Browne Hydroelectric Alternative for the Railbelt Region of Alaska

Volume XV

Ebasco Services Incorporated

August 1982

Prepared for the Office of the Governor
State of Alaska
Division of Policy Development and Planning
and the Governor's Policy Review Committee
under Contract 2311204417

Battelle
Pacific Northwest Laboratories

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ACKNOWLEDGMENTS

The major portion of this report was prepared by the Bellevue, Washington, and Newport Beach, California, offices of Ebasco Services Incorporated. Their work includes the Introduction, Technical Description, Environmental and Engineering Siting Constraints, Environmental and Socioeconomic Considerations and Institutional Considerations. Capital cost estimates were prepared by S. J. Groves and Sons of Redmond, Washington, and reviewed by the Ebasco cost estimating department in New York City. Cost of energy estimates were prepared by Battelle, Pacific Northwest Laboratories of Richland, Washington.

PREFACE

The state of Alaska, Office of the Governor, commissioned Battelle, Pacific Northwest Laboratories (Battelle-Northwest) to perform a Railbelt Electric Power Alternatives Study. The primary objective of this study was to develop and analyze long-range plans for electrical energy development for the Railbelt Region (see Volume I). These plans will be used as the basis for recommendations to the Governor and Legislature for Railbelt electric power development, including whether Alaska should concentrate its efforts on development of the hydroelectric potential of the Susitna River or pursue other electric power alternatives.

Substantial hydro resources exist in the Railbelt Region. Many of these resources could be developed with conventional (~15 MW installed capacity or larger) hydroelectric plants. Several sites have the potential to provide power at first-year costs competitive with thermal alternatives and have the added benefit of long-term resistance to effects of inflation. Environmentally, hydroelectric options are advantageous because they produce no atmospheric pollution or solid waste. However, environmental disadvantages may include the destruction and transformation of habitat in the area of the reservoir, destruction of wilderness value and recreational opportunities, and negative impacts on downstream and anadromous fisheries. High capital investment costs render many sites noncompetitive with alternative sources of power.

Based on environmental and economic considerations, the Browne hydroelectric project was among several hydroelectric projects identified as preferred hydroelectric alternatives to the Upper Susitna project. An individual study of the Browne project was commissioned, partly because of its estimated capacity and energy production, which were somewhat greater than most of the other sites, and also because of its apparently modest environmental impact. This report, Volume XV of a series of seventeen reports, documents the findings of this study.

Other power-generating alternatives selected for in-depth study included pulverized coal steam-electric power plants, natural gas-fired combined-cycle power plants, the Chakachamna hydroelectric project, large wind energy conversion systems and coal-gasification combined-cycle power plants. These alternatives are examined in the following reports:

Ebasco Services, Inc. 1982. Coal-Fired Steam-Electric Power Plant Alternatives for the Railbelt Region of Alaska. Prepared by Ebasco Services Incorporated and Battelle, Pacific Northwest Laboratories for the Office of the Governor, State of Alaska, Juneau, Alaska.

Ebasco Services, Inc. 1982. Natural Gas-Fired Combined-Cycle Power Plant Alternative for the Railbelt Region of Alaska. Prepared by Ebasco Services Incorporated and Battelle, Pacific Northwest Laboratories for the Office of the Governor, State of Alaska, Juneau, Alaska.

Ebasco Services, Inc. 1982. Chakachamna Hydroelectric Alternative for the Railbelt Region of Alaska. Prepared by Ebasco Services Incorporated and Battelle, Pacific Northwest Laboratories for the Office of the Governor, State of Alaska, Juneau, Alaska.

Ebasco Services, Inc. 1982. Wind Energy Alternative for the Railbelt Region of Alaska. Prepared by Ebasco Services Incorporated and Battelle, Pacific Northwest Laboratories for the Office of the Governor, State of Alaska, Juneau, Alaska.

Ebasco Services, Inc. 1982. Coal-Gasification Combined-Cycle Power Plant Alternative for the Railbelt Region of Alaska. Prepared by Ebasco Services Incorporated and Battelle, Pacific Northwest Laboratories for the Office of the Governor, State of Alaska, Juneau, Alaska.

SUMMARY

Numerous sites showing potential for hydroelectric development have been identified in the Railbelt Region of Alaska. Many, however, appear at this time to be uneconomic to construct due to high capital costs, or appear to have the potential for unacceptably severe environmental impacts. Among the sites of sufficient size to be of interest in the context of a Railbelt-wide electric power planning and that present potentially competitive economic characteristics and acceptable environmental impacts is a site on the Nenana River, approximately 2 miles north of the Alaska Railroad siding of Browne.

The proposed Browne hydroelectric project would be a conventional hydroelectric development, consisting of a dam, reservoir and power plant. The installed capacity of the power plant would be 100 MW. Power from the project would be transmitted to the proposed Anchorage-Fairbanks intertie, approximately 3-1/2 miles north of the powerhouse. The estimated annual average energy production would be 430 GWh and the estimated annual firm energy production would be 298 GWh.

Cost estimates for the proposed project indicate an overnight capital cost of 4460 $/kW, with operation and maintenance costs of 4.80 $/kW/yr. Based on a 1990 in-service date, levelized busbar energy costs were estimated to be 52 mills/kWh in January 1982 dollars. (Not included in this estimate is the cost to relocate approximately 8 miles of highway and 16 miles of railroad.)

Approximately 9 years would be required for project construction, including preconstruction studies and a 4-1/2 year construction period. Given a mid-1982 authorization to proceed, the project could be in service in late 1990.

Environmental effects of the Browne project appear to be relatively minor. Anadromous fish runs are not known to be present in this portion of the Nenana River and no critical terrestrial habitat appears to be present in the area of the reservoir.

Two engineering constraints may impact the feasibility of the project. Previous materials underlie the proposed site and the dam would be located within the proximity of a seismically active zone. Pervious materials can be removed by dredging. However, their depth and extent are not known at this time. Structures can be designed to withstand severe seismic loads, but at additional cost. An uncertainty relating to the required seismic design considerations is the presence and extent of soils or sands subject to liquefaction during a seismic event.

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FIGURES

<u>TABLES</u>

1.0 INTRODUCTION

The proposed Browne hydroelectric project will be a conventional hydroelectric development consisting of a dam, reservoir, and power plant located on the Nenana River approximately 65 air miles southwest of Fairbanks. The Alaska Railroad is adjacent to the powerhouse site and the Anchorage-Fairbanks highway is located about 1 mile west of the Nenana River. A dam will be built across the Nenana River to form the storage reservoir. Water will be conveyed from this reservoir through a high-pressure tunnel and penstocks to a power plant with an installed capacity of 100 MW. The power from the project will be brought into the proposed Anchorage-Fairbanks intertie.

The advantages of the project may be categorized generically, as related to hydro power, and on a site-specific level. In a generic sense, the pertinent advantages of hydro power are: zero fuel costs, maturity of technology, simplicity, reliability, and quick responsiveness of the generating equipment to changes in load.

More specific advantages of the Browne site are its close proximity to existing transportation facilities, thus minimizing access requirements. Also, transmission corridor requirements will be minimal due to the suggested routing of the Anchorage-Fairbanks intertie, which is within 3 miles of the Browne powerhouse location (Commonwealth Associates 1981). Geographically, the site is centrally located and well removed from any natural physical impediments (e.g., mountainous terrain, glaciers, large rivers, etc.). Potential environmental effects appear to be minor. Finally, the conceptual layout developed herein is quite conventional, containing no unusual project features and therefore should not require any unusual construction techniques.

The project site, however, possesses certain disadvantages. Seismically, the site is located in an area of major activity, with the powerhouse being approximately 25 miles north of a significant fault zone. Foundation materials along this portion of the Nenana River are not generally well suited for a dam foundation. This is particularly true for that portion of the foundation that lies directly under the dam axis. These materials basically consist of coarse pervious sands and gravels.

Another significant disadvantage of the Browne project is that its development will require the relocation of the Alaskan Railroad siding at Browne, as well as the relocation of approximately 16 miles of Alaska Railroad track and 8 miles of the Anchorage-Fairbanks highway. At their present locations, these features will be inundated by the reservoir.

2.0 PROJECT DESCRIPTION

2.1 SITE DESCRIPTION

The project site will be located at the start of the foothills north of the Alaska Mountain Range. Topography in the vicinity of the proposed reservoir, along the Nenana River, is relatively flat. This topography rises fairly abruptly to the east of the river valley and more gradually to the west (see Figure 2.1). The dam for the project will be constructed across this valley at its narrowest point.

Seismically, the area is very active. In 1937 and again in 1947 severe earthquakes shook the area. The epicenter of the 1947 earthquake was at Clear, 10 miles north of the proposed powerhouse, and registered an intensity of VIII+ on the Mercalli Scale. The 1937 earthquake, slightly less intense than the 1947 event, had its epicenter near Salcha, approximately 50 miles east of the powerhouse. Also, approximately 25 miles south of the proposed powerhouse is a major fault zone that has produced offsets within Holocene sediments dated younger than 10,000 years.

The Nenana River originates on the northern slope of the Alaska Range and runs generally in a northerly direction to the Tanana River. The Browne damsite is located approximately 1.7 miles downstream from the railroad siding at Browne, with a drainage area of approximately 2,450 square miles above the damsite. Streamflow records exist for three locations on the river, as shown on Table 2.1.

In hydropower simulation studies performed by Acres American, Inc. (1981), the 23-year period of record for the USGS gage near Windy was used to generate a monthly streamflow model for the Browne site. This was accomplished by multiplying the records from the gage near Windy times the ratio of the drainage area at the damsite to the drainage area of the gage (2,450/710 = 3.45). In generating a monthly streamflow model for use in Ebasco's independent simulation studies, the 29-year period of record for the gage near Healy was utilized rather than the gage near Windy. The Healy gage was considered more appropriate for use than the gage near Windy because the drainage area at

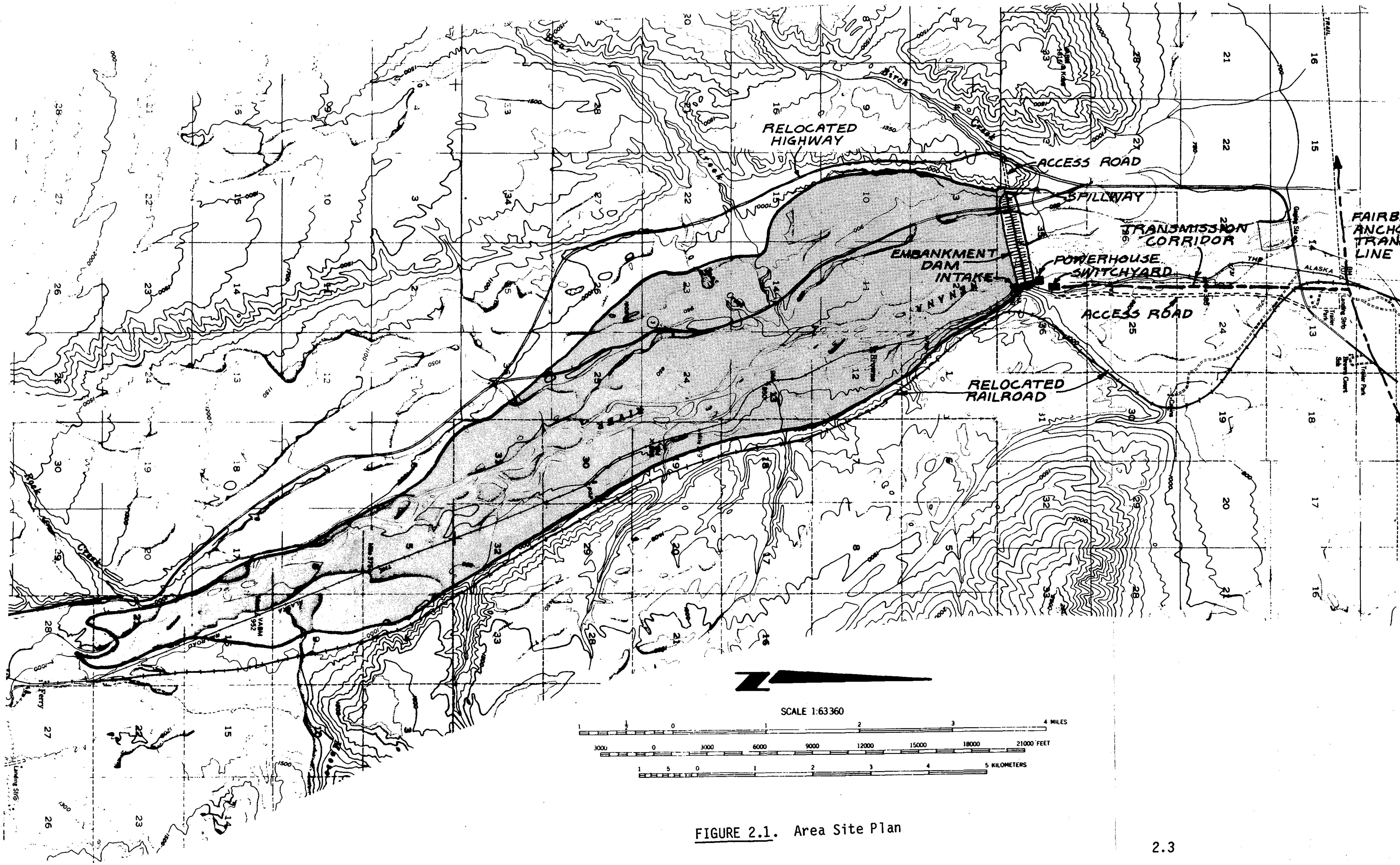


FIGURE 2.1. Area Site Plan

TABLE 2.1. USGS Gaging Stations on the Nenana River

Gage No.	Gaging Station	Drainage Area (mi^2)[(a)]	Period of Record
15516000	Nenana River Near Windy	710	10/51-9/73
15518000	Nenana River Near Healy	1910	10/50-9/79
15518300	Nenana River Near Rex	2450	10/64-9/68

