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BRADLEY LAKE PROJECT

FERC No. 8221

ALASKA

DRAFT SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

OFFICE OF HYDROPOWER LICENSING
FEDERAL ENERGY REGULATORY COMMISSION

February 1985

FERC/DEIS-0039

BRADLEY LAKE PROJECT

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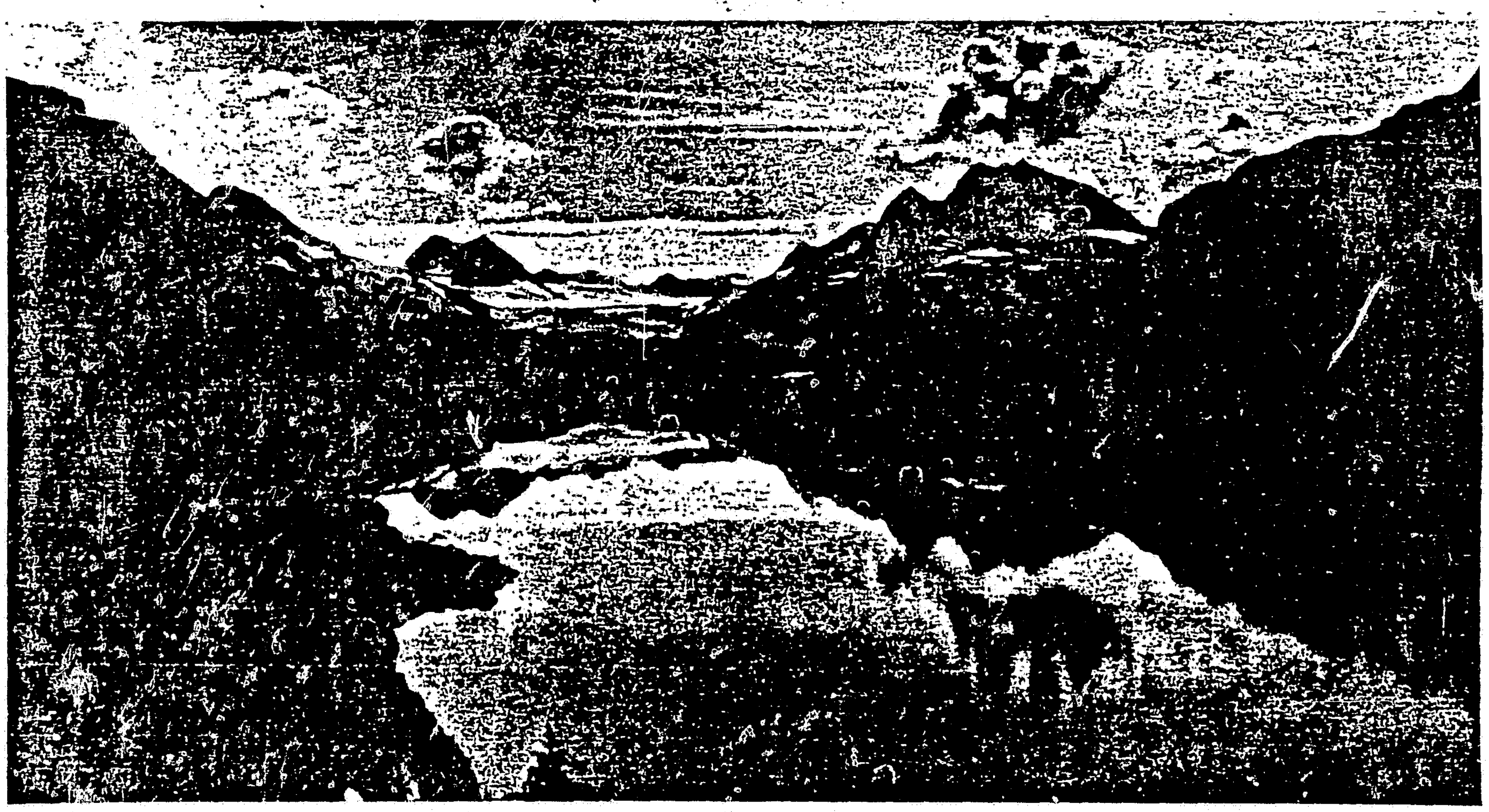

OFFICE OF HYDROPOWER LICENSING
FEDERAL ENERGY REGULATORY COMMISSION

February 1985

FEDERAL ENERGY REGULATORY COMMISSION
WASHINGTON, D.C. 20426

DATE DUE

TO THE PARTY ADDRESSED:

Attached is one copy of the Draft Supplemental Environmental Impact Statement for the proposed Bradley Lake Project No. 8221.

Agencies, organizations, or individuals receiving copies of this Draft Supplemental Environmental Impact Statement are invited to file comments pursuant to the requirements of the National Environmental Policy Act of 1969 and Commission Order No. 415-C, issued December 18, 1972. Any comments, conclusions, or recommendations that draw upon studies, reports, or other working papers for substance should be supported by appropriate documentation.

Any person desiring to be heard, to present evidence, to be advised of all hearings and proceedings with reference to this application for license or to this Draft Supplemental Environmental Impact Statement, and to receive notice of subsequent statements, must file with the Secretary, Federal Energy Regulatory Commission, Washington, D.C. 20426, a petition to intervene, in accordance with the requirements of the Commission's Rules of Practice and Procedure (18 C.F.R. 1.8), unless the person has already filed a petition to intervene in this proceeding. Comments, protests, or petitions to intervene are due on the same date specified by the Environmental Protection Agency in the Federal Register, approximately April 15, 1985.

Recipients of this Draft Supplemental Environmental Impact Statement are also requested to provide comments on the Draft Mitigation Plan for the proposed Bradley Lake Project, which was provided to Federal, state, and local agencies and filed with the Commission on January 28, 1985. Additional copies of the Draft Mitigation Plan are available upon request from the Alaska Power Authority, 334 West Fifth Avenue, Anchorage, Alaska 99501.

FEDERAL ENERGY REGULATORY COMMISSION
OFFICE OF HYDROPOWER LICENSING

DRAFT SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

BRADLEY LAKE HYDROELECTRIC PROJECT
FERC No. 8221 - Alaska

Applicant: Alaska Power Authority
334 West Fifth Avenue
Anchorage, Alaska 99501

Additional copies of the Draft Supplemental EIS may be ordered from:

Division of Public Information
Federal Energy Regulatory Commission
825 North Capitol Street, NE
Washington, D.C. 20426

February 1985

COVER SHEET

a. Lead Agency: Federal Energy Regulatory Commission (FERC)

b. Title: Bradley Lake Hydroelectric Project, FERC Project No. 8221, Alaska

c. Contact: Mr. Peter Foote
Federal Energy Regulatory Commission
OHL-DEA
825 North Capitol Street, NE
Washington, D.C 20426
Telephone: (202) 376-9053

d. Draft Supplemental Environmental Impact Statement

e. Abstract: Alaska Power Authority (Applicant) of Anchorage, Alaska, proposes to construct and operate a hydroelectric project with an installed capacity of 90 megawatts (MW) on Bradley Lake approximately 25 miles northeast of Homer, Alaska. The proposed project would consist of: (1) a 125-foot-high, concrete-faced, rockfill dam, with a crest elevation of 1,190 feet above project datum (equals mean sea level plus 4.02 feet), located at the outlet of Bradley Lake; (2) a 20-foot-high diversion dam, with a crest elevation of 2,204 feet, located on the Middle Fork of the Bradley River; (3) a 6-foot-diameter underground pipe from the Middle Fork diversion dam to Marmot Creek, a tributary to Bradley Lake; (4) a low diversion dike on the upper Nuka River immediately below the Nuka Glacier; (5) an 11-foot-diameter, 18,610-foot-long power tunnel from an intake at Bradley Lake to a powerhouse at sea level; (6) a powerhouse located adjacent to Kachemak Bay, and containing two 45-MW Pelton generating units; (7) a 20-mile-long, 115-kilovolt transmission line from the powerhouse to a proposed interconnection between Fritz Creek and Soldotna; (8) access facilities, including a barge basin and channel in Kachemak Bay, an airstrip, two construction camps, and about 10 miles of access roads; (9) construction facilities, including two concrete-batching plants, borrow areas, and spoil areas; and (10) other appurtenant facilities. Construction would commence subsequent to issuance of a license.

f. Transmittal: This draft supplemental environmental impact statement, prepared by the Commission staff in connection with an application filed by the Alaska Power Authority for proposed project No. 8221, is being transmitted for your information pursuant to the requirements of the National Environmental Policy Act of 1969 and Commission Order No. 415-C, issued December 18, 1972. This draft statement supplements the final environmental impact statement prepared by the Department of the Army, Alaska District, Corps of Engineers (Corps), in August 1982, for a similar project proposed by the Corps at the same location, but later deauthorized.

g. The draft supplemental environmental impact statement was sent to the Environmental Protection Agency and made available to the public on or about February 25, 1985.

FOREWARD

The Federal Energy Regulatory Commission (FERC), pursuant to the Federal Power Act (FP Act)* and the Department of Energy (DOE) Organization Act,** is authorized to issue licenses for terms up to 50 years for the construction and operation of non-Federal hydroelectric developments subject to its jurisdiction, on the necessary condition:

> (T)hat the project adopted ... shall be such as in the judgement of the Commission will be best adapted to a comprehensive plan for improving or developing a waterway or waterways for the use or benefit of interstate or foreign commerce, for the improvement and utilization of waterpower development, and for other beneficial public uses, including recreational purposes ... ***

The Commission may require such other conditions not inconsistent with the provisions of the FP Act as may be found necessary to provide for the various public interests to be served by the Project.† Compliance with such conditions during the license period is required. Section 1.6 of the Commission's Rules of Practice and Procedure allows any person objecting to a licensee's compliance with such conditions to file a complaint noting the basis for such objection for the Commission's consideration. ††

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* 16 U.S.C. § 791(a) - 825(r)
** Public Law 95-91, 91 Stat. 556
*** 16 U.S.C. Sec. 803(a)
† 16 U.S.C. Sec. 803(g)
†† 18 C.F.R. Sec. 1.6

PREFACE

Since 1962, the Corps had studied a proposed hydroelectric project on Bradley Lake. The Corps' study culminated in a project design very similar to the design now proposed by the Applicant. The Corps published a final environmental impact statement (FEIS) on its proposed project in August 1982, but soon thereafter the Congress deauthorized the project.

Since the presently proposed project is located on the identical site of the Corps project, and contains very similar major design features, Commission staff is adopting the Corps' FEIS and has prepared the Bradley Lake draft environmental impact statement (EIS) as a supplement to the Corps' FEIS. This avoids the duplication of effort that would occur by reproducing the extensive data and information contained in the Corps' FEIS and its appendices. A copy of the Corps' FEIS is included in Volume 10, Appendix I, of the application for license for the Bradley Lake Project. The Bradley Lake draft supplemental EIS focuses on: (1) areas where additional information has come to light as a result of the Applicant's recent studies; (2) areas that in Staff's opinion were not fully treated by the Corps' FEIS; and (3) environmental issues that have not been resolved by the Applicant and resource agencies.

The Bradley Lake draft supplemental EIS does not, however, consider or treat the information contained in the Applicant's draft mitigation plan, received by the Commission staff on January 29, 1985. The draft supplemental EIS was already in final form when the plan was received, thus precluding any consideration in the draft EIS. The draft mitigation plan will be fully considered and treated in the final supplemental EIS. Copies of the draft mitigation plan are available upon request from the Alaska Power Authority, 334 West Fifth Avenue, Anchorage, Alaska 99501.

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SUMMARY

The Alaska Power Authority (Applicant) proposes to construct and operate the 90-megawatt(MW)-capacity Bradley Lake Project to meet the late 1980's electrical energy needs of the Kenai Peninsula area of the Alaska Railbelt region in central Alaska. Major project facilities would include: (1) a 125-foot-high, concrete-faced rockfill dam, with a crest elevation of 1,190 feet above project datum (equals mean sea level plus 4.02 feet), located at the outlet of Bradley Lake; (2) a 20-foot-high diversion dam, with a crest elevation of 2,204 feet, located on the Middle Fork of the Bradley River; (3) a 6-foot-diameter underground pipe from the Middle Fork diversion dam to Marmot Creek, a tributary to Bradley Lake; (4) a low diversion dike on the upper Nuka River, immediately below the Nuka Glacier; (5) an 11-foot-diameter, 18,610-foot-long power tunnel from an intake at Bradley Lake to a powerhouse at sea level; (6) a powerhouse, located adjacent to Kachemak Bay and containing two 45-MW Pelton generating units; (7) a 20-mile-long, 115-kilovolt transmission line from the powerhouse to a proposed interconnection between Fritz Creek and Soldotna; and (8) access facilities, including a barge basin and channel in Kachemak Bay, an airstrip, two construction camps, and about 10 miles of access roads.

