be required under the three stage project include the development of a sixth recreation phase to coincide with completion of the Stage III construction, and appropriate signage placed at upper Susitna River sites warning boaters of construction and access restrictions at the Watana damsite. Restrictions may include closure or some type of permit.

## H. AESTHETICS ANALYSIS

### 1. Summary

The three stage project would not significantly change the aesthetic resource effects that would occur for the two stage project. While some areas, such as temporary construction camps, would be disturbed for a longer period of time because of the extended construction period, they would be reclaimed as they would under the two stage project. Likewise, monitoring aesthetic mitigation implementation would occur for a longer period of time due to the extended construction period.

### 2. Project Facilities

Three stage construction would result in some positive short-term aesthetic effects. Namely, a lower Watana reservoir in Stage I would result in fewer mudflats due to reduced drawdown and confinement of the reservoir to steeper valley slopes. The reduction in mudflats would be most apparent in the Watana Creek drainage.

The project's transmission line system would also be built in three stages. The transmission system would be identical to the two stage project at the end of Stage III, but during Stages I and II fewer lines would exist than shown in the two stage project. While the presence of fewer transmission lines in Stages I and II would result in a short-term reduction of visual impacts, this reduction would be offset because transmission line construction (with its associated visual impact from construction activities) would occur in all three stages.

Visual impacts related to borrow areas are not expected to differ substantially from the two stage project. The three stage project would reduce the amount of material required from Borrow Site A because all borrow material for Stage I would be obtained through excavation of the deeper spillway required for the three stage project. Borrow Site A, which is located near

Watana Dam and the presently proposed visitor center, would be highly visible. Although the borrow area would still be needed for Stage III construction, the extent of its visual impact would be lessened with the three stage project.

3. Mitigation

No additional aesthetic mitigation beyond that proposed for the two stage project is anticipated for the three stage project. Field monitoring related to construction and implementation of mitigation measures, however, would continue for a longer period of time.

The transmission system would be identical to the two stage project at the end of Stage III, but during Stages I and II fewer lines would exist than shown in the two stage project. While the presence of fewer transmission lines in Stages I and II would result in a short-term reduction in visual impacts, this reduction would be offset because transmission line construction (with its associated visual impact from construction activities) would occur in all three stages.

# SECTION VIII

**SUSITNA HYDROELECTRIC PROJECT**
**FERC License Application-Project No. 7114**

**DISTRIBUTION OF PRE-FILING CONSULTATION PACKAGE**

**STATE AGENCIES**

**ALASKA DEPARTMENT OF COMMERCE AND ECONOMIC DEVELOPMENT**

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**ALASKA DEPARTMENT OF COMMUNITY AND REGIONAL AFFAIRS**

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**ALASKA DEPARTMENT OF NATURAL RESOURCES**

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**ALASKA DEPARTMENT OF PUBLIC SAFETY**

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**ALASKA PUBLIC UTILITIES COMMISSION**

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**ALASKA DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES**

The Honorable Richard J. Knapp
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**DEPARTMENT OF HEALTH AND HUMAN SERVICES**

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**HISTORIC PRESERVATION COUNCIL**

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**NATIONAL PARK SERVICE**

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**RURAL ELECTRIFICATION ADMINISTRATION**

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**U.S. DEPARTMENT OF AGRICULTURE**

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Attention: Mr. Davey Lacey
General Manager

**FRIENDS OF THE EARTH**

Friends of the Earth
530 7th Street, S.E.
Washington, D.C. 20003

Attention: Mr. Dave Conrad

**GERLACH**

Mr. Robert Gerlach
Box 23
Talkeetna, Alaska 99676

**KNIK KANOERS AND KAYAKERS, INC.**

Knik Kanoers and Kayakers, Inc.
P.O. Box 101935
Anchorage, Alaska 99510

Attention: Mr. Mike Grijalva
President

**MANNIX**

Mr. Arthur J. & Karen I. Mannix
P.O. Box 284
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**NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION**

National Oceanic and Atmospheric Administration
P.O. Box 1668
Juneau, Alaska 99802

Attention: Mr. Ben Rosenthal
Staff Attorney

**NATIONAL WILDLIFE FEDERATION**

National Wildlife Federation
1412 Sixteenth Street, NW
Washington, DC 20036

Attention: Mr. David G. Burwell

**NORTHERN ALASKA ENVIRONMENTAL CENTER**

Northern Alaska Environmental Center
725 Christiansen Drive
Anchorage, Alaska 99501

Attention: Mr. H. Clifton Eames, Jr.

**NATIONAL AUDUBON SOCIETY**

National Audubon Society
125 Christensen Drive, Suite 2
Anchorage, Alaska 99501

Attention: Mr. David R. Cline

**PAGE**

Mr. Joe C. Page
Box 1477
Talkeetna, Alaska 99676

**POPE AND ROGERS**

Pope and Rogers
526 Main Street
Juneau, Alaska 99801

Attention: Mr. Douglas Pope

**SHELDON**

Ms. Roberta Sheldon
Main Street
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**SIERRA CLUB LEGAL DEFENSE FUND, INC.**

Sierra Club Legal Defense Fund, Inc.
419 6th Street, Suite 321
Juneau, Alaska 99801

Atention: Ms. Lauri Adams

cc: Sierra Club Legal Defense Fund, Inc.
542 E 4th Ave # 5
Anchorage, Alaska 99501

Attention: Ms. Sally Kabisch

**TRUSTEES FOR ALASKA - SUSITNA PROJECT**

Trustees for Alaska - Susitna Project
725 Christiansen Drive, Suite 4
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Attention: Robert Adler, Esq.

**UNITED FISHERMEN OF ALASKA**

United Fishermen of Alaska
P.O. Box 558
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Attention: Mr. Ken Castner

**U.S. DEPARTMENT OF THE INTERIOR**

U.S. Department of the Interior
18th and C Street, NW
Washington, D.C. 20240

Attention: Solicitor

**WAITE**

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**WILSON**

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**RESOURCE DEVELOPEMENT COUNCIL**

Resource Development Council
Box 100516
807 G Street
Anchorage, Alaska 99510-0516

Attention: Ms. Paula Easley
Executive Director