(a) Drainage area at Browne damsite is approximately 2,450 mi^2.

the Healy gage (1,910 mi^2) is closer in size to that at the damsite (2,450 mi^2) and the period of record is longer. The average monthly flows for the 29-year period of record as recorded at the Healy gage are shown in Table 2.2. The flows at the damsite were estimated by multiplying the flows at the Healy gage times the ratio of the drainage area at the damsite to the drainage area at the gage (2,450/1,910 = 1.28). The estimated average annual flow at the damsite is 4,500 cfs.

2.2 PLANT DESCRIPTION

2.2.1 Overview

The Browne project will consist of a dam, spillway, storage reservoir, powerhouse, and appurtent structures. The storage reservoir will be formed by an earth and rockfill dam. The intake, water conductors, and powerhouse will be located in the left abutment and the spillway will be located in the right abutment. A site plan of the project is shown in plan and section in Figure 2.1 and the general arrangement of project features is shown in Figure 2.2. Detailed plans and sections of the proposed powerhouse are shown in Figures 2.3 and 2.4, and details of the power intake and tunnel are shown in Figures 2.5 and 2.6. A summary of the principal project features is shown in Table 2.3.

TABLE 2.2. Average Monthly Discharge in Nenana River Near Healy, Alaska (cfs)[a,b]

Water Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1951	1,354	610	565	545	465	430	627	5,874	7,211	8,155	7,032	8,461
1952	1,929	1,092	830	600	500	480	510	2,348	10,050	11,290	7,,355	4,701
1953	3,074	1,300	800	430	360	430	600	3,640	10,990	9,082	8,460	5,978
1954	1,702	750	650	570	488	390	450	3,130	7,618	7,386	9,580	5,260
1955	2,429	1,200	552	500	460	440	380	2,979	9,906	10,760	9,154	6,290
1956	1,858	825	640	550	510	440	437	4,222	11,240	10,010	9,805	6,003
1957	2,213	875	715	689	608	514	510	5,451	12,370	7,573	6,450	6,185
1958	2,474	1,765	1,387	771	457	369	550	3,133	10,260	7,805	8,212	2,732
1959	1,503	745	549	568	481	339	400	4,472	8,963	11,280	7,420	4,475
1960	2,535	1,250	760	688	561	516	580	6,442	5,480	8,069	7,737	6,107
1961	1,995	795	764	730	454	422	635	5,281	9,638	9,034	10,530	4,386
1962	2,208	1,200	760	610	470	420	520	4,443	15,060	10,860	8,035	6,926
1963	2,370	1,160	670	540	500	470	520	5,558	9,883	13,970	12,680	5,450
1964	2,818	1,225	580	580	420	360	505	919	12,280	10,260	6,573	3,609
1965	2,713	1,200	740	520	440	430	595	4,129	10,630	11,080	6,369	7,168
1966	2,944	1,200	697	500	500	500	540	2,450	12,440	7,589	7,913	4,963
1967	2,375	740	624	555	491	460	450	3,899	11,910	15,340	13,090	4,816
1968	1,829	900	713	660	625	599	632	4,749	14,180	10,310	6,064	2,941
1969	1,287	404	262	228	220	220	468	4,132	7,434	5,876	4,307	2,109
1970	1,034	659	530	477	452	440	507	3,953	7,882	11,110	7,284	4,302
1971	1,880	756	546	540	540	540	533	3,716	14,500	10,730	10,410	4,865
1972	2,384	1,293	877	678	539	462	434	3,361	10,330	8,972	6,638	3,999
1973	2,532	1,667	794	600	500	450	524	3,287	6,201	7,709	7,178	3,136
1974	1,416	767	415	247	190	190	202	2,536	5,721	7,339	6,434	4,997
1975	2,366	913	655	500	500	500	533	2,864	10,390	9,877	6,630	5,410
1976	2,045	800	627	474	400	360	448	3,316	7,216	5,871	5,436	2,747
1977	1,694	967	700	600	500	450	483	3,278	12,030	10,010	8,129	5,621
1978	3,511	1,613	844	651	576	510	806	4,350	6,336	8,418	6,796	3,678
1979	1,853	927	705	579	500	450	535	4,749	7,494	10,180	6,603	4,165

(a) From USGS Gage No. 15518000, Nenana River near Healy (Drainage Area = 1,910 mi^2).
(b) Flows at damsite computed by multiplying recorded flows by ratio of drainage areas (2,450/1,910 = 1.28).

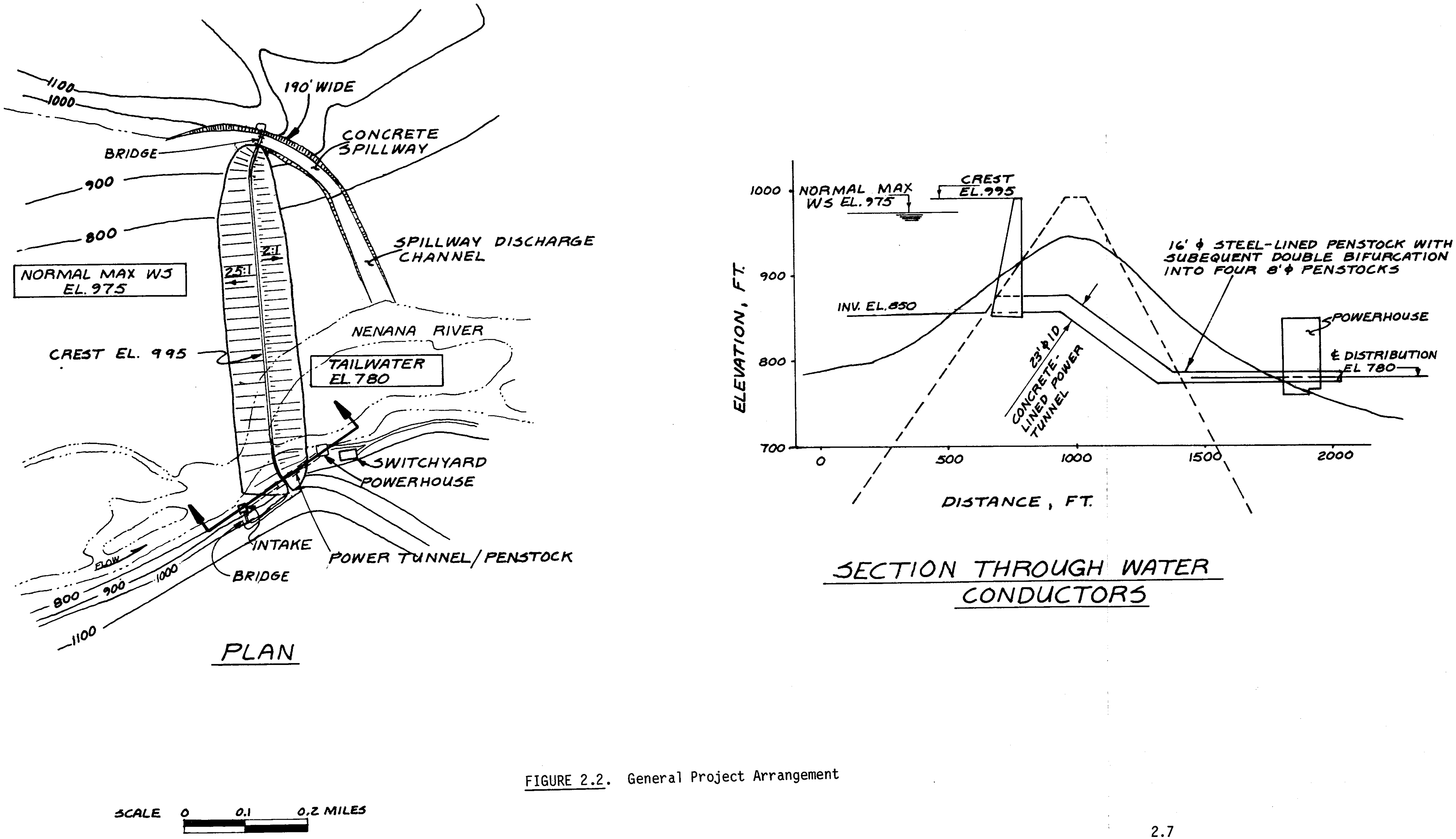
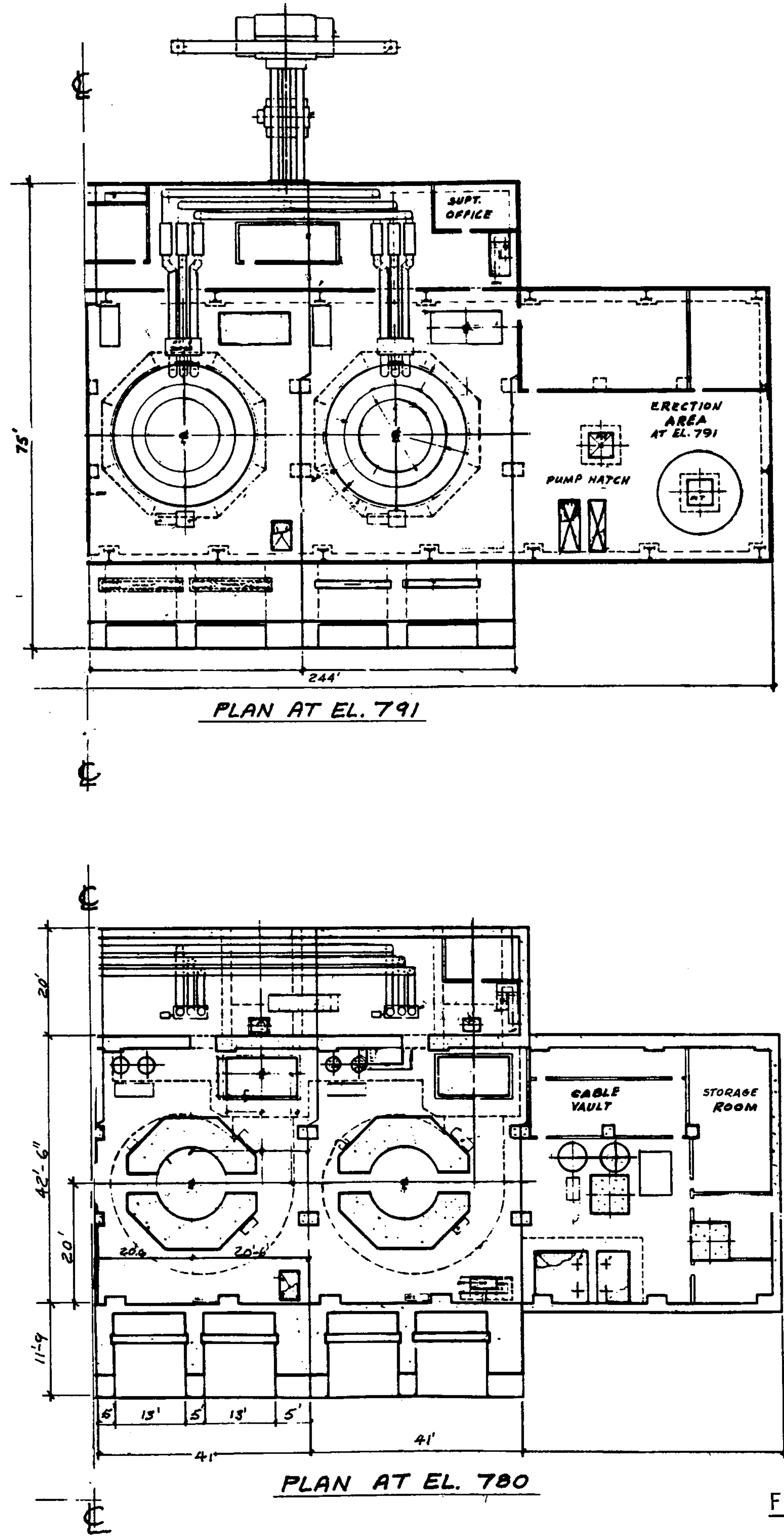
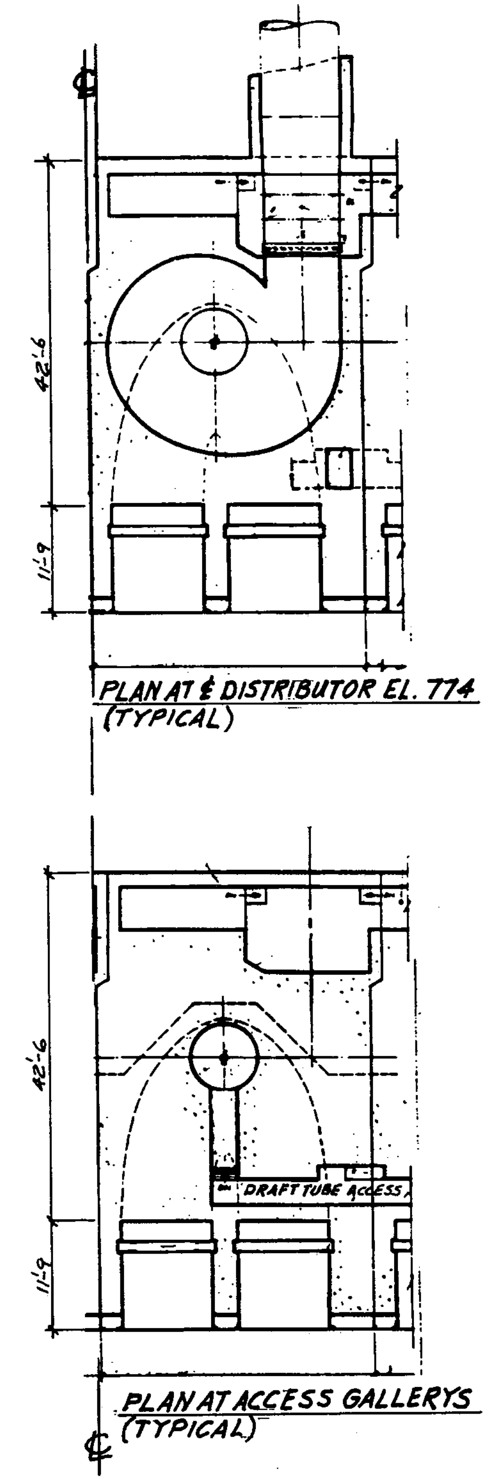