Staff identified two feasible alternatives that could also meet the growing electrical energy needs of the Kenai Peninsula, beginning in the late 1980's. These alternatives include: (1) a 200-MW combined-cycle (natural gas) generation project, and (2) a 200-MW coal-fired generation project, used in conjunction with a 70-MW gas turbine facility that would be brought on line to meet loads prior to the in-service date for a coal-fired plant. The combined-cycle alternative would be located somewhere in the western Cook Inlet area, near natural gas distribution pipelines and close to a cooling-water source. The coal-fired plant would be located near the Nenana coal fields of central Alaska, close to a cooling-water source.

An economic comparison of the proposed Bradley Lake Project and the two non-hydro alternatives indicates that the Bradley Lake Project would be more economical than either of the alternatives at a real discount rate of 5.6 percent and less.

The no-action alternative, denial of the license for the Bradley Lake Project, was also considered by Staff. This alternative would result in the maintenance of the existing environmental resources and values of the Bradley Lake Basin, but would require the Applicant to develop alternative hydroelectric or thermal generation projects to meet the electrical energy needs of the Kenai Peninsula.

Construction and operation of the proposed Bradley Lake Project would result in the following significant environmental impacts:

(1) erosion of disturbed land areas and increased sedimentation and turbidity in Battle Creek, Martin River, Bradley River, Sheep Creek, and the Fox River;

(2) temporary loss of 115 acres of marine benthic habitat in upper Kachemak Bay;

(3) removal of 3,352 acres of existing vegetation, including inundation of 2,578 acres of terrestrial and wetland habitat by the enlarged Bradley Lake;

(4) disturbance of wildlife usage of affected portions of the tidal wetlands, forested, and other upland areas, to include mountain goat movement and moose migration in the vicinity of Bradley Lake;

(5) disruption of a relatively pristine viewscape by large-scale construction activities, transforming the existing, unspoiled area into one with obvious signs of disturbance by man;

(6) long-term alteration of the flow regime of the lower Bradley River by reducing peak summertime flows and increasing and stabilizing winter low flows;

(7) long-term alteration of the thermal regime of the lower Bradley River, by increasing early summer water temperatures and decreasing late summer and fall water temperatures;

(8) alteration of the pattern of freshwater inflow to the Bradley River-Sheep Creek estuary and upper Kachemak Bay, with probable disruption of salmon migration patterns within the estuary; and

(9) permanently opening the Bradley River Basin to human access, subjecting fish and wildlife resources of the basin to long-term, increased harvesting pressures.

Construction and operation of the combined-cycle alternative somewhere in the western Cook Inlet area would result in the following significant environmental impacts:

(1) erosion of disturbed lands areas and increased sedimentation and turbidity in water bodies associated with project construction activities;

(2) loss of large areas of vegetation resulting from the construction of project facilities and associated access roads, construction camp, airfield, and transmission line, with disturbance of wildlife usage of the area;

(3) disruption of a relatively pristine viewscape by large-scale construction activities and placement of project facilities, resulting in permanent alteration of the area to one with obvious signs of man's activities; and

(4) permanently opening the project area to human access, with probable increased hunting and fishing pressure on local fish and wildlife resources.

Construction and operation of the coal-fired alternative in the Nenana area of the Railbelt would result in the following significant environmental impacts:

(1) erosion of disturbed lands areas and increased sedimentation and turbidity in water bodies associated with project construction activities;

(2) loss of large areas of vegetation resulting from the construction of project facilities and associated access roads, construction camp, airfield, and transmission line, with disturbance of wildlife usage of the area;

(3) disruption of a relatively unspoiled viewscape, permanently changing the area to one with obvious signs of man's activities;

(4) permanently opening the project area to human access, with probable increased hunting and fishing pressure on nearby fish and wildlife resources;

(5) long-term degradation of air quality in the area because of the release of the byproducts of burning coal, with possible minimal impacts on Denali National Park; and

(6) long-term impacts on land features and use, and water quality, as a result of mining coal for the life of the project.

A comparison of the action alternatives indicates that all three alternatives would have similar construction impacts if the project sites were located in an undeveloped, remote area, such as the Bradley Lake Basin. Long-term operational impacts would be greatest for the coal-fired alternative, which would require a continuous coal mining operation for the life of the project. A coal-fired project would also result in a long-term degradation of air quality from the byproducts of burning coal. Operational impacts of the Bradley Lake Project and the combined-cycle projects would generally be minor, although the proposed Bradley Lake Project would potentially have greater effects on aquatic resources. A disadvantage of both of the thermal generation alternatives would be the burning of non-renewable fossil fuels.

Based on the consideration of the long-term environmental impacts, economic factors, and long-term energy needs, Staff believes that the proposed Bradley Lake Project would be the preferred alternative for meeting the electrical energy requirements of the Kenai Peninsula area of the Alaska Railbelt for the period beginning in the late 1980's.

1. PURPOSE OF ACTION AND NEED FOR POWER

1.1 PURPOSE OF ACTION

The proposed Bradley Lake Project would be developed for the single purpose of producing hydroelectricity. The completed project would have a total installed capacity of 90 megawatts (MW) and would produce an average of 369.2 gigawatthours (GWh) of electricity annually. The Applicant would use the energy developed by the proposed project to serve the needs of customers within the "Railbelt" region, the area of south-central Alaska served by the Alaska Railway.

The Bradley Lake Project would be located in the southern end of the Kenai Peninsula, about 105 miles south of Anchorage, the largest electrical energy load center in the Railbelt region.

The proposed development would use the effective head between Bradley Lake, located in the Kenai Mountain region, and Kachemak Bay to generate electricity. Outflow from the Nuka Glacier would be diverted into the upper Bradley River, a small diversion dam would divert natural flows from the Middle Fork drainage basin to Bradley Lake, and a dam at the outlet of Bradley Lake would impound water and would raise the lake level 100 feet. A concrete-lined tunnel and buried penstock would convey water from the Bradley Lake Dam to an above-ground, enclosed powerhouse, located on the eastern shoreline of Kachemak Bay.

1.2 NEED FOR POWER

1.2.1 Historical Energy Requirements

1.2.1.1 Geographical Perspective

The Alaskan Railbelt encompasses more than 150,000 square miles of territory, stretching from the southern terminus of the Alaska Railway north through Anchorage and through the Matanuska and Susitna Valleys to the northern terminus of the railway at Fairbanks (Figure 1-1).

Anchorage is the primary business center of the state and is a major port and rail station. Fairbanks is the transportation and business center of the interior section of the Railbelt and the takeoff and supply point for activities in the Arctic and for maintenance activity for the Trans-Alaska Pipeline.

1.2.1.2 Regional Development

Available economic and electric power data for Alaska and for the Railbelt are summarized in Table 1-1. The table shows the rapid growth that has occurred in the state's and the Railbelt's population, economy, and use of electric power. The growth has been especially rapid during the last decade.

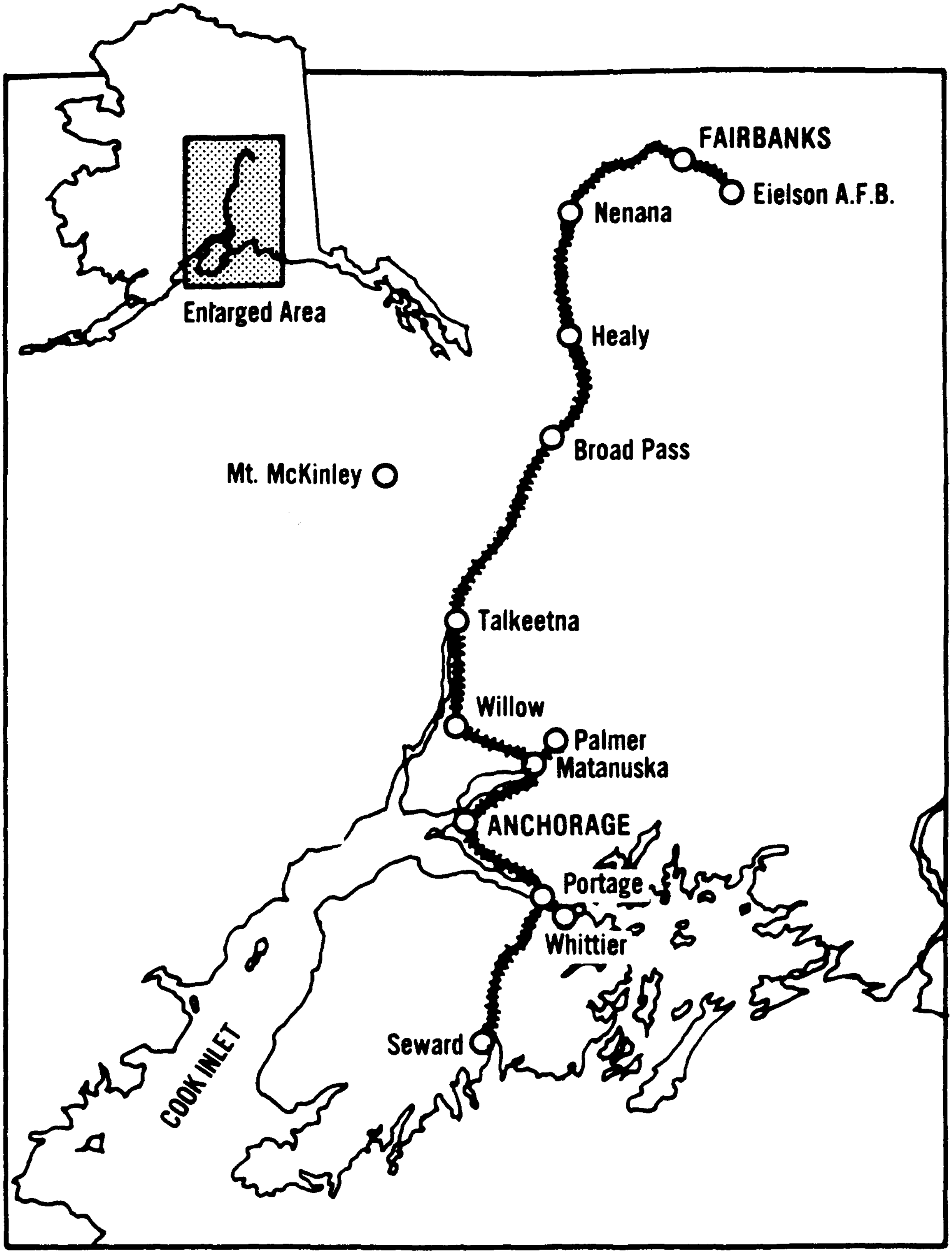

Figure 1-1. The Alaska Railway from Seward to Eielson Air Force Base (Source: Department of Energy, 1980).

Table 1-1. Historic Railbelt economic and electric power data (Source: Alaska Power Authority, 1983, Exhibit R).

Item 1/	Unit	Year 1960	1965	1970	1975	1980	1982
State oil and gas revenues to general fund	10^6x$	4.2 2/	16.3	938.6 3/	88.3	2,262.3	3,567.3
State general fund expenditures		NA	82.7	188.6	453.3	1,172.8	4,601.9
State population		226,200	265,200	304,700	390,000	402,000	437,175
State employment		94,300	110,000	133,400	197,500	211,200	231,984
Railbelt population		140,486	NA	199,670	NA	275,818	307,107
Railbelt employment 4/		NA	74,100	88,500	130,400	132,000	154,033
Railbelt households		37,062	NA	54,057	NA	94,210	106,599
Railbelt electric 5/ energy generation	GWh						
Anchorage		NA	526	885	1,451	2,365	2,709
Fairbanks		NA	231	433	617	627	691
Total		NA	757	1,318	2,068	3,012	3,400
Railbelt peak demand 5/	MW	NA	171	296	420	634	655
Railbelt generation capacity	MW	NA	NA	NA	NA	1,143	1,272

1/ Annual data are not available on a consistent basis for all items listed.
2/ Figure is for 1961.
3/ This figure results from the collection of a large petroleum lease bonus.
4/ Excludes agriculture workers and self employed.
5/ Includes electric utilities, military generation, and self-supplied industrial.

Between 1960 and 1982, employment in the Railbelt grew from 94,300 to 231,984, an increase of 146 percent, at a rate of 4.2 percent annually. The number of households in the Railbelt grew at a faster rate during this period, 4.9 percent annually, reflecting the nationwide trend toward fewer persons per household. Much of the population and economic growth during this period is attributable to the tremendous increase in state petroleum revenues and general fund expenditures. State petroleum revenues grew from $4.2 million in 1960 to $3.57 billion in 1982, mainly because of the discovery and development of petroleum on Alaska's North Slope. Between 1960 and 1982, state general fund expenditures rose from less than $100 million per year to $4.6 billion.

Consumption of electric energy in the Railbelt has risen significantly faster than the rate of economic growth. Between 1965 and 1982, total electric energy generation increased from 757 GWh to 3,400 GWh, an annual rate of 9.2 percent. Table 1-2 gives the net annual generation of each Railbelt utility between 1976 and 1982.

1.2.2 Present Energy Scenario

Data collected by the Alaska Department of Commerce and Economic Development (DOCED) provides a fairly complete picture of 1981 energy use by the state and the Railbelt region. In 1981, Alaskans used 543 trillion British thermal units (Btu) of primary energy. Of this total, approximately 184 trillion Btu of refined products, ammonia-urea, and liquefied natural gas (LNG) were exported from Alaska; some 86 trillion Btu were lost in refining operations, generating electricity, and processing natural gas for ammonia-urea and LNG; and 273 trillion Btu were consumed by the residential, commercial, industrial transportation and national defense sectors within the state. Oil, natural gas, coal, and hydroelectricity were the four main sources of the energy consumed by the end-use sectors, with oil and natural gas supplying approximately 93 percent of the total. A regional breakdown of end-use energy consumption is shown in Table 1-3.

The Railbelt region receives over 75 percent of the total energy delivered to the six basic consumption sectors in Alaska. Of the total energy delivered to the Railbelt, 11 percent is for national defense, 41 percent (exclusively petroleum) goes to the transportation sector, and the remaining 48 percent is delivered to the residential, commercial, industrial, and electric utility sectors. Natural gas provides most of the energy for space heating and electric generation. Table 1-4 shows state and Railbelt consumption by consumption sector.

Table 1-2. Net generation by electric utility in GWh (Source: Alaska Power Authority, 1983, Exhibit B).

Utility	1976	1977	1978	1979	1980	1981	1982
Anchorage Municipal Light and Power (AMLP)	444.9	420.3	443.1	473.1	486.6	485.3	579.5
Chugach Electric Association (CEA)	1,054.5	1,179.7	1,308.6	1,401.0	1,434.1	1,467.7	1,718.4
Alaska Power Administration (APAD)	118.0	203.5	180.1	171.1	184.3	222.7	147.9
Anchorage-Cook Inlet Subtotal 1/	1,617.4	1,803.6	1,931.8	2,045.2	2,105.0	2,175.7	2,445.8
Fairbanks Municipal Utility System (FMUS)	123.3	128.5	124.7	124.7	125.6	126.1	140.7
Golden Valley Electric Association (GVEA)	344.7	353.5	341.5	322.9	317.7	316.9	350.3
Fairbanks area Subtotal 1/	468.0	481.7	466.2	447.6	443.3	443.0	491.1
Railbelt Total 1/	2,085.4	2,285.3	2,398.0	2,492.8	2,548.3	2,618.7	2,936.9

1/ Subtotals and total shown may differ from column totals because of rounding.

Table 1-3. Alaskan fuel consumption, 1981, in trillion British thermal units (Btu) 1/ [Source: Staff, from Alaska Department of Commerce and Economic Development, 1983].

Region (population)	Fuel Type: Petroleum	Natural gas	Coal	Hydro	Wood	All fuels 2/
Railbelt 3/ (313,767)	137.1	81.0	12.6	2.9	1.6	235.2
Southeast (51,689)	19.9	---	---	3.3	1.2	24.4
North Slope (3,282)	11.9	1.7	---	---	---	13.6
Bush (53,449)	29.8	---	---	---	0.3	30.1
State total	198.7	82.7	12.6	6.2	31.1	303.2

1/ Includes 30 trillion Btu lost in conversion to electric power.

2/ Does not include LNG or ammonia-urea.

3/ Includes the Valdez-Cordova area, with a population of 9,301.

Table 1-4. Total Alaska and Railbelt energy consumption by energy sector, 1981 (Source: Alaska Department of Commerce and Economic Development, 1983).

Sector	Alaska Billion Btu	Alaska (Percent)	Railbelt Billion Btu	Railbelt (Percent)
Transportation	114,672	38	88,715	38
Industrial	64,823	21	44,699	19
Utility 1/	46,344	15	40,115	17
Military	25,847	9	25,847	11
Residential	26,571	9	19,434	8
Commercial & Public	11,913	4	10,658	5
Off-highway	13,059	4	6,430	3
Total	303,239	100	235,929	100

1/ Includes total electricity consumption.

The mixture of fuels used within the Railbelt reflects the prices of energy. Natural gas, for instance, presently is priced at less than $2.00 per thousand cubic feet (Mcf) to the residential sector, the lowest price in any state. Where a gas distribution pipeline is available, gas clearly is more cost effective to use than the alternatives--electricity, distillate oil, or liquid propane.

In the following tabulation, the FERC staff uses 1983 data from the DOCED to show the comparative cost of heating fuels in the Railbelt for 1981, in 1981 dollars per 1 million Btu. (The figures do not account for the efficiencies of equipment used to produce heat from specific fuel.) Table 1-5 shows the Railbelt energy consumption by sector and fuels.

Fuel	Anchorage	Fairbanks	Matanuska
Electricity	11.49	26.83	12.58
Fuel oil	9.45	9.94	10.24
Natural gas	1.65	----	----
Wood	6.36	5.23	4.87
Propane	13.82	13.85	17.86

1.2.2.1 Electric Power Resources

The 1982 total installed capacity for utilities within the Railbelt is reported by the Alaska Power Administration to be 1128.5 megawatts (MW), including 18.6 MW owned by the University of Alaska at Fairbanks, but excluding 101.3 MW of capacity owned by the military at various installations within the region and excluding 27 MW of older or more expensive utility capacity relegated to standby or "black-start" service (start-up power following a system blackout). A survey by the Battelle Pacific Northwest Laboratories disclosed that approximately 28 MW of unreported capacity was owned by industrial concerns within the Railbelt in 1981.

A summary of the Railbelt's 1982 utility capacity by is presented in Table 1-6. A current, planned retirement schedule for the existing facilities is shown in Table 1-7.

The existing electric transmission system within the Railbelt is composed of isolated networks in the Anchorage and Fairbanks areas. An interconnection currently under construction between Willow and Healy was scheduled to link the two areas by 1984. The transmission system is shown in Figure 1-2.

Table 1-5. Railbelt energy consumption by fuel type for each sector, 1981. (Source: Alaska Department of Commerce and Economic Development, 1983).

Sector & Fuel type 1/	Energy consumption (billion Btu)	Percent
Transportation		
Fuel oil	88,649	99.9
Coal	66	0.1
Total	88,715	100.0
Industrial		
Fuel oil	13,264	28.3
Natural gas	31,435	67.1
Electricity	2,130	4.6
Total	46,829	100.0
Utility		
Fuel oil	2,152	5.9
Natural gas	29,652	73.9
Coal	5,407	13.5
Hydro	2,904	7.2
Total	40,115	100.0
Military		
Fuel oil	15,364	55.8
Natural gas	4,590	16.7
Coal	5,893	21.4
Electricity	1,690	6.1
Total	27,537	100.0
Residential		
Fuel oil	9,647	41.6
Natural gas	8,109	35.0
Coal	140	0.6
Wood	1,561	6.7
Electricity	3,745	16.1
Total	23,202	100.0
Commercial & Public		
Fuel oil	2,256	15.6
Natural gas	7,333	50.5
Coal	1,069	7.4
Electricity	3,842	26.5
Total	14,500	100.0

1/ Electricity consumption is included in the utility sector and also is reported in the other sectors.

Table 1-6. Railbelt existing generating capacity in MW for 1982, by load center, company ownership, type, and fuel use (Source: Staff, from Alaska Power Authority, 1984a, Technical Comment NFP 032).

			Combustion turbine		Combined cycle		Installed
	Hydro	Diesel	Oil	Gas	Gas	Coal	Capacity 1/
Anchorage-Cook Inlet area							
APAD	30						30.0
AMLP				172.6	139.0		311.6
CEA	16			269.5	178.0		463.5
MEA		0.9					0.9
HEA		2.6					2.6
SES		5.5					5.5
Subtotal	46	9.0		442.1	317.0		814.1
Fairbanks-Tanana Valley Area 4/							
GVEA		23.8	172.8			25.0	221.6
FMUS		8.4	35.8			30.0	74.2
UAK		5.6				13.0	18.6
Subtotal		37.8	208.6			68.0	314.4
Total	46.0	46.8	208.6	442.1	317.0	68.0	1,128.5 2/

1/ Installed capacity as of 1982 at 0°F.
2/ Excludes National Defense installed capacity of 101.3 MW; 101.3 MW modified from 95.0 by FERC staff.
3/ APAD—Alaska Power Administration.
AMLP—Anchorage Municipal Light and Power Department.
CEA—Chugach Electric Association.
MEA—Matanuska Electric Association.
HEA—Homer Electric Association.
SES—Seward Electric System.
4/ GVEA—Golden Valley Electric Association.
FMUS—Fairbanks Municipal Utility System.
UAK—University of Alaska.

Table 1-7. Railbelt generating capacity retirement schedule (Source: Staff, from Alaska Power Authority, 1984a, Technical Comment NFP 032).

Year	Utility 2/	Station	Unit	Type 1/	Capacity O°F	Annual Total	Cumulative Total
1982	AMLP	#1	1	SCCT	16.3		
	FMUS	Chena	2	Steam	2.5		
	FMUS	Chena	3	Steam	1.5	20.3	
1983	CEA	Bernice Lobe	1	SCCT	8.6		
	FMUS	Chena	4	SCCT	7.0	15.6	35.9
1984	AMLP	#1	2	SCCT	16.3		
	CEA	International	1	SCCT	14.0		
	HEA	Seldoria	2	Diesel	0.6		
	FMUS	Chena	1	Steam	5.0	35.9	71.8
1985	CEA	International	2	SCCT	14.0		
	SES	SES	1	Diesel	1.5		
	SES	SES	2	Diesel	1.5		
	SES	SES	3	Diesel	2.5		
	GVEA	Zendher	Combined Diesels	Diesel	21.0	40.5	112.3
1986							112.3
1987	MEA	Talkeetna	1	Diesel	0.9		
	FMUS	Chena	D1	Diesel	2.8		
	GVEA	Healy	D	Diesel	2.8	6.5	118.8
1988	AMLP	#1	3	SCCT	18.0		
	CEA	Beluga	1	SCCT	16.1		
	CEA	Beluga	2	SCCT	16.1		
	FMUS	Chena	D2	Diesel	2.8		
	FMUS	Chena	D3	Diesel	2.8	55.8	174.6
1989							174.6

1/ SCCT—simple-cycle combustion turbine; RCCT—regenerative-cycle combustion turbine.

2/ AMLP—Anchorage Municipal Light and Power Department.
FMUS—Fairbanks Municipal Utility System.
CEA—Chugach Electric Association.
SES—Seward Electric System.
GVEA—Golden Valley Electric Association.
MEA—Matanuska Electric Association.

Table 1-7 (continued). Railbelt generating capacity retirement schedule (Source: Staff, from Alaska Power Authority, 1984a, Technical Comment NFP 032).

Year	Utility 2/	Station	Unit	Type 1/	Capacity O°F	Annual Total	Cumulative Total
1990	CEA	International	3	SCCT	18.0		
	HEA	Seldonia	3	Diesel	0.6	18.6	193.2
1991	HEA	Pt. Graham	1	Diesel	0.2		
	GVEA	Zendher	1	SCCT	18.4	18.6	211.8
1992	AMLP	#1	4	SCCT	32.0		
	CEA	Bernice Lake	2	SCCT	18.9		
	GVEA	Zendher	2	SCCT	17.4	68.3	280.1
1993	CEA	Beluga	3	RCCT	53.0	53.0	333.
1994							333.
1995	CEA	Beluga	5	RCCT	58.0		
	GVEA	Zendher	3	SCCT	3.5		
	GVEA	Zendher	4	SCCT	3.5	65.0	398.
1996	GVEA	North Pole	1	SCCT	65.0		
	FMUS	Chena	6	SCCT	28.8	93.8	491.
1997	GVEA	Healy	Coal	Steam	25.0		
	GVEA	North Pole	2	SCCT	65.0	90.0	581.9
1998	CEA	Bernice Lake	3	SCCT	26.4	26.4	608.
1999	HEA	Kenai	1	Diesel	0.9	0.9	609.
2000	UAK		D1	Diesel	2.8		
	UAK		D2	Diesel	2.8		
	FMUS	Chena	5	Steam	21.0	26.6	635.9

1/ SCCT--simple-cycle combustion turbine; RCCT--regenerative-cycle combustion turbine.

2/ CEA--Chugach Electric Association.
HEA--Homer Electric Association.
GVEA--Golden Valley Electric Association.
AMLP--Anchorage Municipal Light and Power Department.
FMUS--Fairbanks Municipal Utility System.
UAK--University of Alaska.

Table 1-7 (concluded). Railbelt generating capacity retirement schedule (Source: Staff, from Alaska Power Authority, 1984a, Technical Comment NFP 032).