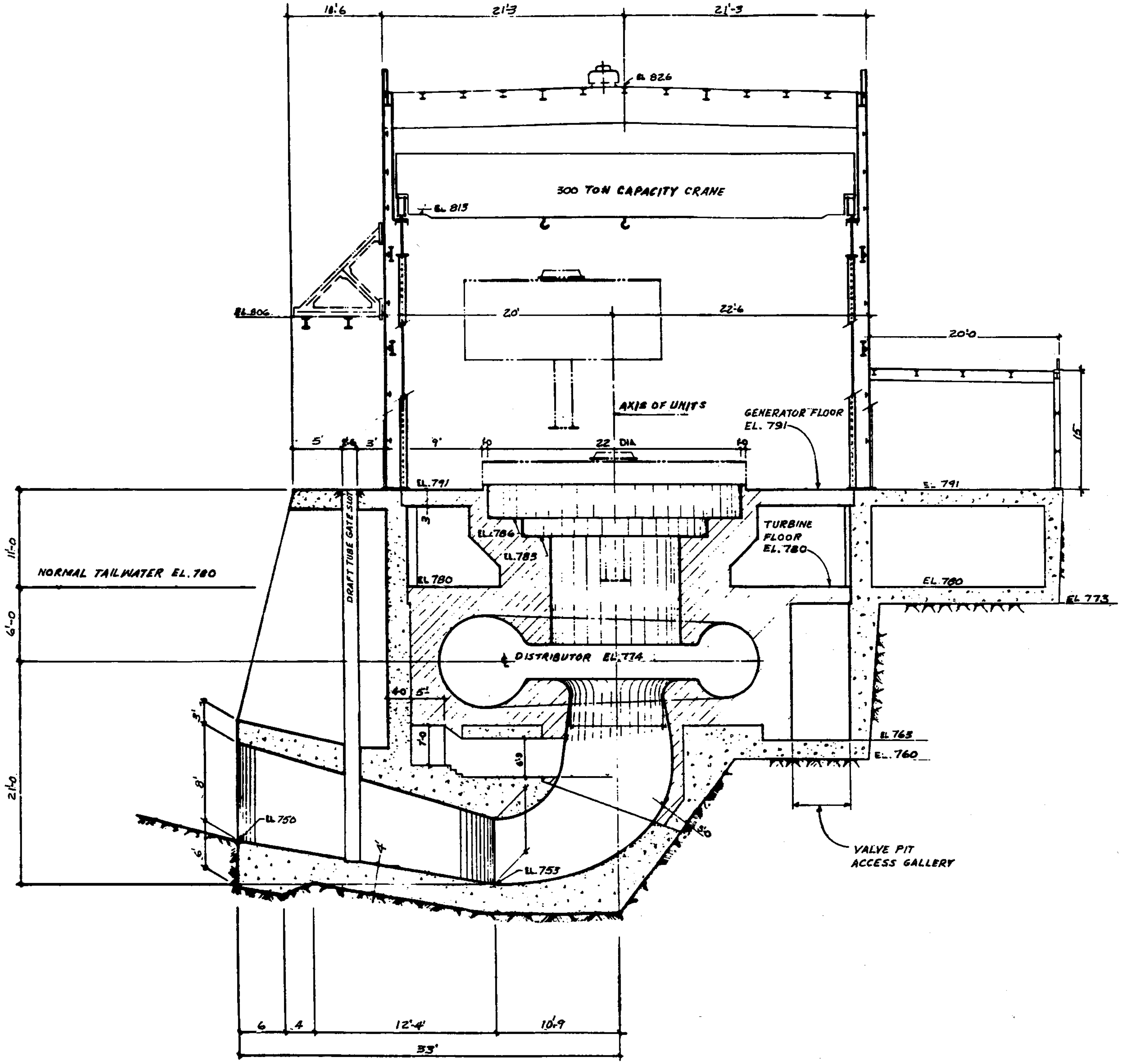
FIGURE 2.2. General Project Arrangement





NOT TO SCALE

FIGURE 2.3. Powerhouse Plan



SECTION THRU CENTER-LINE OF UNIT
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FIGURE 2.4. Powerhouse Section

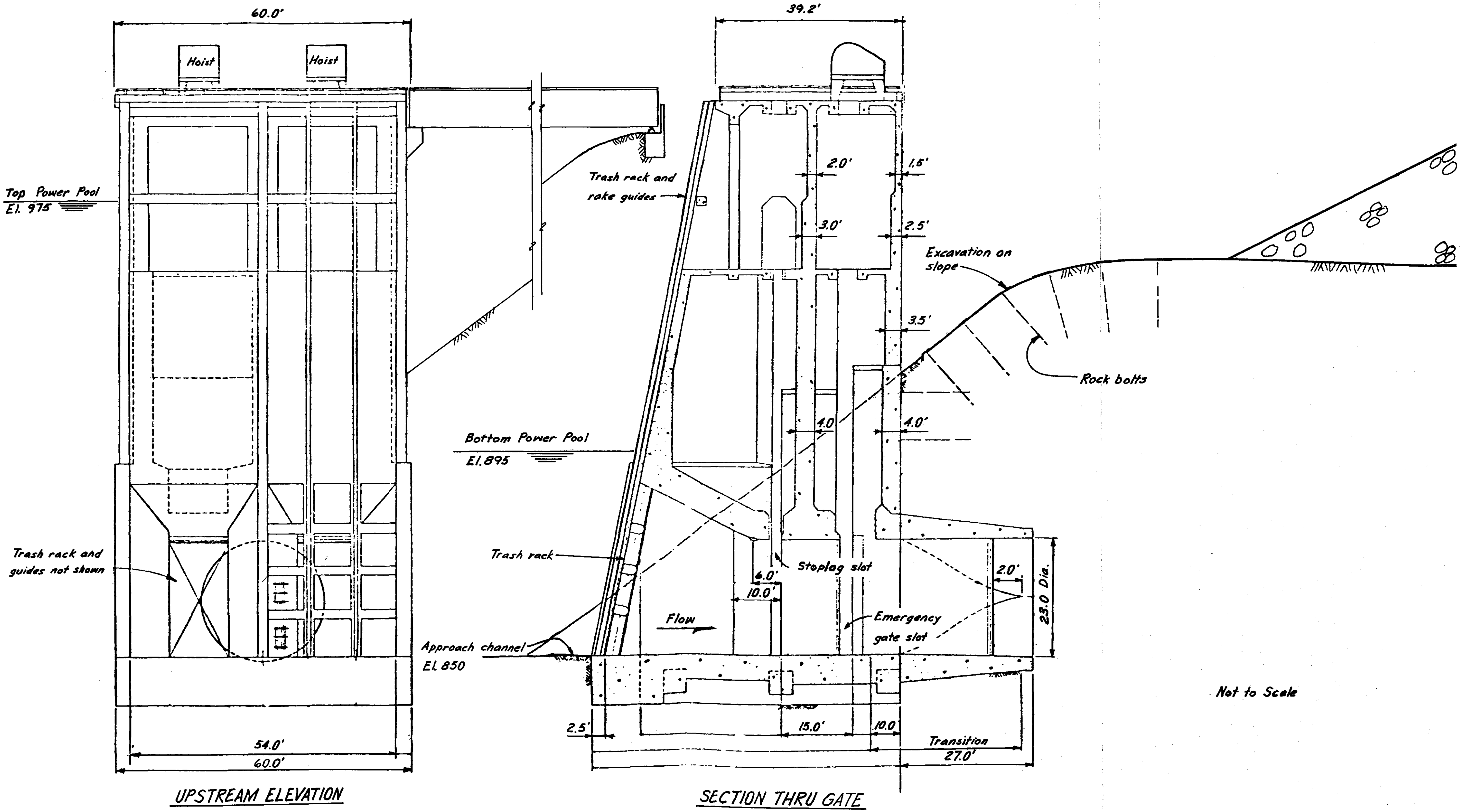


FIGURE 2.5. Power Intake Elevation and Typical Section

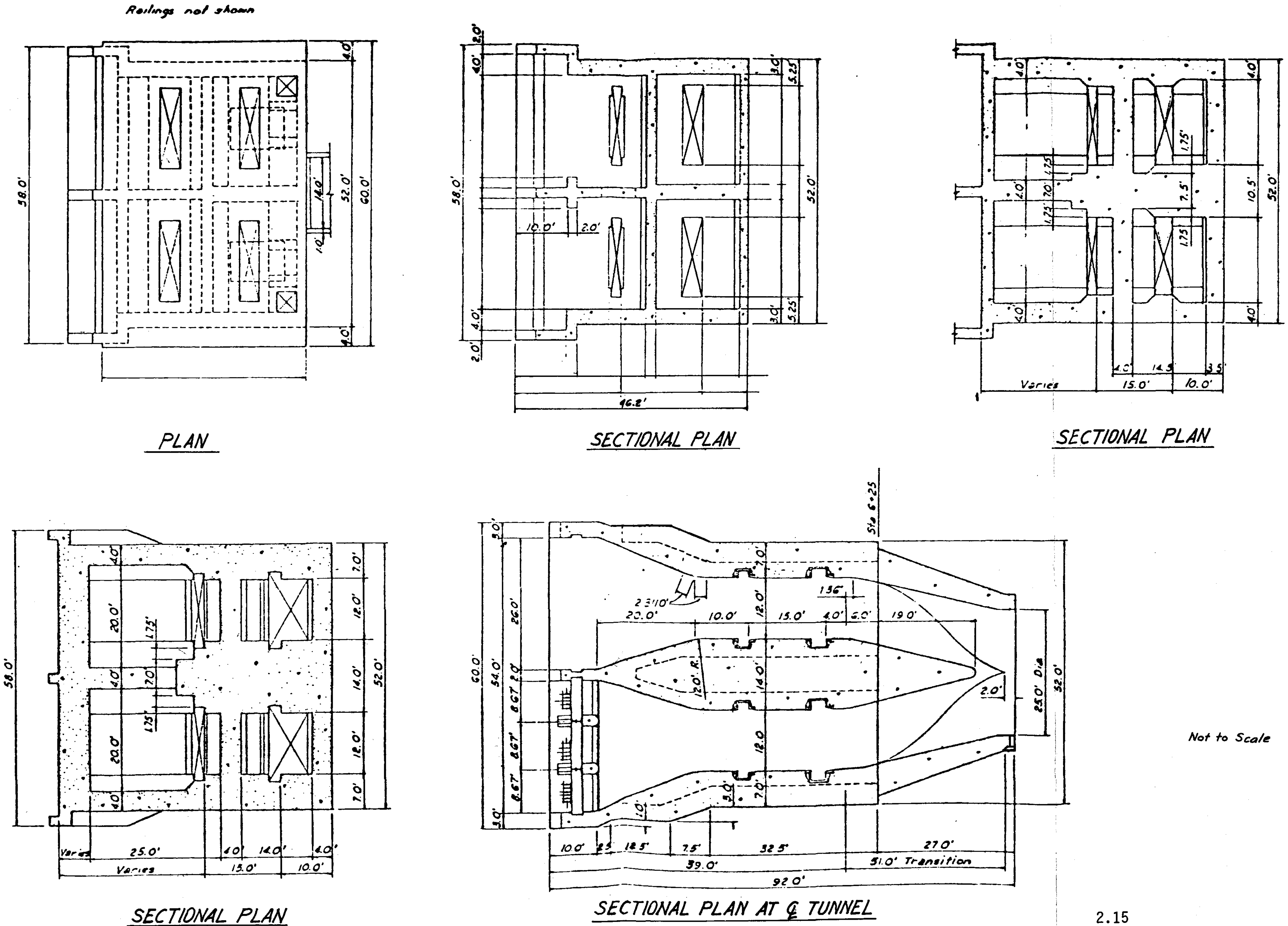


FIGURE 2.6. Power Intake and Tunnel

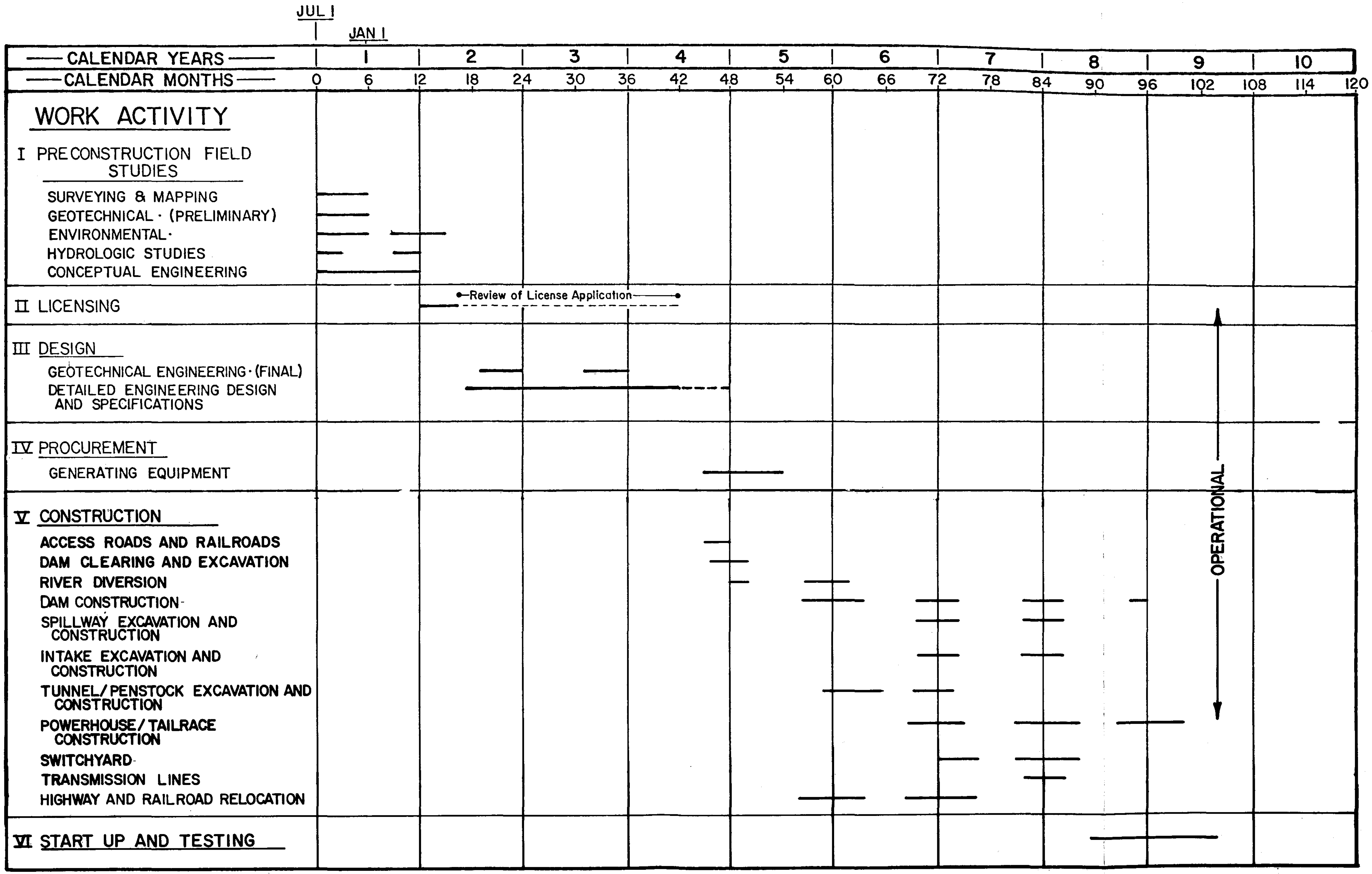


FIGURE 2.7. Construction Schedule

TABLE 2.3. Summary of Project Features

Intake Structure -	
Outside dimensions:	width - 39 ft length - 60 ft height - 145 ft
Two intake gates	
Power Tunnel:	700 lineal feet 23 ft inside diameter concrete lined
Penstocks:	1 - 400 lineal feet 16 ft inside diameter steel-lined
	4 - 100 lineal feet 8 ft inside diamter steel-lined
Powerhouse:	100 MW installed capacity 4 Francis Turbines, 34,600 hp, 170 ft net design head 4 Generators, 27,800 kVA, 225 rpm at 0.90 PF
Outside Powerhouse dimensions:	width = 75 ft length = 244 ft height = 75 ft (35 ft above grade)
Transformers (2):	3-phase 240 MVA, 13 kV to 138 kV
Tailrace Channel:	width = 90 ft depth = 23 ft length = 500 ft
Dam:	Earth and rockfill, zoned embankment length = 3,000 ft maximum height = 200 ft crest width = 25 ft upstream slope 2.5:1 downstream slope 2.0:1
Damsite Excavation:	2 ft under entire dam plus 30 feet beneath the impervious core in the streambed tapering off to 10 feet at the top of the dam (these values are assumed - no data was available for depth of gravels at damsite)
River Diversion (2):	12 ft diameter concrete encased diversion conduits - 600 ft long
Spillway:	190 ft wide tapering to 150 ft wide 40 ft deep at the crest 850 ft long 4 tainter gates (40 ft x 40 ft)
Spillway Discharge Channel:	1000 ft long, approximately 250 ft wide and 10 ft deep
Switchyard Dimensions:	300 ft x 100 ft
Access Roads:	3.5 miles
Transmission Line:	3.5 miles 138 kV (all new corridor)
Relocations:	Alaska Railroad siding at Browne 16 miles of Alaska Railroad track 8 miles of Anchorage-Fairbanks Highway

The maximum gross head at the project will be 195 feet and the average net operating head is estimated to be approximately 170 feet. Maximum reservoir storage will be 1,100,000 acre-feet at the normal maximum pool elevation of 975. Dead storage will be 340,000 acre-feet, which provides a total usable storage of 760,000 acre-feet. It is estimated that approximately 88 percent of the total flow available from the drainage basin will be used for power production. The installed capacity of the plant will be 100 MW and the average annual energy production from the facility is estimated to be 430 GWh with a 49 percent plant factor.

Access to the site will be by road and will utilize existing transportation facilities as much as possible. Suggested plant access routes to be constructed are shown in Figure 2.1.

Power transmission from the site will tie into the projected Anchorage-Fairbanks grid system and will be along the corridor shown in Figure 2.1.

2.2.2 Dam and Reservoir

The dam will be constructed of zoned earth and rockfill. It will be approximately 200 feet high (crest elevation 995 ft) over most of its 3000-foot length and will have 2-1/2 to 1 upstream and 2 to 1 downstream side slopes. The central portion of the dam, approximately 15 percent of the width, will consist of an impervious clay core and the outer portions will consist of rockfill. Sand and gravel filters will separate the central core from the rockfill.

The concrete-lined spillway will be cut deeply into the left abutment. It will be 190 feet wide, 40 feet deep, 800 feet long and will be equipped with four 40 ft by 40 ft tainter gates. The crest of the spillway will be at elevation 955 feet. The spillway discharge channel will be cut in the river sands and gravels and will be approximately 1000 feet long, 250 feet wide, and 10 feet deep.

As discussed previously, the maximum reservoir pool will be at elevation 975 feet, with a maximum reservoir storage of 1,100,000 acre-feet. At this level, the reservoir will extend south of the dam for approximately 11 miles. The formation of the reservoir will require the relocation of approximately

16 miles of Alaska Railroad track and 8 miles of the Anchorage-Fairbanks highway. The reservoir will also inundate a railroad siding referred to as Browne, which is shown on the USGS Fairbanks A-5 quadrangle as five structures adjacent to the Alaska Railroad about 2 miles south of the damsite. Discussions with personnel from the Alaska Railroad indicate that the Brown siding is uninhabited.

2.2.3 Power Plant

The powerhouse will be an indoor-type, above-ground powerhouse located on the east bank of the Nenana River. The structure will be reinforced concrete, with the approximate dimensions being 244 feet long, 75 feet wide, and 75 feet high, with 35 feet above grade.

The general layout of the powerhouse is shown in Figure 2.3. The powerhouse will contain four vertical water wheel generating units rated at 27,800 kVA, with a 0.90 power factor. The generators will be driven by four Francis-type turbines at a synchronous speed of 225 rpm.

The powerhouse will consist of five monoliths, with the end bay being designated as the erection bay. The erection bay monolith will be in line with the axis of the powerhouse and its ground floor will be approximately at the same level as the turbine floor.

The steel superstructure will house the generator floor, public facilities and access, office, control, and equipment areas. The principal elements of the concrete substructure will be the turbines and waterways, but it will also house service functions, including the dewatering sump and pumps, oil storage and purification, potable water and sewage systems.

The generator floor will have the actuator cabinet, potential transformers and surge cubicles, switchgear, battery room, and cable vault. The control room will be located at the same level as the generator floor. Adjacent to the control room will be the heating and ventilation (H and V) equipment room. Additional powerhouse H and V equipment rooms will be located at this level at the rear of the powerhouse.