Year	Utility 2/	Station	Unit	Type 1/	Capacity O°F	Annual Total	Cumulative Total
2001							635.8
2002	AMLP	#2	8	SCCT	90.0		
	CEA	Bernice Lake	4	SCCT	26.4	116.4	752.2
2003-2008							752.2
2009	AMPL	#2	5,6,7	CC	139.0	139.0	891.2
2010	UAK		S1	Steam	1.5		
	UAK		S2	Steam	1.5		
	UAK		S3	Steam	10.0	13.0	904.2
2012	CEA	Beluga	6,7,8	CC	178.0	178.0	1082.2
Not retired		Eklutna			30.		
		Cooper Lake			16.		46.0
	HEA	Seldovia					.3
Total Railbelt capacity 1982							1128.5

1/ SCCT--simple-cycle combustion turbine; RCCT--regenerative-cycle combustion turbine; CC--combined cyle.

2/ AMLP--Anchorage Municipal Light and Power Department.
CEA--Chugach Electric Association.
UAK--University of Alaska.
HEA--Homer Electric Association.

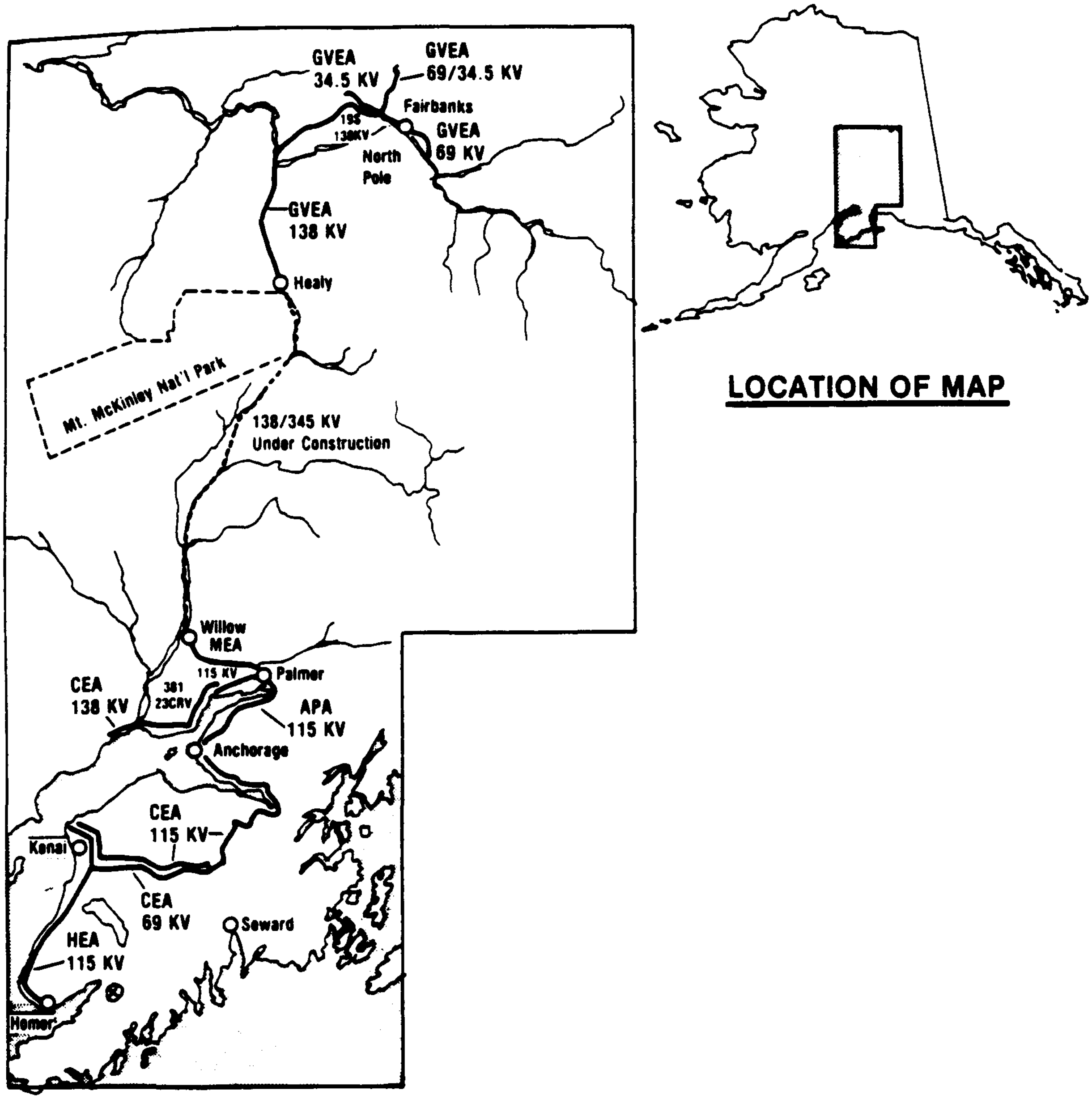

Figure 1-2. Electrical Transmission System of the Railbelt (Source: Staff, from Alaska Power Authority, 1984a, Application).

1.2.3 Future Energy Resources

Staff considered the following planned capacity additions through 1988:

Plant	Type	MW	Year	Average Energy (GWh)
Grant Lake	Hydro	7.0	1988	33
Soldotna	Combustion Turbine	30.0	1985	

1.2.4 Load Growth Forecasts

1.2.4.1 Applicant's Load Projections

In performing power studies for the Bradley Lake application, the Applicant selected a load-growth projection based on a Sherman H. Clark Associates' No Supply Disruption Case (Clark case) [Alaska Power Authority, 1983]. The Clark case projection was developed by using four interrelated computer models to project the future Railbelt load-growth for various oil price projections. These models are the following.

PETREV--Operated by the Alaska Department of Revenue (DOR). This mode uses a probability distribution of possible values that affect Alaska petroleum revenues to predict a range of royalties and production taxes.

MAP--Developed by the Institute of Social and Economic Research (ISER) of the University of Alaska. The MAP (Man-in-the-Arctic Program) is an economic model that simulates the behavior of the Alaska economy and the population growth for each of twenty regions of the state.

RED--Developed by ISER and modified by Battelle Pacific Northwest Laboratories. The RED (Railbelt Electricity Demand) model is a simulation model that forecasts annual electricity consumption for each end-use sector in the Anchorage-Cook Inlet and Fairbanks-Tanana Valley load centers.

OGP --Developed by General Electric Company. OGP (Optimized Generation Planning) is a model used to produce generation expansion plans based on system reliability, operating, and investment costs.

Several oil price projections were considered, including the Clark Case projections. The oil price affects the need for electric power within the Railbelt in four ways: petroleum revenues available to the State of Alaska are a direct function of the market price of petroleum; the price of electricity to the consumer is impacted since most Railbelt power is generated from fossil fuels; the ability to economically substitute different fuels for power generation is dependent on the price of oil; and the level of oil exploration and development in Alaska will vary with the world oil price.

A summary of the input and output data for the Clark case is presented in Table 1-8. During the 28 years included in this scenario, the net use of electric energy within the Railbelt is projected to increase from 2,803 GWh to 5,858 GWh, with a corresponding increase in the peak demand from 579 MW to 1,217 MW (Table 1-9). The Kenai Peninsula load is included in the Anchorage-Cook Inlet category.

To identify the impact of the Bradley Lake Project on the Kenai Peninsula, the Applicant prepared a separate load projection for the Kenai Peninsula using historical loads in the Achorage and Kenai Peninsula areas. During recent years, the peak and energy requirements of the Kenai Peninsula amount to about 14 to 16 percent of the total Anchorage-Cook Inlet load. For the purpose of the study, it is assumed that the Kenai Peninsula will represent 15 percent of the Anchorage-Cook Inlet load during the study period of 1983 through 2007. The resulting load projections for the Anchorage area and the Kenai Peninsula shown in Table 1-10 represent a conservative estimate of the Kenai Peninsula load.

The fuel price projections reflected in the Clark case and used by the Applicant in the Bradley Lake analysis are shown in Table 1-11. The fuel prices shown are based on the following assumptions.

The escalation in the price of natural gas will vary in the same manner as that of oil.

Although proven Cook Inlet natural gas reserves will be exhausted around the year 2000, sufficient additional reserves will be discovered to meet all future demand during the study period. No supply restrictions were imposed in any portion of the Bradley Lake power study.

The Beluga coal field, presently undeveloped, will be opened for development and coal will be exported to Japan.

Table 1-8. Summary of input and output data in the Sherman H. Clark No Supply Disruption Case (Clark case) [Source: Alaska Power Authority, 1983, Exhibit B].

ITEM DESCRIPTION	1983	1985	1990	1995	2000	2005	2010
World Oil Price (1983$/bbl) 1/	28.95	26.30	27.90	32.34	37.50	43.47	50.39
Energy Price Used by RED (1980$)							
Heating Fuel Oil - Anchorage ($/MMBTU) 2/	7.75	6.45	6.84	7.93	9.19	10.65	12.35
Natural Gas - Anchorage ($/MMBTU)	1.73	1.95	2.88	4.05	4.29	4.96	5.38
State Petroleum Revenues 3/ (Nom.$x10^6) 4/							
Production Taxes	1,474	1,561	2,032	1,868	1,910	2,150	2,421
Royalty Fees	1,457	1,555	2,480	2,651	3,078	3,799	4,689
State Gen. Fund Expenditures (Nom. $x10^6)	3,288	3,700	5,577	7,729	9,714	13,035	17,975
State Population	457,836	490,146	554,634	608,810	644,111	686,663	744,418
State Employment	243,067	258,396	293,689	313,954	325,186	345,701	376,169
Railbelt Population	319,767	341,613	389,026	423,460	451,561	486,851	533,218
Railbelt Employment	159,147	169,197	190,683	204,668	214,542	231,584	255,974
Railbelt Total Number of Households	111,549	120,140	138,640	152,463	163,913	177,849	195,652
Railbelt Electricity Consumption (GWh)							
Anchorage	2,322	2,561	3,045	3,371	3,662	4,107	4,735
Fairbanks	481	535	691	800	880	986	1,123
Total	2,803	3,096	3,736	4,171	4,542	5,093	5,858
Railbelt Peak Demand (MW)	579	639	777	868	945	1,059	1,217

1/ 1983 dollars per barrel.
2/ Dollars per 1 million Btu.
3/ Petroleum revenues include corporate income taxes, oil and gas property taxes, lease bonuses, and Federal shared royalties.
4/ Nominal dollars in millions.

Table 1-9 . Projected peak demand and energy, net, in the Clark case (Source: Alaska Power Authority, 1983, Exhibit B).

	Anchorage-Cook Inlet Area		Fairbanks-Tanana Valley Area		Total Railbelt	
Year	Energy GWh	Peak MW	Energy GWh	Peak MW	Energy GWh	Peak MW
1983	2,322	469	481	110	2,803	579
1984	2,442	493	508	116	2,950	609
1985	2,561	517	535	122	3,096	639
1986	2,658	538	566	129	3,224	667
1987	2,755	558	597	136	3,352	695
1988	2,852	579	629	144	3,481	722
1989	2,949	599	660	151	3,609	750
1990	3,045	619	691	158	3,737	777
1991	3,111	633	713	163	3,824	796
1992	3,176	646	735	168	3,911	814
1993	3,240	659	757	173	3,997	832
1994	3,306	672	778	178	4,084	850
1995	3,371	686	800	183	4,171	868
1996	3,429	697	816	186	4,245	884
1997	3,487	709	832	190	4,319	899
1998	3,545	721	848	194	4,394	914
1999	3,604	732	864	197	4,468	930
2000	3,662	744	880	201	4,542	945
2001	3,751	762	902	206	4,652	968
2002	3,840	780	923	211	4,762	991
2003	3,929	798	944	215	4,872	1,013
2004	4,018	816	965	220	4,983	1,036
2005	4,107	834	986	225	5,093	1,059
2006	4,232	859	1,013	231	5,246	1,091
2007	4,358	885	1,041	238	5,399	1,122
2008	4,484	910	1,068	244	5,552	1,154
2009	4,609	936	1,096	250	5,705	1,186
2010	4,735	961	1,123	256	5,858	1,217

Table 1-10. Separation of the Anchorage-Cook Inlet load into Anchorage and Kenai Peninsula loads in the Clark case (Source: Alaska Power Authority, 1984a, Application, Appendix F).

Year	Anchorage		Kenai Peninsula	
	Energy-GWH	Demand-MW	Energy-GWH	Demand-MW
1983	1,974	399	348	70
1984	2,076	419	366	74
1985	2,177	439	384	78
1986	2,259	457	399	81
1987	2,342	474	413	84
1988	2,424	492	428	87
1989	2,507	509	442	90
1990	2,588	526	457	93
1991	2,644	538	467	95
1992	2,700	549	476	97
1993	2,754	560	486	99
1994	2,810	571	496	101
1995	2,865	583	506	103
1996	2,915	592	514	105
1997	2,964	603	523	106
1998	3,013	613	532	108
1999	3,063	622	541	110
2000	3,113	632	549	112
2001	3,188	648	563	114
2002	3,264	663	576	117
2003	3,340	678	589	120
2004	3,415	694	603	122
2005	3,491	709	616	125
2006	3,597	730	635	129
2007	3,704	752	654	133
2008	3,811	774	673	137
2009	3,918	796	691	140
2010	4,025	817	710	144

Table 1-11. Fuel price projections in the Clark case, in 1983 dollars per 1 million Btu (Source: Alaska Power Authority, 1983, Exhibit D).

Year	Natural Gas 1/	Diesel Oil	Turbine Oil	Beluga Coal	Nenana Coal
1983	2.77	6.87	6.23	1.86	1.72
1984	2.57	6.55	5.94	1.89	1.74
1985	2.46	6.25	5.66	1.92	1.77
1986	2.81	6.25	5.66	1.95	1.83
1987	2.81	6.25	5.66	1.98	1.83
1988	2.89	6.25	5.66	2.01	1.92
1989	2.96	6.43	5.83	2.05	1.97
1990	3.04	6.63	6.01	2.08	2.02
1991	3.13	6.83	6.19	2.11	2.07
1992	3.21	7.03	6.38	2.15	2.11
1993	3.30	7.24	6.57	2.18	2.17
1994	3.39	7.46	6.76	2.21	2.22
1995	3.48	7.68	6.97	2.25	2.27
1996	3.57	7.91	7.18	2.29	2.32
1997	3.67	8.15	7.39	2.32	2.38
1998	3.77	8.39	7.61	2.36	2.43
1999	3.88	8.64	7.84	2.40	2.48
2000	3.99	8.91	8.08	2.44	2.55
2001	4.10	9.18	8.32	2.48	2.60
2002	4.21	9.45	8.57	2.51	2.66
2003	4.33	9.74	8.83	2.55	2.73
2004	4.45	10.03	9.09	2.60	2.79
2005	4.57	10.32	9.36	2.64	2.85
2006	4.70	10.63	9.64	2.68	2.93
2007	4.83	10.95	9.93	2.72	2.99
2008	4.97	11.28	10.23	2.77	3.06
2009	5.11	11.62	10.54	2.81	3.14
2010	5.25	11.97	10.85	2.86	3.21
2011	5.38	12.26	11.31	2.90	3.28
2012	5.50	12.57	11.40	2.95	3.35
2013	5.63	12.88	11.69	2.99	3.43
2014	5.77	13.21	11.98	3.04	3.51
2015	5.90	13.54	12.28	3.09	3.58
2016	6.04	13.88	12.59	3.14	3.66
2017	6.19	14.22	12.90	3.19	3.75
2018	6.34	14.58	13.23	3.24	3.83
2019	6.49	14.94	13.56	3.29	3.91
2020	6.64	15.32	13.89	3.35	4.00

1/ Includes 30 cents/1 million Btu for pipeline transportation cost.

Table 1-11.(concluded). Fuel price projections in the Clark case, in 1983 dollars per 1 million Btu (Source: Alaska Power Authority, 1983, Exhibit D).

Year	Natural Gas 1/	Diesel Oil	Turbine Oil	Beluga Coal	Nenana Coal
2021	6.74	15.55	14.10	3.40	4.09
2022	6.83	15.78	14.31	3.45	4.18
2023	6.93	16.02	14.53	3.51	4.28
2024	7.03	16.26	14.75	3.57	4.37
2025	7.13	16.50	14.97	3.62	4.47
2026	7.23	16.75	15.19	3.68	4.57
2027	7.34	17.00	15.42	3.74	4.67
2028	7.44	17.25	15.65	3.80	4.77
2029	7.55	17.51	15.89	3.86	4.88
2030	7.66	17.78	16.13	3.92	4.99
2031	7.73	17.95	16.29	3.98	5.10
2032	7.81	18.13	16.45	4.05	5.21
2033	7.88	18.31	16.61	4.11	5.33
2034	7.96	18.50	16.78	4.18	5.45
2035	8.03	18.68	16.95	4.25	5.57
2036	8.11	18.87	17.12	4.31	5.70
2037	8.19	19.06	17.29	4.38	5.82

1/ Includes 30 cents/1 million Btu for pipeline transportation cost.

The Applicant checked the sensitivity of load and fuel price variations on the economics of the Bradley Lake Project by studying a Railbelt no-growth case, assuming that the 1983 load remained constant for the duration of the study and that the fuel price projections were the same as in the reference case. In further sensitivity analyses, the Applicant considered Railbelt load growth and fossil fuel price projections that correspond to a DOR 50-percent case (Alaska Power Authority, 1983).

The load growth and fossil fuel projections for the DOR 50-percent case for the years from 1983 to 2010 are shown in Tables 1-12 and 1-13. These tables show the following: the Railbelt load grows at an average annual compound rate of about 2.3 percent; the real coal price remains constant; the real turbine oil price decreases by about 25 percent between 1983 and 2000 and then remains constant; and the real natural gas price decreases by about 11 percent between 1983 and 2000 and then remains constant.

1.2.4.2 FERC Load Projections

In the FERC staff review of the Susitna license application (Alaska Power Authority, 1983), Staff evaluated the various possibilities for future oil prices and identified the following mid-range projection shown in 1983 dollars:

Year		1983	1985	1990	1995	2000	2010
Oil price	($/barrel)	29	24	20	22	24	29
	($/metric ton)	213	176	147	162	176	213

The range of Staff's projects are shown in Figure 1-3. Various forecasts of others are shown in Figure 1-4.

The Staff projection is based on an assumption that the strength of economic forces now acting in the direction of reducing oil prices (fuel switching, conservation, and the growth of non-OPEC oil production) will continue through the 1980s to exceed the strength of economic forces tending to increase oil prices (renewed world economic growth). Oil price projections from the DOR, the Clark case, and the Department of Energy's (DOE) Northwest Energy Policy Project (NEPP) are Shown in Figure 1-4. The Clark and DOE projections are all postulated on an assumption that the combination of economic forces will cause a sufficient growth in demand for oil to allow OPEC to increase its output, and hence maintain its market power.

Table 1-12. Railbelt peak demand and energy, net, in the Alaska Department of Revenue 50-percent case (Source: Alaska Power Authority, 1984b, Application, Appendix F).

Year	Peak Demand 1/		Energy 1/, 2/
	MW	Change 3/	GWH
1983	580	5.34	2,808
1984	611	4.91	2,956
1985	641	3.12	3,104
1986	661	3.18	3,198
1987	682	2.93	3,292
1988	702	2.99	3,385
1989	723	2.77	3,479
1990	743	1.35	3,573
1991	753	1.33	3,620
1992	763	1.18	3,667
1993	772	1.30	3,714
1994	782	1.28	3,761
1995	792	1.64	3,808
1996	805	1.61	3,871
1997	818	1.59	3,935
1998	831	1.56	3,998
1999	844	1.54	4,062
2000	857	2.10	4,125
2001	875	2.06	4,211
2002	893	1.90	4,297
2003	910	1.98	4,384
2004	928	1.94	4,470
2005	946	2.64	4,556
2006	971	2.57	4,676
2007	996	2.41	4,796
2008	1,020	2.45	4,916
2009	1,045	2.39	5,036
2010	1,070	----	5,156

1/ Average annual compound growth rate: 2.3 percent.
2/ Average load factor: 55 percent.
3/ Percent change from current to following year.

Table 1-13. Fuel price projections in the Alaska Department of Revenue 50-percent case, in 1983 dollars per 1 million Btu (Source: Alaska Power Authority, 1984b, Application, Appendix F).

Year	Natural Gas 1/	Turbine Oil	Coal
1983	2.77	6.23	1.80
1984	2.60	5.80	1.80
1985	2.43	5.37	1.80
1986	2.47	5.30	1.80
1987	2.51	5.23	1.80
1988	2.54	5.16	1.80
1989	2.58	5.09	1.80
1990	2.62	5.02	1.80
1991	2.60	4.98	1.80
1992	2.58	4.95	1.80
1993	2.57	4.91	1.80
1994	2.55	4.88	1.80
1995	2.53	4.84	1.80
1996	2.52	4.81	1.80
1997	2.50	4.77	1.80
1998	2.49	4.74	1.80
1999	2.47	4.70	1.80
2000 2/	2.46	4.67	1.80

1/ Includes 30 cents per 1 million Btu for pipeline transportation cost.

2/ All fuel prices remain constant after the year 2000.

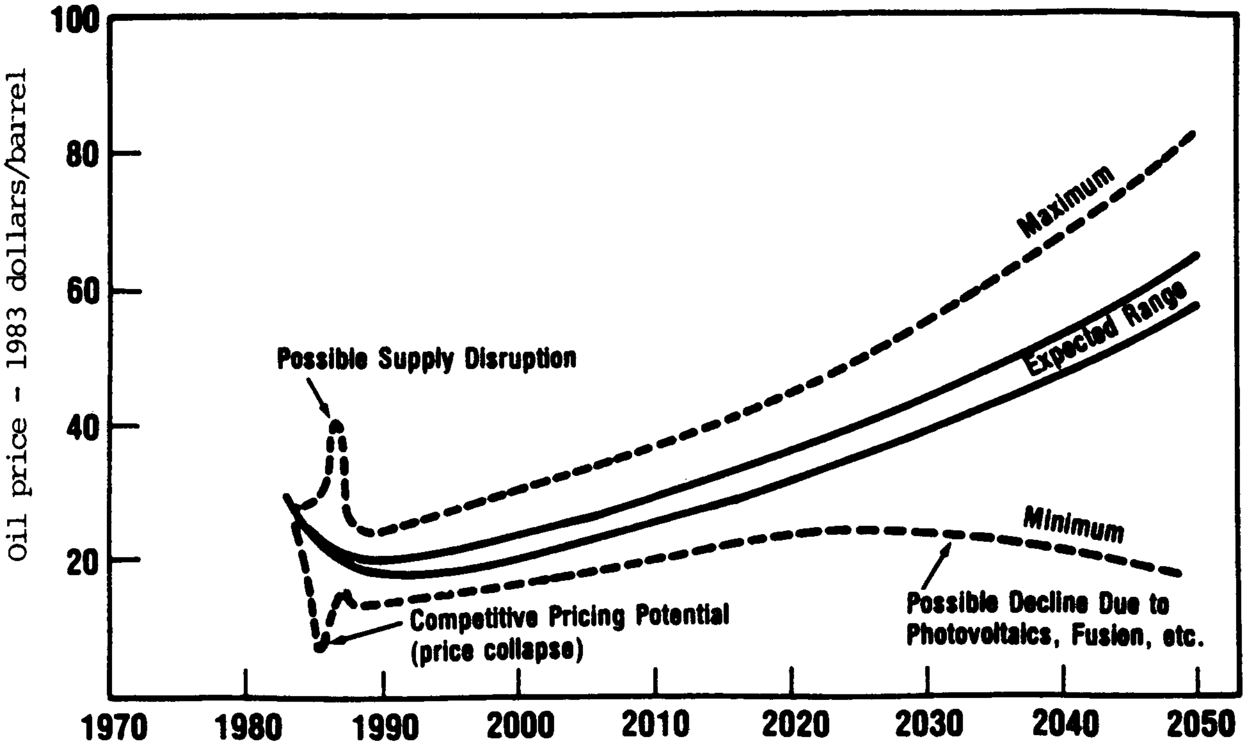

Figure 1-3. Projected world oil prices (Source: Staff).