The turbine floor will support the actuator cabinet, pressure tank, excitation control and rheostat cubicles. The dewatering pumps and motors will be located on a platform in the sump pit, just under the turbine floor.

A butterfly valve will be located immediately upstream of each turbine. Hatches with removable covers will be located in the upstream service parking area for installation and maintenance of the valves.

To supply water to the powerhouse, a concrete intake structure will be constructed in the upstream right abutment. Details of this structure are shown in Figure 2.2. A power tunnel will be excavated through the right abutment connecting the intake structure to the powerhouse (see profile in Figure 2.1). This tunnel will have a 23-foot inside diameter and an invert elevation of 850 feet at the intake. The 600-foot-long upstream half of this tunnel will be reinforced concrete lined and slope to elevation 780 feet where it will then connect to a 16-foot-diameter steel-lined penstock tunnel. This subhorizontal tunnel reach will continue to the vicinity of the powerhouse where it will, through double bifurcations, reduce to four 8-foot-diameter steel-lined penstock tunnels connecting to the turbines.

A tailrace channel with an average width of 90 feet will be excavated to the natural river channel from the downstream end of the powerhouse draft tubes. The average tailwater elevation will be 780 feet.

A two-bay, one-and-a-half breaker switchyard containing six breakers and measuring approximately 300 x 100 feet will be located adjacent to the powerhouse. Two main 240 MVA three-phase transformers will transform the voltage from 13 kV to 138 kV transmission voltage.

2.3 TRANSMISSION SYSTEM

Transmission of power from the site will be over a 138-kV line and will utilize the Fairbanks-Anchorage intertie as suggested in the Commonwealth Associates (1981) report. The proposed location of the interconnection of the transmission line from the Browne project with the Fairbanks-Anchorage intertie is shown in Figure 2.1.

Basically, an overhead line will start in the switchyard close to the powerhouse and head northward along the flood plain of the Nenana River for approximately 3.5 miles. At that point connection with the Fairbanks-Anchorage intertie will be provided. The exact location of this intertie has not yet been finalized, however. The suggested 3.5-mile transmission corridor is so short and direct that no alternative routing is considered necessary.

Selection of transmission line structures is based on strength requirements, terrain, and visual appearance. Towers and angle structures will be composed of tubular steel-guyed columns, 50 to 80 feet high and pin-connected to their foundations. Steel H-pile foundations will be required, with sufficient penetration to withstand the active freeze-thaw zone as well as the normal structural uplift forces. This overall structure will combine the necessary strength with an inconspicuous appearance and will be economical to construct.

2.4 SITE SERVICES

Access to the site will be provided by road to both abutments. The left abutment/spillway will be reached by the relocated Anchorage-Fairbanks highway and via a 1/2-mile access road. The right abutment will be provided access via a 3-mile road paralleling the existing railroad and connecting with the Anchorage-Fairbanks highway. In addition, the existing railroad will be utilized for transportation of major equipment items to the powerhouse during construction. These access routes are shown in Figure 2.1.

The formation of the reservoir will require the relocation of approximately 16 miles of Alaska Railroad track to higher ground about 1/2 mile to the east. Similarly, about 8 miles of Anchorage-Fairbanks highway will require relocation 1 mile to the west of its present alignment.

No pipeline, air, or waterway access will be required. Living facilities during construction will be provided by either a trailer park-type arrangement or by temporary housing. No formal living facilities will be required during operation because the plant will be remote-controlled.

2.5 CONSTRUCTION

2.5.1 General Construction Methods

Prior to the start of construction of the dam, its entire foundation and abutments will be cleared and grubbed. Information on the amount of sands and gravels that will have to be excavated from beneath the dam impervious core alignment is not available and considerable quantities may prove to be involved. In addition, any other unsuitable material, such as excessively compressible materials, will be stripped from beneath the other dam zones. For estimating purposes, it was assumed that 2 feet of stripping were required beneath the entire dam, and 30 feet of excavation beneath the impervious core, tapering off to 10 feet at the top of the dam.

Concurrently with the above operations, the Nenana River will be diverted. This will be accomplished in two phases. First, the river will be allowed to flow along its present course while a double barrel concrete-encased diversion conduit with a gated intake is constructed to the west of the river. Diversion dikes and temporary cofferdams will be used to contain the river in its present location. With the completion of the conduit the river will then be routed from its present course to run through the conduit. This river diversion will remain in effect throughout most of the dam construction. Ultimately, the conduit intake gates will be closed and the conduit filled and sealed with concrete and grout.

Construction of the dam will utilize standard accepted practices except for some restrictions. All fill zones, for example, will have to be constructed fairly uniformly and simultaneously. No single fill zone will be allowed to be constructed significantly (more than a few feet) ahead of any other zone. Also, placement of impervious core materials will not be permitted during freezing weather and rain.

Excavation of the intake structure, power tunnel, penstock, spillway, and powerhouse will utilize conventional drilling and blasting methods and will be performed concurrently with the dam construction. The intake structure and powerhouse will be conventional in size and location, and should therefore not require any unusual construction methods or techniques. The only special consideration is the harsh winter climate, which could shorten the construction season by approximately 5 months, particularly during early stages of construction. To compensate for this, extended work shifts may be utilized in the summer months.

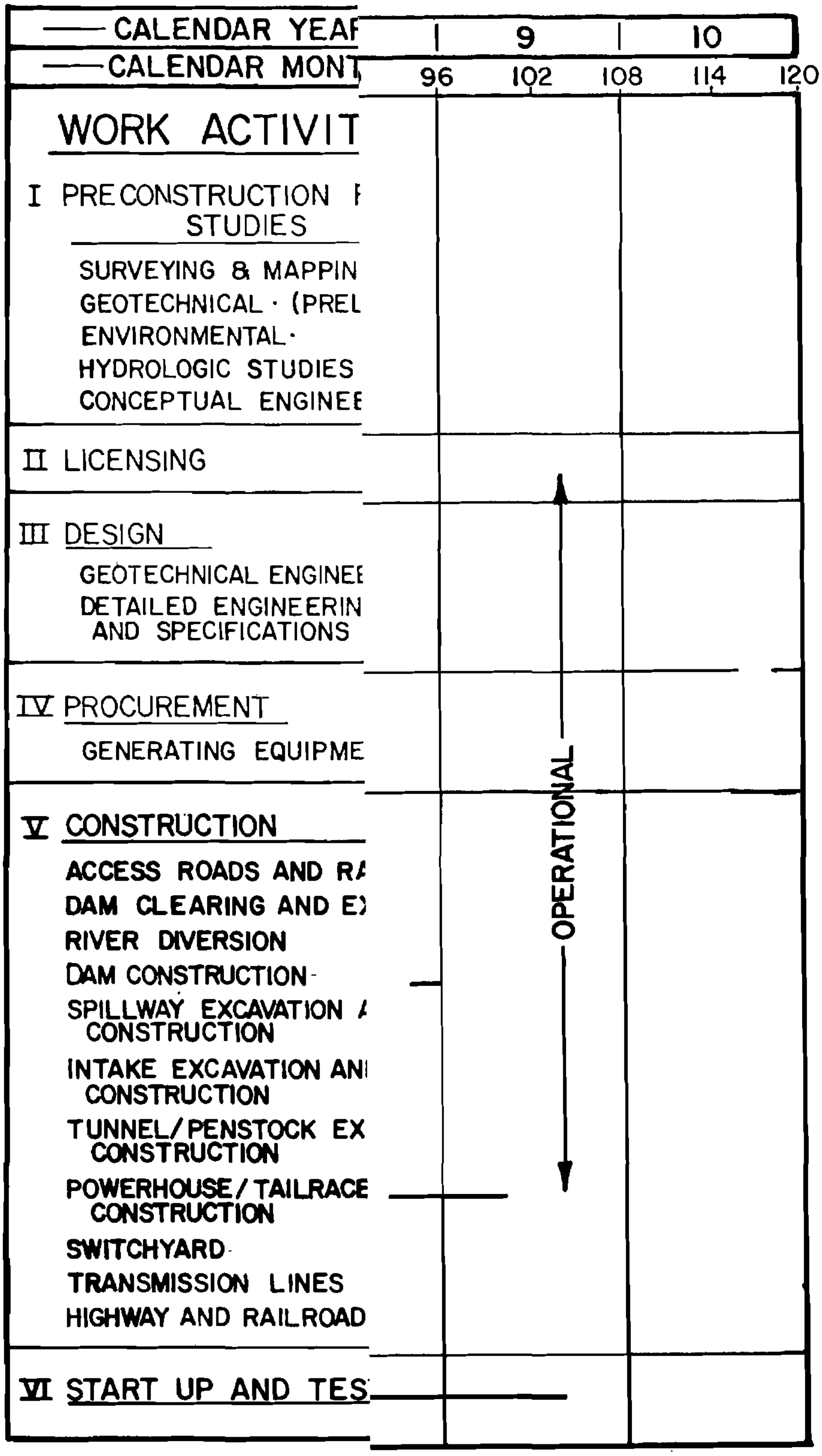
Construction of transmission lines, as well as access roads and railroads, should not require any unusual construction features or methods except for those required to cope with permafrost areas wherever encountered. Neither will the relocation of existing transportation facilities require other special consideration. However, these relocations will have to be performed without interruption of the facility's normal operation.

2.5.2 Construction Schedule

A complete project schedule from preliminary field studies though licensing, design, construction, startup testing, and commercial operation is presented in Figure 2.7. The schedule is broken down by major project activities versus calendar months; month zero representing July 1 of the base year.

From the start of work authorization at month zero it is estimated that approximately 18 months will be required to perform the preliminary field and office work necessary to support the conceptual engineering and licensing efforts. Part of this work will consist of field surveying and mapping, as well as preliminary geotechnical, hydrologic, and environmental studies. These efforts will utilize existing published information, as well as data gathered through preliminary field work.

Conceptual engineering will be performed concurrently with the field studies and will identify and evaluate possible alternative project layouts and features that best utilize the water resources of the Nenana River drainage basin. Power production analysis will consider a range of operational alternatives; and installed capacities will be investigated to define an optimum plant size and operation scheme. The selected plant size and operation scheme will maximize power output benefits and also incorporate any identified environmental constraints on project operation.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III DESIGN
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DETAILED ENGINEERIN AND SPECIFICATIONS
IV PROCUREMENT
GENERATING EQUIPME
V CONSTRUCTION
ACCESS ROADS AND RA
DAM CLEARING AND EX
RIVER DIVERSION
DAM CONSTRUCTION
SPILLWAY EXCAVATION A CONSTRUCTION
INTAKE EXCAVATION ANI CONSTRUCTION
TUNNEL/PENSTOCK EX CONSTRUCTION
POWERHOUSE/TAILRACE CONSTRUCTION
SWITCHYARD
TRANSMISSION LINES
HIGHWAY AND RAILROAD
VI START UP AND TES
OPERATIONAL

The above 18-month effort will terminate with the preparation and submittal of the necessary documentation for a license application to the Federal Energy Regulatory Commission (FERC). For schedule estimating purposes, it is assumed that 2 years will be required by FERC for processing of the license application.

Upon submittal of the FERC license application, detailed design will commence for the dam, power plant, and conveyance systems. This will also include design of the structures and the mechanical, electrical and control systems, as well as provision of support services to assure that the work is performed with appropriate management controls and that materials are available to support project schedules. Specifically, this work will include the following:

- Preparation of detailed design criteria and the development of project design drawings. Design drawings will accommodate all of the construction-related activities required by the project. This includes solicitation of bids for services, construction and erection activities, as well as actual construction of the tunnel, powerhouse, and transmission facilities. In addition to the detailed design drawings, the architect/engineer will prepare bills of material for supply of miscellaneous electrical, mechanical, and civil materials.

- Performance of engineering calculations required for preparation of drawings, specifications, and other pertinent data used in the design of the project, consistent with the requirements of regulatory bodies and design codes and standards.

- Preparation of technical specifications in sufficient detail to allow for project procurement and/or construction.

- Establishment of quality assurance requirements based on the detailed project design, as well as on information provided by vendors and contractors. These requirements will serve as a basis for construction and for erection of structures, for procurement, and for installation, testing, and operation of equipment.

It is estimated that 2.5 years will be required to carry out these design efforts.

Procurement activities that will commence after receipt of a FERC license will consist of the following:

- Preparation of bid documents and evaluation of bids.
- Review of vendor documents and drawings for conformance to architect-engineer specifications and for confirmation of physical interfaces with related systems.
- Monitoring and control of procurement contracts.
- Vendor quality assurance services to assure that purchased items are supplied in accordance with the requirements of applicable procurement documents.
- Expediting services to assure the timely arrival of purchased items at the site.

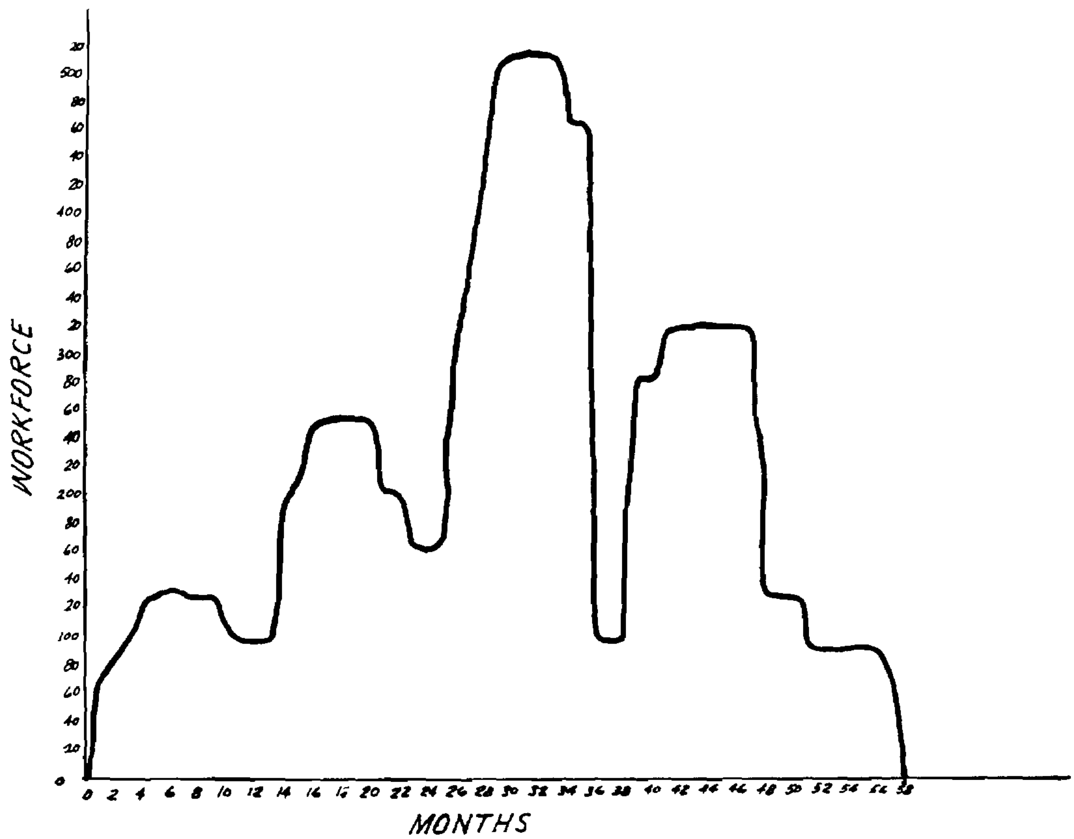
Full-scale construction activities on the main features of the project will start in the spring after receipt of the FERC license. It is estimated that construction of the entire project could be accomplished in about 4-1/2 years. As shown on the project schedule (Figure 2.7), this estimate is based on the yearly cessation of outdoor construction activities for a 5-month period during the winter months. Indoor activities will, however, be performed year-around.

Startup testing of all major equipment and auxiliary appurtenances will be performed before commercial acceptance. This testing will start during the last year of powerhouse construction and will continue for a period of approximately 4 months after construction has been completed.

Slightly less than 9 years would be required for development of the project, including preconstruction studies, licensing, design, construction and startup. Given authorization to proceed in mid-1982, the project could be fully operational by late 1990/early 1991.

2.5.3 Construction Work Force

The number of workers necessary for construction of the 100-MW hydroelectric power plant will vary over the approximate 4-1/2-year construction period. The distribution of this work force over the schedule duration is shown in Figure 2.8. Construction is estimated to peak in year 2, requiring a work force of approximately 515 personnel.



NOTE: Does not include vendor personnel, owner personnel, A-E engineers, or transmission line construction personnel located at site.

FIGURE 2.8. Construction Work Force Requirements

2.6 OPERATION AND MAINTENANCE

2.6.1 General Operating Procedures

The Browne project will be operated as a conventional hydroelectric facility, with releases being made through the power plant on a daily basis as required to meet load demands. The project will ordinarily operate 24 hours a day, with the greatest releases being made during daytime periods of peak load. During off-peak periods, the plant discharge will vary depending on system requirements but will never fall below a minimum discharge requirement. The reservoir level will vary on a seasonal basis as a function of load characteristics and available streamflow. The details of the operating characteristics are discussed in greater detail below.

2.6.2 Operating Parameters

Forced Outage Rate

The estimated forced outage rate for the project is 1 percent.

Scheduled Outage Rate

The scheduled outage rate for the plant is estimated to be an average of 5 days per year per unit over the life of the project.

Power Output and Project Operation Characteristics

A hydropower simulation study was performed for the Browne project by Acres American, Inc (1981). This study involved utilization of a reservoir and power plant model that simulated the operation of the project on a monthly basis for the 23-year period of hydrologic record. As discussed in Section 2.1, the Acres American study generated monthly inflows for the damsite using recorded flows from the USGS streamgage on the Nenana River near Windy. To provide an independent check to the Acres American study, Ebasco performed a similar operation study using the 29-year period of record of the USGS gage near Healy as a basis for developing monthly inflows at the project site. As indicated in Section 2.1, it was felt that the recorded streamflows at Healy were more appropriate than those from the Windy gage in view of the fact that the drainage area of the Healy gage is closer in size to the damsite than that of the Windy gage, and the period of record of the Healy gage is longer. Several parameters used in Ebasco's simulation study were obtained directly from the Acres American study. These include storage-elevation data, maximum and minimum storages, average tailwater level, minimum downstream release requirements, monthly demands, load factor, the discharge coefficient, and average overall efficiency. The results of Ebasco's operation study have been utilized herein as a basis for estimating the power output and operational characteristics of the project.

On an average annual basis, the reservoir level will vary between the normal maximum level of elevation 975 feet and a minimum of elevation 919 feet, with the average reservoir level being elevation 956 feet. The estimated average tailwater level at the Nenana River at the powerhouse site is elevation 780 feet, which provides an average gross power head of 176 feet. The monthly variation in reservoir level during an average year of operation is shown in Table 2.4. Based on the results of the power operation studies for the period of record, the estimated average annual energy is 430,300,000 kWh, which compares favorably to the value of 408,091,000 kWh obtained from the Acres American study. The annual firm energy obtained from Ebasco's operation study is 297,660,000 kWh, which is approximately 27 percent greater than the value obtained from the Acres American study. This difference is due to the difference in dry year streamflows between the two models of estimated monthly streamflow at the site.

TABLE 2.4. Reservoir Operation During Average Year

Month	Average Reservoir Elevation (feet)
October	975
November	969
December	959
January	949
February	939
March	928
April	919
May	936
June	972
July	975
August	975
September	975
Annual Average	956

The plant discharge into the Nenana River will vary from a maximum of approximately 8,400 cfs, under conditions of maximum reservoir level and power output, to a minimum of 700 cfs during offpeak hours.

2.6.3 Plant Life

The economic life of the project is estimated to be 50 years.

2.6.4 Operating Work Force and General Maintenance Requirements

It is anticipated that the Browne project will be a remote-controlled facility and will not require resident operating personnel. Weekly trips will, however, be made to the plant to perform routine maintenance and inspection. These weekly inspections could be performed by one or two operators. Major overhauls and maintenance work will ordinarily be performed on an annual basis by a larger crew.

Major components of the generating machinery are not expected to need to be replaced during the life of the project. Repair to the runner blades are likely, and certain parts of the turbine may have to be replaced during the turbine life, such as bearings, wicket gates, wear rings, and face plates. Generator bearing and windings are other items that might have to be replaced during the plant life. In addition, many pieces of auxiliary or supporting equipment may have to be replaced at least once during the project life. As frequently is the case, this may be caused by the equipment item having become obsolete and replacement parts not being available. Replacement is then often less costly than fabricating special parts.

3.0 COST ESTIMATES

3.1 CAPITAL COSTS

3.1.1 Construction Costs

Construction costs have been developed for the major bid line items common to hydroelectric power plants. These line item costs have been broken down into the following categories: labor and insurance, construction supplies, equipment repair labor, equipment rental, permanent materials, and subcontracts. Results of this analysis are presented in Table 3.1. Total overnight construction cost is estimated to be $446.1 million.[a] The equivalent unit capital cost is $4,461 per kilowatt.

3.1.2 Payout Schedule

A payout schedule has been developed for the entire project and is presented in Table 3.2. The payout schedule was based on a 58-month basis from start of project to completion.

3.1.3 Escalation

Estimates of real escalation in capital costs for the plant are presented below. These estimates were developed from projected total escalation rates

Year	Materials and Equipment (Percent)	Construction Labor (Percent)
1981	1.0	0.5
1982	1.2	1.7
1983	1.2	1.7
1984	0.7	1.3
1985	-0-	-0-
1986	-0.1	-0.1
1987	0.3	0.3
1988	0.8	0.8
1989	1.0	1.0
1990	1.1	1.1
1991	1.6	1.6
1992 - on	2.0	2.0

(a) January 1982 dollars, not including land or land rights, owner's costs or transmission costs beyond the switchyard.

TABLE 3.1. Bid Line Items Costs for the Browne Hydroelectric Project[a] (January 1982 Dollars)

	Bid Line Item	Construction Labor and Insurance	Construction Supplies	Equipment Operation Cost	Equipment Rent	Permanent Materials	Sub-Contracts	Total Direct Cost
1.	Improvements to Site	89,500	6,700	99,900	76,300	7,400		279,800
2.	Earthwork and Piling	18,581,000	17,781,000	31,384,200	21,121,400	47,966,500	240,000	137,074,100
3.	Concrete	14,236,600	1,600,500	1,759,900	1,079,100	7,704,100		26,380,200
4.	Structural Steel and Lift Equipment	1,163,900	140,300	35,300	344,100	5,092,500		6,776,100
5.	Buildings	93,000	28,800		7,000	191,000		319,800
6.	Turbine Generator	3,234,200	23,000		10,000	13,800,000		17,067,200
7.	Other Mechanical Equipment	258,200	22,400		75,000	652,000		1,007,600
8.	Piping	782,600	28,800		15,000	950,000		1,776,400
9.	Instrumentation	62,300	2,300		500	50,000		115,100
10.	Electrical Equipment	934,500	23,000		15,000	1,500,000		2,472,500
11.	Painting	301,800	34,500		15,000	220,000		571,300
12.	Off-Site Facilities	7,705,100	2,965,400	9,715,000	7,612,500	20,484,300		48,482,300
13.	Substation	603,600	11,500		5,000	1,700,000		2,320,100
14.	Construction Camp Expenses	5,246,900	16,809,500					22,056,400
15.	Indirect Construction Costs and Architect/Engineer Services[b]	14,948,900	56,392,900	2,149,500	1,405,700			74,897,000
	SUBTOTAL	68,242,100	95,870,600	45,143,800	31,781,600	100,317,800	240,000	341,595,900
	Contractor's Overhead and Profit							44,500,000
	Contingencies							60,000,000
	TOTAL PROJECT COST							446,095,900

(a) The project cost estimate was developed by S. J. Groves and Sons Company. No allowance has been made for land and land rights, client charges (owner's administration), taxes, interest during construction or transmission costs beyond the substation and switchyard. Also not included are the costs associated with removing approximately 8 miles of highway and 16 miles of railroad.

(b) Includes $44,500,000 for engineering services and $30,396,900 for other indirect costs, including construction equipment and tools, construction related buildings and services, nonmanual staff salaries, and craft payroll related costs.