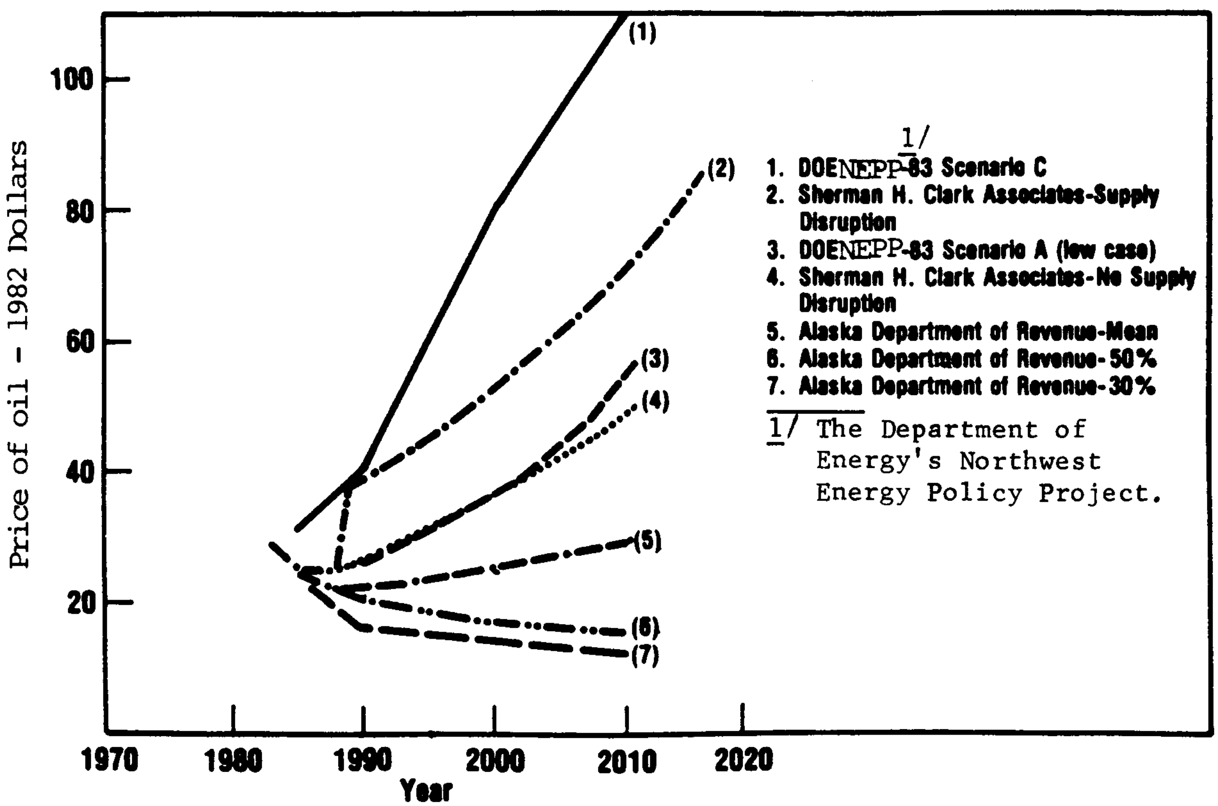

Figure 1-4. Price of oil under various forecasts (Source: Staff).

If oil prices decline, then the magnitude of fuel switching and conservation should diminish, less exploration and development should occur in non-OPEC countries, and the world's economic growth should be stimulated. In short, a reduction in oil prices will reduce the magnitude of forces tending to further reduce oil prices and will increase the magnitude of forces tending to cause prices to rise. As a consequence, even if oil prices decline in the near term, they eventually will start to rise again. Almost all analysts project increasing prices after about a decade or less. Conversely, if oil prices rise, then the economic forces tending to cause oil prices to fall will be strengthened, whereas the degree of the world's economic recovery will tend to be reduced.

Using world oil price forecasts, Staff made a series of load projections to forecast state petroleum revenues for use in the MAP model and to define end-user fuel prices for input into RED model. The resulting load projections for medium and high world oil price assumptions are shown in Tables 1-14 and 1-15.

No projections consistent with the low world oil price trajectory could be generated. The state economic model component of MAP was unable to compute a solution, given the drastic reductions in state revenues implied by the low oil price in 1985. This should not be viewed as a failure of the MAP model. The result is indicative of the very serious economic problems that the world, and Alaska in particular, are likely to face if the price of oil collapses to a range of $10 a barrel.

A graph comparing FERC staff's projections of electric demand and the Applicant's projections is shown in Figure 1-5.

Staff's midrange projections of fuel costs related to the midrange load forecast are shown below.

Fuel forecast	1983	1985	1990	1995	2000	2010	2020	2030	2040
Diesel oil ($/barrel)	41	36	32	34	36	41	49	57	67
Gas ($/1 million Btu)	2.77	2.47	2.23	2.70	2.83	3.13	3.55	4.02	4.62
Coal ($/1 million Btu)	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60

Staff, in addition to making changes in world oil price scenarios, attempted to alter the MAP model in order to improve the economic consistency of what appears to be a sophisticated fore-

Table 1-14. Railbelt load forecast, FERC staff medium world oil price scenario, 1983-2022 (Source: Staff).

Year	Energy (GWh)	Peak Demand (MW)
1983	2,802	579
1985	3,094	639
1990	3,474	722
1995	3,788	788
2000	4,168	866
2005	4,623	960
2010	5,234	1,086
2020	6,424	1,332
2022	6,693	1,388

Table 1-15. Railbelt load forecast, FERC staff, high world oil price scenario, 1983-2022 (Source: Staff).

Year	Energy (GWh)	Peak Demand (MW)
1983	2,814	581
1985	3,116	644
1990	3,567	742
1995	3,927	817
2000	4,447	925
2005	4,793	996
2010	5,371	1,115
2020	6,591	1,367
2022	6,866	1,424

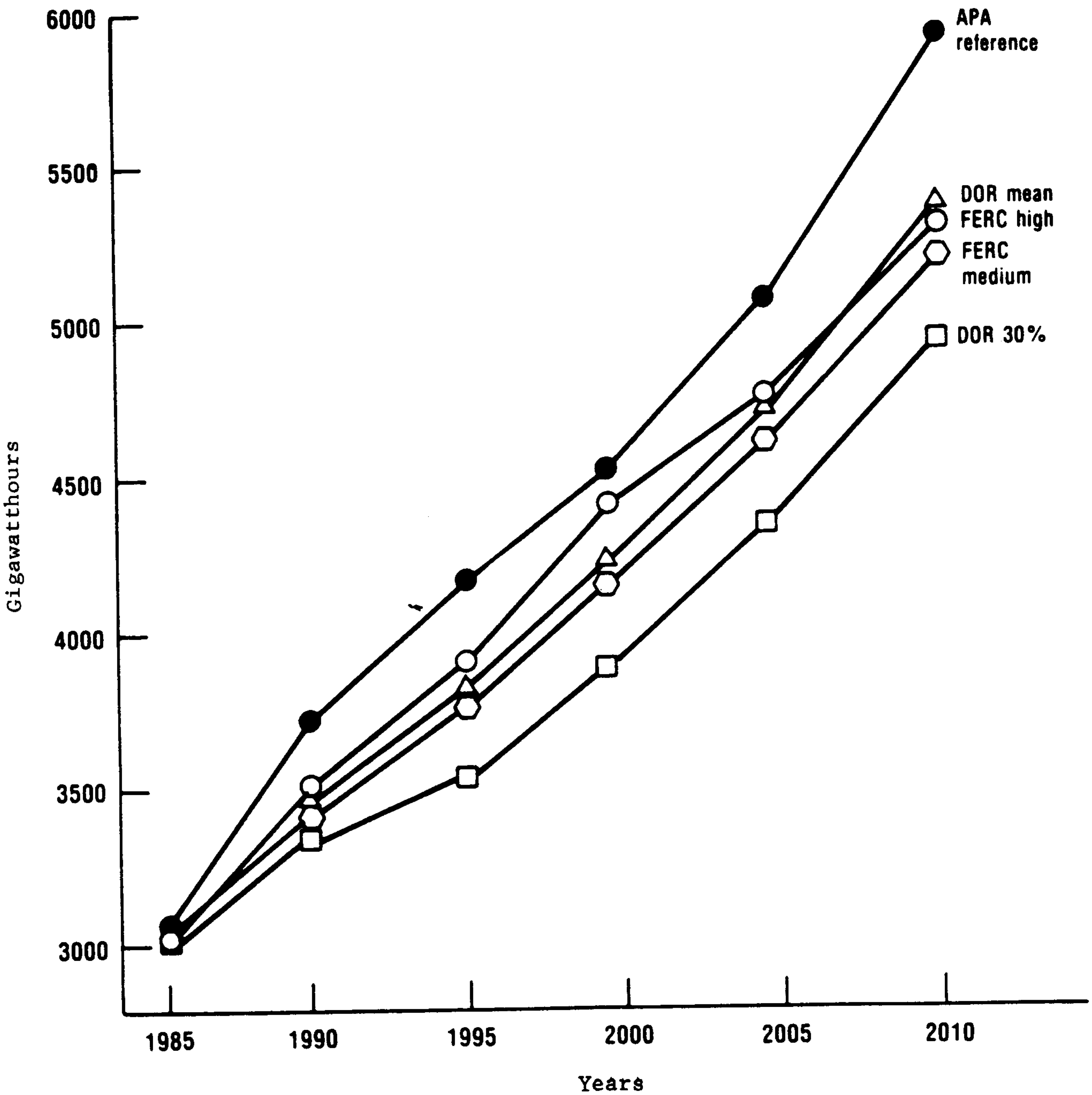

Figure 1-5. FERC staff load projections and selected Alaska Power Authority (APA) load projections for 1983-2010 (including the Clark, Alaska Department of Revenue mean, FERC high, FERC medium, and Alaska Department of Revenue 30-percent cases). [Source: Staff].

casting tool. Where the specification of an equation could be altered to add economic content, as well as to improve both the statistical fit and the significance of coefficients in the equation, then such a modification was made. In those instances where an equation was successfully altered, however, it was found that substitution of the new equation into the model caused the system to become unstable. This is not an unreasonable circumstance, given a model with the complexity of the MAP system. For this reason, Staff has judged that the forecasting models employed by the Applicant could not be improved upon in a reasonable time, and the models, unchanged, were used to generate Staff's Railbelt forecasts.

1.2.5 Load Resource Comparisons

1.2.5.1 Comparison Based on Applicant's Load Projection

The Applicant's power requirement projections for the Railbelt are shown in Table 1-9, and a load resource comparison for the Railbelt, based on the Applicant's projection of power requirements and on current retirement schedules for existing resources, is shown in Table 1-16. The comparison in Table 1-16 indicates a need for the Bradley Lake Project or some other resource in 1988, assuming the installation of a 30-MW combustion turbine at Soldotna, scheduled for 1985, and the construction of a 7-MW hydro project at Grant Lake by 1988. The comparison also shows that the Bradley Lake Project can be fully absorbed by the Railbelt prior to the proposed operation of the Susitna Project in 1993.

1.2.5.2 Comparison Based on FERC staff Load Projections

A load resource forecast based on FERC staff power requirement projections is shown in Table 1-17.

Staff's loads forecast also indicates the need for additional generating resources in the 1988-1989 period and that the Bradley Lake Project could be fully absorbed by the Railbelt prior to the proposed installation of Susitna in 1993.

1.3 ALTERNATIVES TO THE PROJECT

The Corps, in a Final Environmental Impact Statement (FEIS) for the Bradley Lake Hydroelectric Project (1982), evaluated reasonable alternatives to the proposed project.

Table 1-16. Railbelt load resource comparison in the Clark case (Source: Staff).

	1988	1989	1990	1991	1992
Existing capability1/ 1982 (MW)	1128	1128	1128	1128	1128
Cumulative retirements2/ (MW)	175	175	193	212	280
Available capacity (MW)	953	953	935	916	848
Power demand 3/ (MW)	779	810	839	859	879
Reserve requirement4/ (MW)	243	243	252	258	284
Capacity requirement (MW)	1013	1053	1091	1117	1143
Capacity surplus (deficit)	(60)	(100)	(156)	(201)	(295)
Planned capacity addition5/	37	37	37	37	37
Capacity surplus (deficit)	(23)	(63)	(119)	(164)	(258)

1/ Capacity @ 0°F based on Alaska Power Authority, 1984a.

2/ Retirement data from Alaska Power Authority, 1984a.

3/ Clark case projections, including 8 percent for losses.

4/ Based on 30-percent reserve requirement assumed by Stone and Webster following discussions with Railbelt utilities (Alaska Power Authority, 1984b, Application, Appendix F).

5/ 30-MW combustion turbine scheduled for installation by the winter of 1985, 7-MW hydro project at Grant Lake being considered for 1988 by the Alaska Power Authority.

Table 1-17. Railbelt load resource comparison in the FERC staff midrange forecast (Source: Staff).

	1988	1989	1990	1991	1992
Existing capability1/ 1982 (MW)	1128	1128	1128	1128	1128
Cumulative retirements2/ (MW)	175	175	193	212	280
Available capacity (MW)	953	953	935	916	848
Power demand 3/ (MW)	750	768	787	801	815
Reserve requirement4/ (MW)	225	230	236	240	244
Capacity requirement (MW)	975	998	1023	1041	1059
Capacity surplus-(deficit)	(22)	(45)	(88)	(125)	(211)
Planned capacity addition 5/	37	37	37	37	37
Capacity surplus-(deficit)	15	(8)	(51)	(88)	(174)

1/ Capacity @ 0°F based on Alaska Power Authority, 1984a.

2/ Retirement data from Alaska Power Authority, 1984a.

3/ FERC staff projections, including 9 percent for losses.

4/ Based on 30-percent reserve requirement assumed by Stone and Webster following discussions with Railbelt utilities (Alaska Power Authority, 1984b, Application, Appendix F.)

5/ 30-MW combustion turbine scheduled for installation by the winter of 1985, 7-MW hydro project at Grant Lake being considered for 1988 by the Alaska Power Authority.