TABLE 3.2. Payout Schedule for Browne Hydroelectric Project (January 1982 Dollars)

Month	Cost per Month, Dollars	Cumulative Cost, Dollars
1.	3,561,500	3,561,500
2.	3,718,300	7,279,800
3.	4,060,300	11,340,100
4.	6,314,200	17,654,300
5.	6,314,200	23,968,500
6.	6,892,700	30,861,200
7.	6,838,300	37,699,500
8.	6,838,300	44,537,800
9.	6,838,300	51,376,100
10.	4,584,300	55,960,400
11.	4,481,900	60,442,300
12.	4,481,900	64,924,200
13.	4,481,900	69,406,100
14.	7,720,500	77,126,600
15.	7,720,500	84,847,100
16.	9,947,200	94,794,300
17.	9,947,200	104,741,500
18.	9,947,200	114,688,700
19.	9,947,200	124,635,900
20.	9,947,200	134,583,100
21.	7,720,500	142,303,600
22.	7,720,500	150,024,100
23.	6,193,200	156,217,300
24.	6,193,200	162,410,500
25.	6,193,200	168,603,700
26.	10,209,800	178,813,500
27.	8,615,900	187,429,400
28.	13,741,300	201,170,700
29.	13,741,300	214,912,000
30.	13,741,300	228,653,300
31.	13,741,300	242,394,600
32.	13,741,300	256,741,300
33.	11,514,500	267,650,400
34.	11,514,500	279,164,900
35.	4,599,400	283,764,300
36.	4,599,400	288,363,700
37.	4,599,400	292,963,100
38.	9,974,400	302,937,500
39.	9,974,400	312,911,900
40.	11,564,900	324,476,800
41.	11,564,900	336,041,700
42.	11,564,900	347,606,600
43.	11,564,900	359,171,500
44.	11,564,900	370,736,400
45.	11,564,900	382,564,900
46.	11,564,900	393,866,200
47.	5,173,900	399,040,100
48.	5,173,900	404,214,000
49.	5,173,900	409,387,900
50.	5,207,300	414,595,200
51.	3,936,800	418,532,000
52.	3,936,800	422,468,800
53.	3,936,800	426,405,600
54.	3,936,800	430,342,400
55.	3,936,800	434,279,200
56.	3,936,800	438,216,000
57.	3,936,800	442,152,800
58.	3,943,100	446,095,900

(including inflation) and subtracting a Gross National Product deflator series which is a measure of inflation.

3.2 OPERATION AND MAINTENANCE COSTS

3.2.1 Operation and Maintenance Costs

The annual operation and maintenance cost for the Browne hydroelectric project, expressed in 1982 "Alaskan dollars," is estimated to be $480,000 (4.80 $/kW/yr). All operation and maintenance costs are assumed to be fixed costs that do not vary appreciably with the plant's kilowatt-hour output.

3.2.2 Escalation

Estimated real escalation of fixed and variable operation and maintenance costs are as follows:

Year	Escalation (Percent)
1981	1.5
1982	1.5
1983	1.6
1984	1.6
1985	1.7
1986	1.8
1987	1.8
1988	2.0
1989	2.0
1990	2.0
1991	2.0

3.3 COST OF ENERGY

Estimated busbar energy cost for the Browne hydroelectric project is 52 mills per kilowatt-hour. This is a levelized lifetime cost, in January 1982 dollars, assuming a 1990 first year of commercial operation, and full utilization of the average annual power output of the facility. Estimated busbar energy costs for lower capacity factors and later startup dates are shown in Figures 3.1 and 3.2. These costs are based on the following financial parameters:

Debt Financing	100%
Equity Financing	0%
Interest on Debt	3%
Federal Taxes	None
State Taxes	None
Bond Life	50 years
General Inflation	0%

The escalation factors given above were employed. Weighted average capital cost escalation factors were derived using a labor/material ratio of 25%/75%.

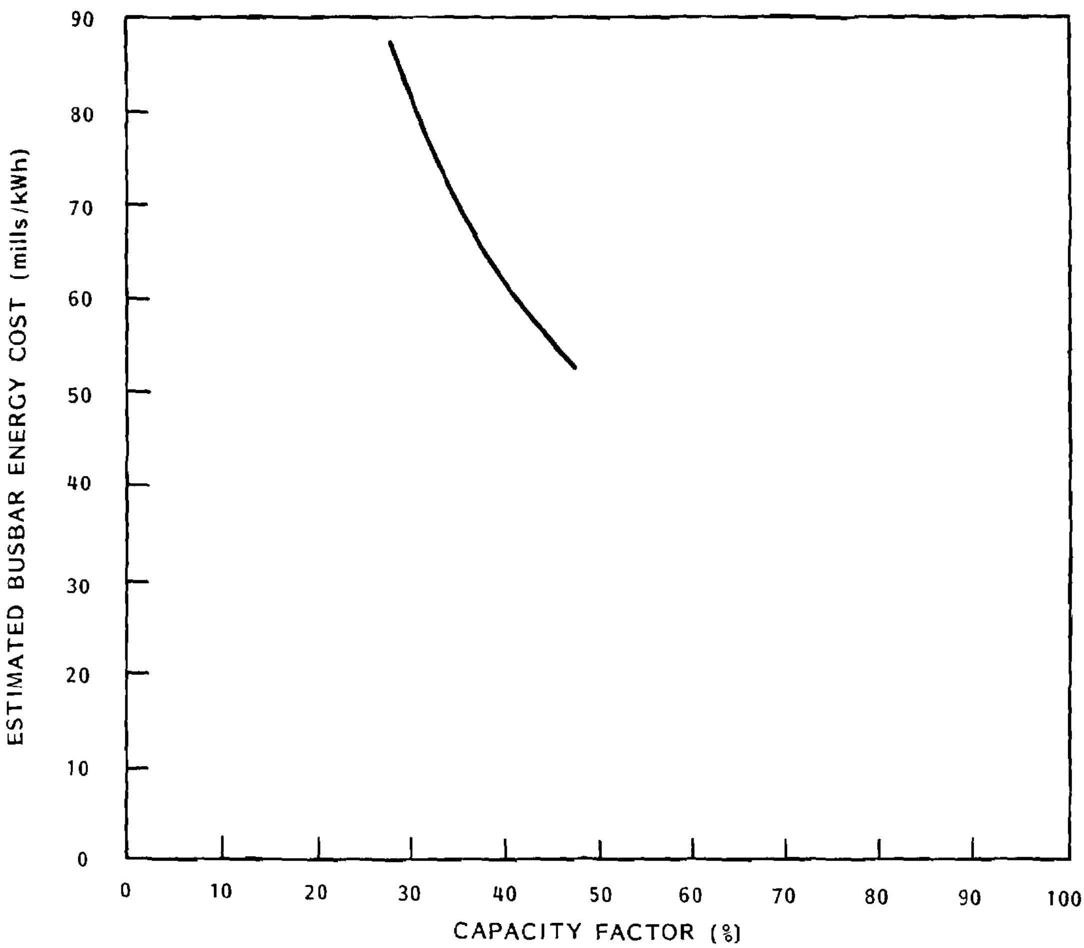


FIGURE 3.1. Cost of Energy Versus Capacity Factor (January 1982 Dollars)

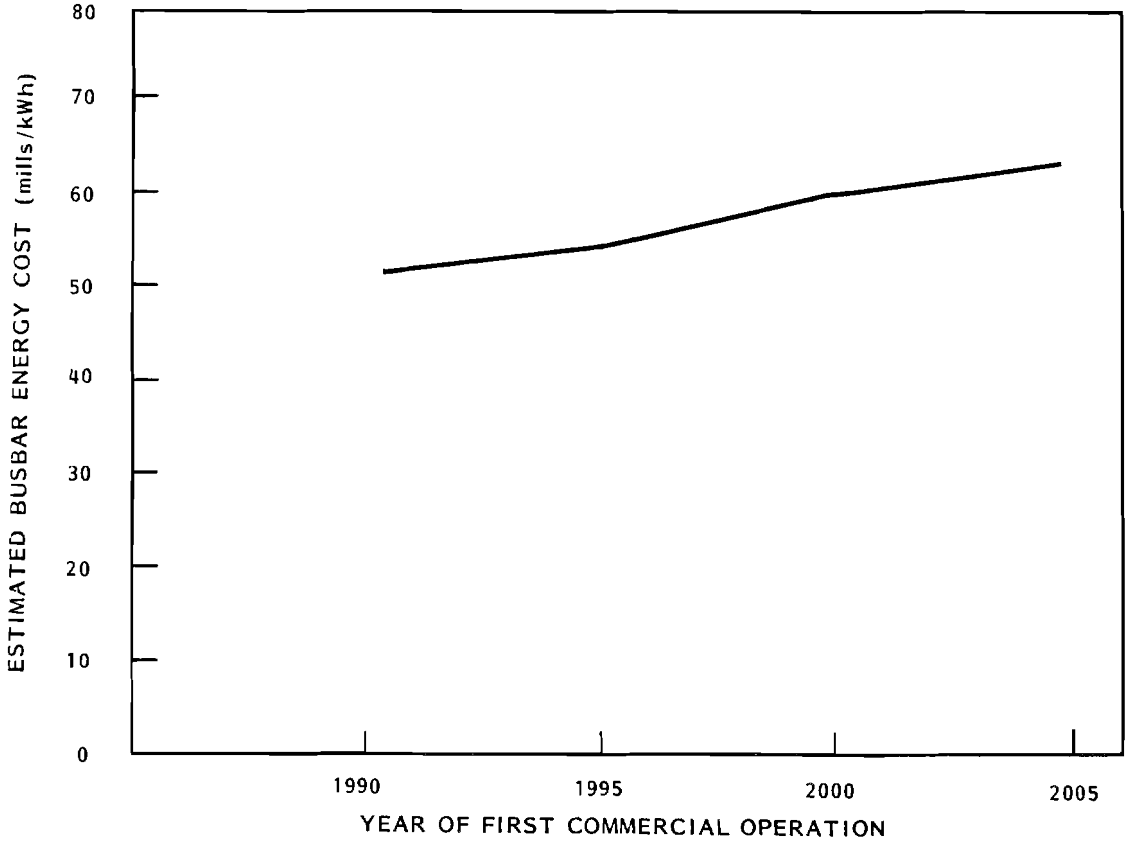


FIGURE 3.2. Cost of Energy Versus Year of First Commercial Operation (January 1982 Dollars)

4.0 ENVIRONMENTAL AND ENGINEERING SITING CONSTRAINTS

Because it would be licensed by the federal government, the Browne hydroelectric project would likely require the preparation of an environmental impact statement. Council of Environmental Quality regulations implemented pursuant to the National Environmental Policy Act of 1969 require that an environmental impact statement include a discussion and evaluation of alternative projects. This requirement is usually satisfied for hydroelectric projects through the evaluation of alternate sites, hydroelectric projects, and often, evaluation of other energy generating technologies. The purpose of such a study is to identify a preferred site and possibly viable alternative projects to supply the required energy.

Presented in this section are many of the constraints that will be evaluated during a siting study, with special attention given to their applicability to the location considered in this study. It should be realized that many of the constraints placed upon the development of a hydroelectric plant are regulatory in nature; therefore, the discussion presented in this section is complemented by the identification of power plant licensing requirements presented in Section 6.0.

4.1 ENVIRONMENTAL SITING CONSTRAINTS

4.1.1 Water Resources

Water resource siting constraints generally center about two topics: water availability and water quality. With a hydroelectric project, there are additional locational constraints placed upon the water resource, e.g., locational suitability of the reservoir formed by the project. Hydrological impacts due to the change in flow regime and creation of a reservoir must be identified and reviewed in the siting report. The resulting impacts on water quality, especially suspended sediment and dissolved gases, must also be evaluated.

At present, it does not appear that any of the above considerations will prove to be a significant constraint with the Brown hydroelectric project. This will have to be confirmed during siting activities.

4.1.2 Air Resources

There may be some changes in microclimatology relating to the creation of the reservoir. However, no significant environmental constraints relating to air resources are anticipated.

4.1.3 Aquatic and Marine Ecology

An inventory of the species present in the river will need to be performed, with emphasis on game fish, significant benthos, and aquatic vegetation supporting terrestrial life. Anadromous fish are not known to exist in this portion of the river; however, this will need to be verified as the dam will create a barrier to upstream and downstream migration. Identification of threatened or endangered species, or significant game habitat, could constrain project development. This is, however, not anticipated at the proposed project location.

4.1.4 Terrestrial Ecology

Since habitat loss is generally considered to represent the most significant impact on wildlife, the prime siting activity of the terrestrial ecology group will be identification of important wildlife areas, especially critical habitat of threatened or endangered species. Based upon this inventory, potential restrictions on reservoir size and/or configuration may be determined, together with preferred locations for access roads and transmission routes. At present, no significant terrestrial constraints are anticipated at the proposed location.