1.3.1 Alternative Project Design

1.3.1.1 Alternative Dam Type

The Applicant performed detailed engineering studies and cost estimates for a concrete gravity dam and a concrete-faced rockfill dam. Both types were found acceptable from an engineering viewpoint, which included earthquake-loading considerations. Geologic conditions existing at the dam site showed that acceptable foundations and abutments could be developed and that seepage under the dam could be limited.

The cost estimates for the two types of dams showed that the concrete-faced rockfill dam is more economical. Other factors favoring the rockfill dam are: readily available quarried material adjacent to the dam; smaller concrete quantities reducing the material borrowed from the Martin River Delta; use of the low cost overflow spillway at the right abutment; and the opportunity to develop a low-level intake channel as part of the quarrying operation.

1.3.1.2 Alternative Reservoir Level

Reservoir operating levels were determined on the basis of economic studies, technical considerations, and environmental considerations. Benefits were assumed to consist only of the project's capability for producing additional average annual energy. The costs associated with providing the increased benefits reflect larger dams and higher spillways, increased power tunnel intake excavation quantities, and additional reservoir clearing.

Three alternative maximum operating lake levels were studied: 1,170 feet mean sea level (msl), 1,180 feet msl, and 1,190 feet msl. Lake levels above 1,190 feet msl were not studied because of potential detrimental environmental impacts on wildlife migration patterns, possible encroachment of the downstream toe of the main dam in the riverbed, and possible interference and difficulty of construction of the intake, cofferdam, and main, concrete-faced rockfill dam toe slab.

Elevation 1,180 feet msl was found to provide the maximum incremental net benefits. Pool elevations above 1,180 feet msl were found to require dam sizes that would encroach on the riverbed area to such an extent that construction of the various facilities would be difficult.

1.3.1.3 Alternative Barge Landing Facilities

The Applicant, in reevaluation studies of the Bradley Lake Project in October 1983, reviewed the Corps' preferred barge site at the south side of Sheep Point, and found the limited accessibility too restrictive and unacceptable. A delay in the delivery of material or equipment could delay the project construction. The Applicant therefore would require an access channel and barge basin that would provide better accessibility during high tides. The Applicant's recommended access channel and barge basin facilities are designed to accommodate a barge 250 feet long by 76 feet beam by 10 feet draft and a design tug size of 90 feet long by 30 feet beam by 10 feet draft. A channel having a bottom width of 200 feet at invert elevation of minus 14 feet and a length of about 5,840 feet would connect to a barge basin approximately 350 feet wide by 500 feet long.

1.3.1.4 Alternative Transmission Facilities

The 115-kV project transmission lines will extend from a switchyard located north of the proposed powerhouse to compatible powerlines scheduled for construction by the Homer Electric Association. Overhead transmission lines and partially buried transmission lines were considered as alternatives, with an overhead line for the entire alignment being the recommended alternative. Each of the three alignments follow essentially the same route near the powerhouse, but would cross the Fox River Valley over three different routes (Figure 1-6). All three alignments are technically feasible and would be of similar cost. The chief difference in the alignments is in land ownership and in infringement on the Kenai National Wildlife Refuge. There is no private ownership of land in the preferred alignment, and other land use considerations along this route appear to be acceptable.

1.3.2 Other Hydroelectric Alternatives

The FERC staff concurs with the Corps' procedure and evaluation of other hydroelectric alternatives.

1.3.3 Nonhydrolectric Generation

The FERC staff concurs with the Corps' procedure and evaluation of nonhydroelectric generation including nuclear, geothermal, solar, wind, tidal, wood thermal energy, and energy transfer.

1.3.3.1 Feasible Alternative Forms of Generation

The nonhydroelectric technologies evaluated by Staff as alternatives to the Bradley Lake Project was a combustion-turbine operation, a combined-cycle operation (a combustion-turbine topping cycle with a steam-turbine bottoming cycle), and a coal-fired steam operation. Staff considers combustion turbines a reasonable alternative to hydro generation, because historically, combustion-turbine plants in the Railbelt have been operated at high capacity. Since a combined-cycle unit using the same fuel can be constructed with moderately increased investment costs and can be operated at a considerable lower heat rate, however, the combined-cycle unit is a

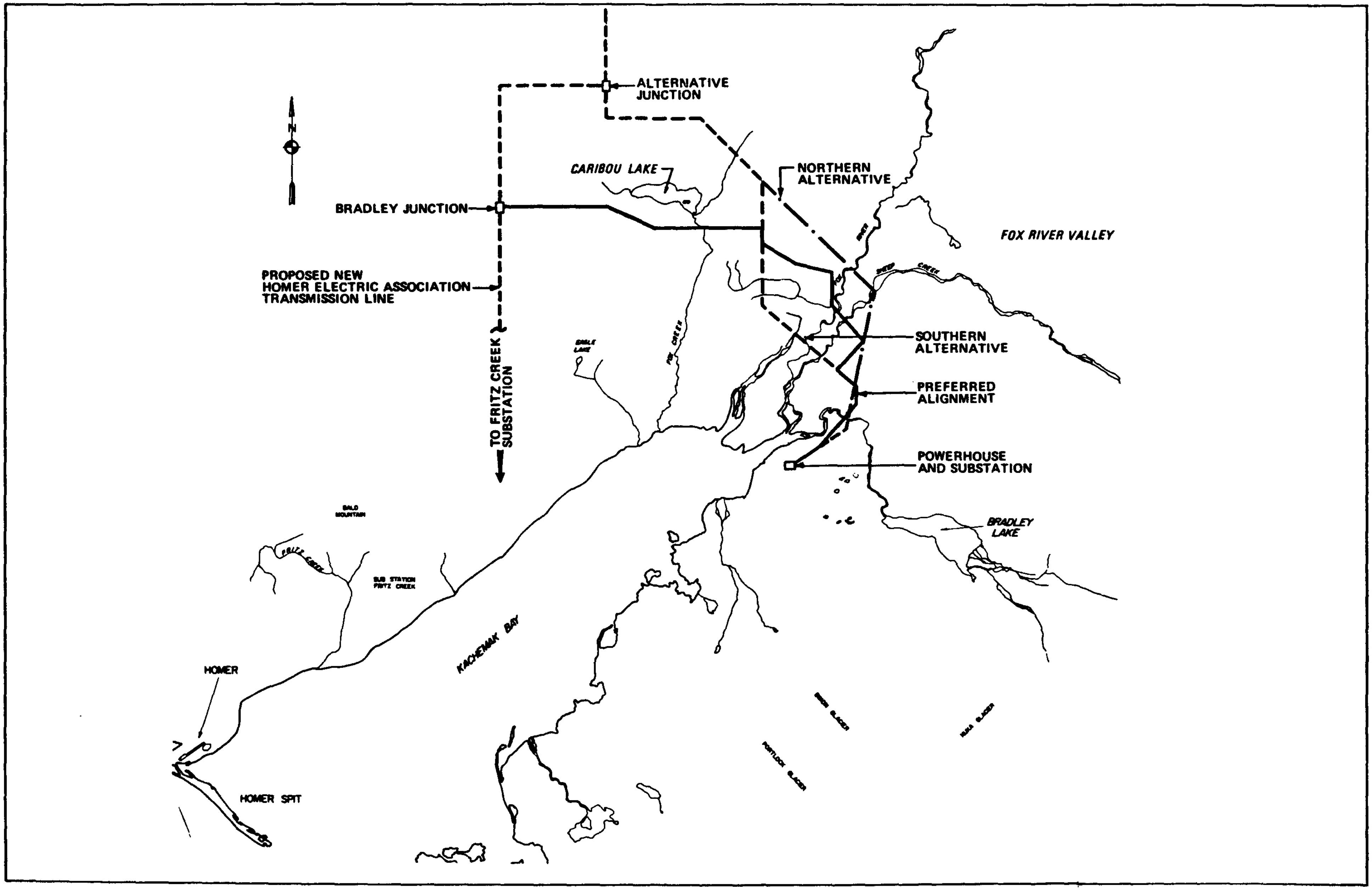

Figure 1-6. Alternative transmission line alignments (Source: Alaska Power Authority, 1984b, Application, Exhibit B).

better alternative than the combustion turbine. A coal-fired, steam-electric plant is also a reasonable alternative, but because of a 6-year construction period, a coal plant could not be brought on line before 1990-1991. This would be particularly true for a steam-electric plant that might be located at the month of a currently nonexisting coal mine in the Beluga area.

Staff has evaluated the economic feasibility of installing combustion turbines to meet load until a coal plant could be placed in operation in the Nenana area of the Railbelt. It was assumed that production of coal from the Nenana coal fields could be expanded within the time needed to construct the steam-electric plant. The alternative was examined to define the effect on total cost of two fuel-cost variations with time, the variations of gas in the combined cycle and coal in the steam plant.

1.3.4 Nongenerating Alternatives

Nongenerating alternatives are being emphasized in many states because of the high capital cost associated with the construction of new generation and the resulting need for rate increases. The most important nongenerating alternatives are conservation, rate revision, and load management. In an effort to advance these alternatives, the Congress has passed three related acts, the National Energy Conservation Act of 1978, the Powerplant and Industrial Fuel Use Act of 1978, and the Public Utility Regulatory Policies Act of 1978. The National Association of Regulatory Utility Commissioners is conducting a separate study on the effects of rate revision and load management.

1.3.4.1 Effects of Conservation On Demand

Conservation of electric energy can reduce load growth, thereby forestalling construction of new generating facilities. To date, most conservation measures have been voluntary, and have been encouraged through public education, utility financing arrangements, or Federal programs. These measures include installing insulation, encouraging the use of major appliances during off-peak hours, lowering the thermostat setting of heating units, and raising the thermostat setting on air conditioning units. Conservation could also be encouraged by revised building codes or by providing tax incentives or low-cost Federal loans for insulating residential and commercial establishments, for designing and constructing energy-efficient homes and offices, and for manufacturing energy-efficient equipment.

There are three principal types of conservation programs that play a part in the current energy scenario of the Railbelt. These program categories are: the state Residential Energy Conservation Program; the Municipality of Anchorage Low-Income Weatherization Program; and various conservation assistance programs sponsored by Railbelt utilities.

The state-sponsored program has undertaken the following: the training of energy auditors; the performance of residential energy audits, entailing the physical inspection of the premises; the provision of grants and loans for conservation improvements recommended by the audit; and the provision of retrofitted insulation and weatherization for qualifying low-income households. The Municipality of Anchorage program provides grants of up to $1,600 for energy conservation materials and repairs. The utility-sponsored conservation programs, at least so far as they address residential consumers, can best be described as educationally oriented. The bulk of this activity appears to be distributing brochures, making presentation to groups, and counseling customers regarding conservation techniques. Most assessments of these conservation programs (including the assessments of the sponsoring organizations) indicate modest impacts, particularly in the Anchorage area. The trend appears to be toward curtailment rather than expansion of most of these efforts. Experience in other states suggests that consumer conservation measures are generally undertaken when electric rates become burdensome and when the savings available from specific measures are well identified.

Utilities have measured the extent of conservation efforts on system load. These measurements are used on input data to the RED model, in addition to forecasts of additional conservation efforts. Thus the load forecast for the Railbelt region includes conservation effects.

1.3.4.2 Effects of Rate Revision on Demand

Restructured or redesigned electric tariffs, developed to reduce electric energy consumption during peak hours, need to accurately represent the incremental cost of producing the electric power. The cost in terms of economic resources to produce a unit of electricity for the supply of utility system loads changes continuously. Cost depends on the system load, which is constantly varying in hourly, daily, weekly, and seasonal cycles, and on the availability and efficiency of generation capacity, which often varies in a 12-month cycle. In theory, seasonal rates designed to account for the average seasonal difference in the cost of producing energy might be used; or if the cost of implementing them can be justified, time-of-day rates--rates that reflect the marginal cost of producing energy, a cost that fluctuates with each change in system load--could be used.

While the economic theory of rate revision is basically sound, its implementation presents a variety of practical problems. Electric energy use appears to be responsive to price in the long run, but is limited in response during shorter periods. For example, most consumers of electricity have a significant investment in electrical equipment. For these consumers, operating existing equipment at high electric costs may be less expensive than investing in more efficient equipment that would operate at a relatively lower cost. In this situation, the implementation of increased rates has the potential to penalize the consumer while achieving little or no reduction in energy consumption.

1.3.5 Economic Comparison of Alternative Forms of Generation

The proposed Bradley Lake Project would have a firm annual energy capability of 334 GWh and a dependable capacity of 65 MW. The dependable capacity was determined by loading the firm energy into the peak week-hourly load curve (Figure 1-7) for the Railbelt region. The 65 MW of dependable capacity would be available for an average of 14 hours per day, based on the December peak-week load.