4.1.5 Socioeconomic Constraints

Major socioeconomic constraints center about potential land use conflicts and community and regional socioeconomic impacts derived from the external effects associated with project activities. Potential exclusionary land uses include lands set aside for public purposes, areas protected and preserved by legislation (federal, state or local laws), areas related to national defense, areas in which a hydroelectric installation might preclude or not be compatible with local activities (e.g., urban areas or Indian reservations), or those areas presenting safety considerations (e.g., aircraft facilities). Avoidance areas will generally include areas of proven archeological or historical importance not under legislative protection, and prime agricultural areas.

The proposed location does not appear to fall under the above constraints.

Regarding other socioeconomic concerns, minimization of the boom/bust cycle will be a prime criterion. Through the application of criteria pertaining to community housing, population, infrastructure and labor force, this important consideration should be evaluated and preferred mitigative measures identified. Due to the fact the site is close to several small communities, and the project will require relocation of portions of the Alaska Railroad and Anchorage-Fairbanks highway, socioeconomic criteria will be heavily weighted in the overall site evaluation process.

4.2 ENGINEERING SITING CONSTRAINTS

The project contains two principal engineering constraints. Potentially, the most significant constraint is that the dam foundation materials are not well suited as impervious foundation. Published literature indicates that surface deposits in the site area along the Nenana River consist of coarse pervious sands and gravels. The depth of these deposits is not known with certainty. At best, the dam foundation will require a considerable amount of excavation of these materials beneath the impervious core to provide a suitable water cutoff.

The second siting constraint is that the project is located within 25 miles of a major or seismically active fault zone. In 1947 an earthquake of intensity VIII+ occurred 10 miles north of the proposed powerhouse location. An earthquake of this size can be adequately designed for but will require more costly and massive structures. High seismicity may also result in a liquefaction of any fine sands that might be present beneath the dam or along the reservoir slopes. However, the presence and extent to which liquefiable soils exists is not known at this time.

5.0 ENVIRONMENTAL AND SOCIOECONOMIC CONSIDERATIONS

5.1 SUMMARY OF FIRST ORDER ENVIRONMENTAL IMPACTS

The construction and operation of a 100-MW hydroelectric generating facility will create changes or impacts to the land, water, and socioeconomic environments in which it is located. These impacts are directly related to various power plant characteristics that represent the primary effects of the plant on the environment. A summary of these characteristics is presented in Table 5.1. These primary effects are then analyzed and evaluated in light of existing environmental conditions to determine the significance of the impact and the need for additional mitigation measures.

5.2 ENVIRONMENTAL AND SOCIOECONOMIC EFFECTS

5.2.1 Water Resource Effects

The construction and operation of the Browne hydroelectric facility will impact the hydrologic regime of the Nenana River. The construction of the dam will create an 11-mile-long reservoir, changing a portion of the river from a flowing water to a stillwater regime. This will tend to increase water losses from the watershed through increased evaporation. In addition, creation of the reservoir may change certain water quality parameters. The parameters most likely experiencing change will be dissolved oxygen and temperature, due to possible stratification in the reservoir; and suspended sediment, due to change in flow. Dissolved gas concentration may change due to passage through the spillway and penstock. Possible downstream erosion and/or sedimentation may occur due to discharges from the tailrace. This effect, however, can be minimized by proper design of the discharge structure.

5.2.2 Air Resource Effects

Since the anticipated reservoir will be relatively small, no noticable meteorological changes in the immediate vicinity are anticipated. Hence, no effects to the air resource are expected.

TABLE 5.1. Primary Environmental Effects

Air		no first order impacts
Water		
	Streamflow Regulation	Average: 3800 cfs Maximum: 8400 cfs Minimum: 700 cfs
	Water Quality	To be determined during siting activities; impacts anticipated to be decreases in downstream suspended sediment and increases in downstream dissolved gas concentration
Land		
	Plant Site	Approximately 16 square miles
	Plant Access	Approximately 3.5 miles of road
	Transmission	Approximately 3.5 miles of 138-kV overhead line
	Relocations: Road	Approximately 8 miles of highway Approximately 16 miles of railroad.
Socioeconomic		
	Construction work force	Peak requirements of approximately 515
	Operating work force	1-2 operators for weekly inspection
	Relocations	None

5.2.3 Aquatic and Marine Ecosystem Effects

There are no reported anadromous fisheries in the project area. Hence, there will be no impact to important commercial species. However, grayling, burbot and possibly dolly varden (arctic char) exist in the project area, based on the best available information. The dam will act as a barrier, preventing upstream and downstream migration. It is uncertain whether the creation of a reservoir will enhance or impede these populations. Baseline data will be required to assess this impact. Benthic commmunities will likely shift from those favoring a high energy (flowing stream) environment to those favoring a low energy (reservoir) environment.

5.2.4 Terrestrial Ecosystem Effects

The primary potential wildlife impacts of the hydroelectric development will be from river level fluctuations and habitat loss. River level fluctuation and creation of the reservoir may have a minor impact on the black and brown bear feeding patterns, as well as on the vegetation that is used by moose and the winter range caribou. There is a fairly low density of waterfowl in the area; therefore, these species are not expected to be significantly impacted. Creation of access roads may result in a loss of habitat.

5.2.5 Socioeconomic Effects

The construction and operation of a hydroelectric plant has a high potential to cause a boom/bust cycle on surrounding small communities, causing significant impact on community infrastructure. This impact can be mitigated to some degree by drawing the work force from the more distant, larger communities of Nenana and Fairbanks. The installation of a construction camp will not mitigate the impacts on the social and economic structure of the surrounding small communities.

The expenditures that flow out of the region account for investment in equipment and supervisory personnel. For this large-scale project, a larger proportion of the expenditures can be attributed to civil costs. Approximately 35 percent of an investment in the project will be made outside the Railbelt region, while 65 percent will be made within the Railbelt. The breakdown of operating and maintenance expenditures for a hydroelectric project will be approximately 11 percent spent outside the Railbelt and 89 percent spent within the region.

6.0 INSTITUTIONAL CONSIDERATIONS

This section presents an inventory of major federal, state of Alaska, and local environmental regulatory requirements that will be associated with the development of the Browne hydroelectric project. The discussion of this inventory is divided into three subsections that set forth federal, state, and local environmental requirements, respectively.

6.1 FEDERAL REQUIREMENTS

A hydroelectric project is not subject to many environmental regulatory programs that are applicable to a fossil fuel-fired power plant. For example, a hydro project may be exempt from the National Pollutant Discharge Elimination System (NPDES) permitting program that is operated for Alaska by the Environmental Protection Agency (EPA) pursuant to section 402 of the Clean Water Act. The NPDES permit applies to discharges from a "point source." As this term is defined (40 CFR 122.3) it is unclear whether the Browne hydroelectric project will include a point source discharge into navigable waters, as EPA generally does not require NPDES permits for hydroelectric projects if water merely passes through a turbine from the reservoir to the receiving waters. However, an NPDES permit may be required if during construction of a dam, water is discharged from settling basins, or if floor drains, sanitary systems, etc., are discharged during operation. This issue can only be resolved with the development of additional information regarding project design.

On the other hand, a hydroelectric project is subject to some environmental regulatory programs not applicable to a fossil fuel-fired facility. The most important of these, which could have a substantial impact upon the licensing schedule, is the license that must be obtained by each individual who wishes to construct a water power project of more than 2000 horsepower installed capacity. These licenses are issued by the Federal Energy Regulatory Commission (FERC) as required by the Federal Power Act (16 USC 792-828c). FERC issues these licenses according to the regulations in 18 CFR 4.

An application for a FERC license for a new project is quite complicated, requiring the preparation of seven exhibits (18 CFR 4.41). Among these is a requirement that the applicant show evidence of compliance with requirements of state laws with respect to water appropriation and use of water for power production (18 CFR 4.41 Exhibit D). This is accomplished by showing that state permits have been obtained, and that the state has certified that water quality will be maintained as is required by section 301 of the Clean Water Act. As a result, submission of a complete FERC permit cannot occur prior to receipt of those permits and certification. Furthermore, the FERC review process is lengthy, even after submittal of all requisite documentation.

Licensing of a hydroelectric project in Alaska could be completed, barring any major difficulties in obtaining a FERC permit, in 42 months. The critical element in the schedule will be the FERC permit, which FERC cannot approve before the applicant has submitted its environmental report (18 CFR 4.41 Exhibit) and state water use permits. This schedule assumes that all necessary environmental monitoring can be completed in 12 months. As climatic conditions in Alaska could impede the collection of necessary field data, the licensing schedule could be delayed. Note also that NEPA compliance, including EIS preparation, for a hydroelectric project is generally the responsibility of FERC. In the scoping sessions between federal agencies and the applicant, FERC is generally selected as the lead agency for a hydro power project. These and other federal requirements are summarized in Table 6.1.

6.2 STATE REQUIREMENTS

In addition to the FERC permit, a hydroelectric project will be subject to some specialized permits required in Alaska, such as the state dam permit and water use permit issued by the Alaska Department of Natural Resources and the permit to interfere with salmon spawning streams and waters issued by the Alaska Department of Environmental Conservation. The State of Alaska also imposes special requirements upon some projects if the project site is located on lands that have been reserved by the state requirements restricting use of

TABLE 6.1. Federal Regulatory Requirements

Agency	Requirement	Scope	Statute or Authority
Environmental Protection Agency	National Pollutant Discharge Elimination System	Discharges to Water	38 USC 1251 *et seq*.; section 1342
U.S. Army Corps of Engineers	Construction Activity in Navigable Water	Construction in Water	33 USC 401 *et seq*.; section 403
	Discharge of Dredged or Fill Material	Discharges to Water	33 USC 1251 *et seq*.; section 1342
Federal Energy Regulatory Commission	Environmental Impact Statement	All Impacts	42 USC 4332 section 102
	License for Major New Hydropower Project	Construction of Hydropower Project	16 USC 792 *et seq*.
National Marine Fisheries Service/ Fish and Wildlife Service	Threatened or Endangered Species Review	Air, Water, Land	16 USC 1531 *et seq*.
Advisory Council on Historic Preservation	Determination that Site is not Archeologically Significant	Land Use	16 USC 402 aa *et seq*.
	Determination that Site Does Not Infringe on Federal Landmarks	Land Use	16 USC 416 *et seq*.
All Federal Agencies	Executive Order No. 11990	Development in Wetlands	
	Executive Order No. 11988	Development in Floodplains	

land (due to preservation of the land by state government or native Alaskans) under one of several special programs. The state requirements are summarized in Table 6.2.

TABLE 6.2. State Regulatory Requirements

Agency	Requirement	Scope	Statute or Authority
Alaska Department of Environmental Conservation	State Certificate that Discharges Comply with CWA and State Water Quality Requirements	Discharges to Water	33 USC 1257 et seq.; section 1341
	Solid Waste Disposal Permit	Solid Waste	Alaska Statute 46.03.100
	Permit to Interfere With Salmon Spawning Streams and Waters	Construction in Water	Alaska Statute
Alaska Department of Natural Resources	Water Use Permit	Appropriation of Water	Alaska Statute 46.15.030-185
	Rights-of-Way Easement	Right of Way on State Lands	11 Alaska Administrative Code 58.200
	Dam Permit	Construction of Dam 10 Feet High or More	Alaska Statute
Alaska Department of Fish and Game	Anadromous Fish Protection Permit	Fish Protection	Alaska Statute 16.05.870
	Critical Habitat Permit	Fish and Game Protection	Alaska Statute 16.20.220 and .260
	Fishways for Obstruction to Fish Passage	Fish Protection	Alaska Statute

6.3 LOCAL REQUIREMENTS

The Browne Hydroelectric project, located on the Nenana River near Browne, south of Fairbanks, will be located in an unorganized region in which no local permitting requirements or land use restrictions have been identified.

7.0 REFERENCES

Acres American, Inc. 1981. Susitna Hydroelectric Project - Development Selection Report - Subtask 6.05. Alaska Power Authority, Anchorage, Alaska.

Commonwealth Associates, Inc. 1981. Feasibility Study of Electrical Interconnection Between Anchorage and Fairbanks. Engineering Report R-2274, Alaska Power Authority, Anchorage, Alaska.