According to the Applicant's life-cycle cost analysis, using load growth and fuel costs equivalent to the Clark case projections and a 3.5 percent real discount rate, the project is economically feasible by a considerable margin. The Applicant's detailed system expansion analysis shows that significant benefits would accrue to the Kenai Peninsula, and to the Railbelt area as a whole, through the additional reserve sharing and economic energy interchange possible between the Anchorage area and the Kenai Peninsula with Bradley Lake in operation.

The detailed system-expansion study and the related Kenai Peninsula transmission system analysis also show that without the Bradley Lake Project, the most economical plan to serve the Kenai Peninsula would be to construct a new transmission line between the Anchorage area and the Kenai Peninsula. With Bradley Lake constructed at 90 MW, the existing transmission intertie is adequate, and the new transmission line between the Anchorage area and the Kenai Peninsula is not needed through the analysis period.

The Bradley Lake Project would be used to displace thermal generation in the Railbelt area. Reasonable alternative methods of providing the Bradley Lake generation, identified in Section 1.3.2, were gas-fired, combined-cycle generation and coal-fired, steam-electric generation. Staff evaluated the economic feasibility of the project and of these alternatives, using 50-year, present worth values and the real discount rate. Various values were assumed for the real discount rate.

The parameters used for the economic analysis are listed in Tables 1-18 and 1-19. Construction of the coal alternative would require an estimated 6 years. Since a coal alternative would not be available to meet the region's capacity demand in 1988 and 1989, the cost of constructing and operating a gas turbine was included to meet the deficit while the coal plant is under construction.

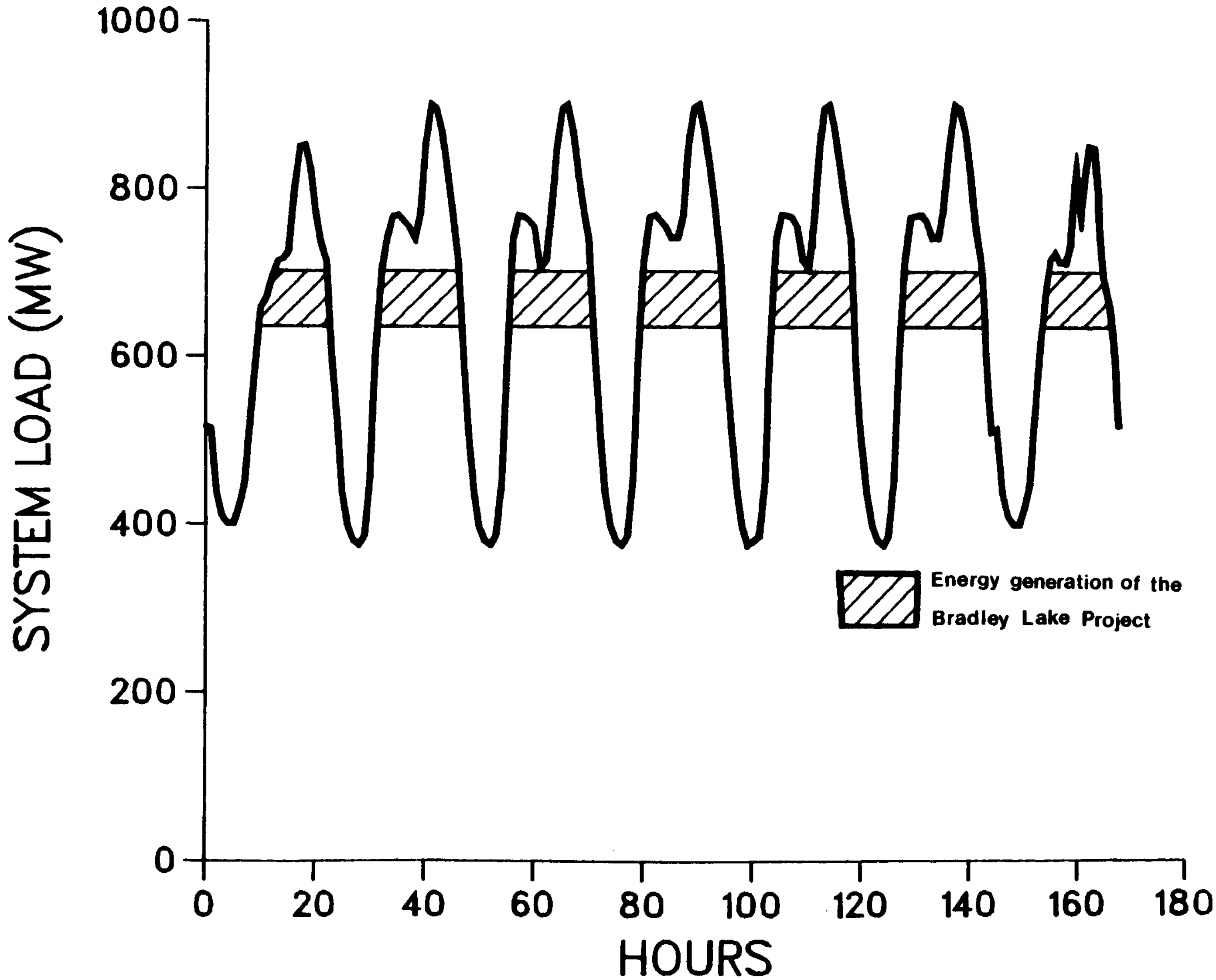

Figure 1-7. A peak-week load curve for the Railbelt region, showing the December peak-week load (Source: Staff-generated load pattern, based on data from Alaska Power Authority, 1983).

Table 1-18. Parameters for thermal alternatives (Source: Staff).

	Combined cycle	Coal plant	Gas turbine
Capital Cost 1/ in $/kW			
@ 3% real discount rate	1180	2,593	681
@ 4.5% real discount rate	1202	2,710	686
@ 6% real discount rate	1220	2,827	692
Fixed Operation and Maintenance (O&M) in $/kW yr	7.76	18.01	2.89
Variable O & M in $/kW yr	1.81	0.64	5.18
Construction period in years	2	6	1
Heat rate in Btu/kWh	8,000	10,000	12,200

1/ All cost is in 1983 dollars and includes interest during construction.

Table 1-19. Parameters and values for the Bradley Lake Project (Source: Staff).

Parameters	Values
Installed capacity	90 MW
Average annual generation	369.2 GWh
Dependable capacity 1/	65 MW
Dependable energy	334.1 GWh
Capital cost 2/ in $/kW	
@ 3% real discount rate	3,352
@ 4.5% real discount rate	3,456
@ 6% real discount rate	3,560
Operation and Maintenance (O&M) 3/ in $/kW yr	13.91
Construction period in years	3

1/ Staff estimate.

2/ All cost is in 1983 dollars and includes interest during construction.

3/ Includes O&M for transmission line to proposed Homer Electric Line.

The results of the Staff analysis, plotted in Figure 1-8, show that the proposed Bradley Lake Project is more economical than the least-cost, nonhydroelectric-generation alternative at real discount rates less than 5.6 percent.

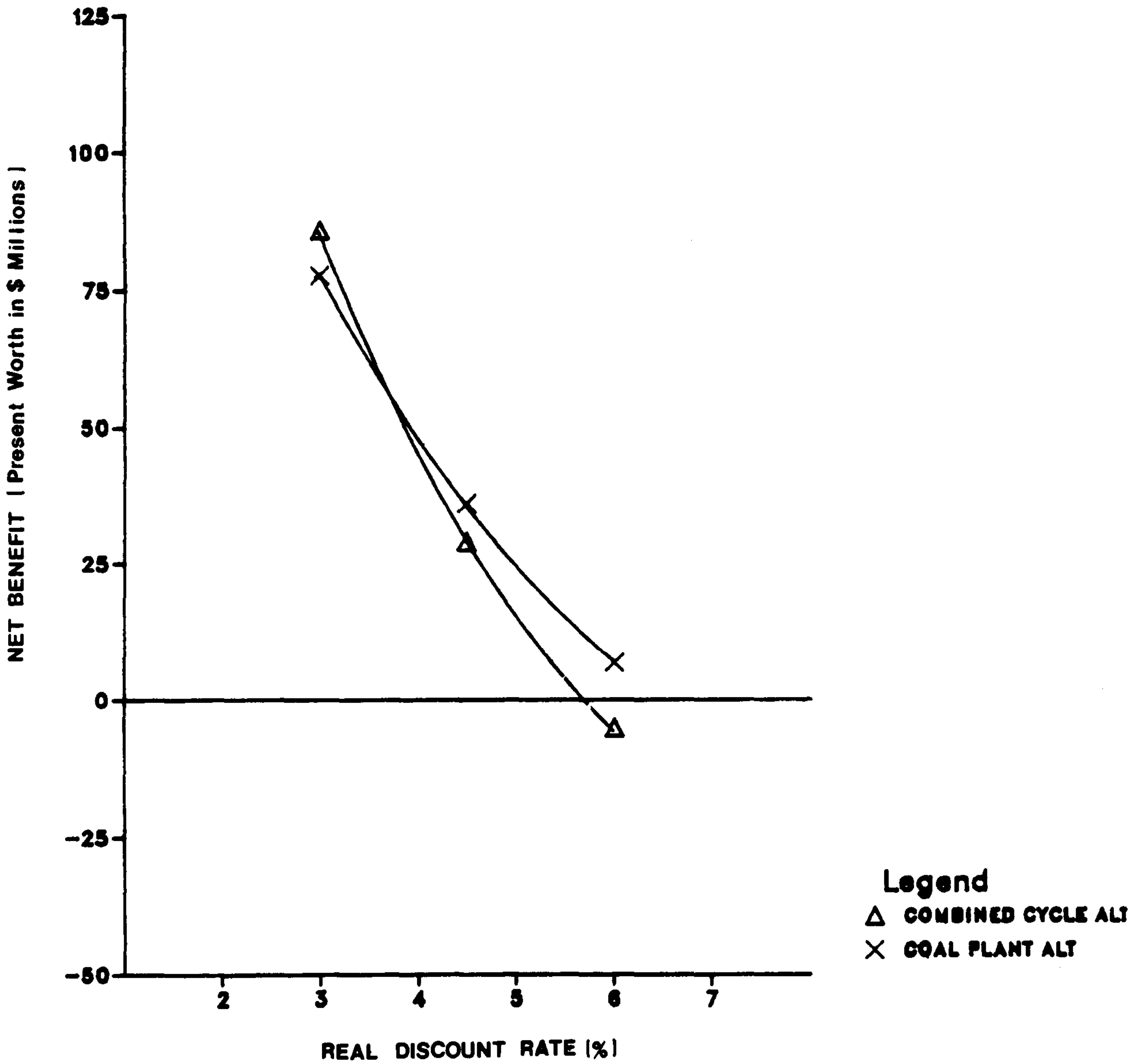

Figure 1-8. A comparison of 1983 present worth of total, 47-year, net benefit of the Bradley Lake Project over the nonhydroelectric generation alternatives, at various discount rates (Source: Staff).

2. PROPOSED ACTION AND ALTERNATIVES

2.1 BRADLEY LAKE PROJECT -- APPLICANT'S PROPOSAL

2.1.1 Location

The proposed Bradley Lake Project would be located on the Bradley River in Kenai Peninsula Borough, largely on lands of the United States administered by the Bureau of Land Management (BLM). The Applicant's proposal is nearly identical in location to a proposal by the Corps. Both proposals include the construction of a dam to raise the level of the existing Bradley Lake.

2.1.2 Proposed Facilities

An overview of the proposed project is provided in Figure 2-1; the design of the proposed dam is shown in Figure 2-2.

2.1.2.1 Glacier Diversion, Dams, and Reservoir

The proposed project would include the diversion of outflow from the Nuka Glacier, the construction of a diversion dam on the Middle Fork of Bradley River, and the construction of a dam at Bradley Lake. The Nuka Glacier diversion would consist of a rock cut at the natural outlet of the Nuka Glacier pool into the upper Bradley River, the construction of a dike in the outlet into the upper Nuka River, and the widening of the upper Bradley River channel immediately downstream of the outlet (Figure 2-3). Construction on the Middle Fork of the Bradley River would consist of a 20-foot-high diversion dam, with a spillway crest elevation of 2,204 feet 1/, which would divert flows through a 6-foot-diameter underground pipe to Marmot Creek, a tributary of Bradley Lake. The dam at Bradley Lake would be a 125-foot-high, concrete-faced, rock-fill dam, with a crest elevation of 1,190 feet at the outlet of Bradley Lake, and with an ungated, ogee spillway, at a crest elevation of 1,180 feet, located on a saddle feature 150 feet east of the dam.

Operation of the proposed dam would raise Bradley Lake 100 feet, giving the reservoir a surface area of 3,820 acres and a usable storage capacity of 315,500 acre-feet at a maximum operating water surface elevation of 1,180 feet.

These features of the Applicant's proposal differ from the Corps' proposal in that the Corps had proposed a concrete gravity dam with an integral spillway and a reservoir elevation that would be 14 feet lower than that proposed by the Applicant.

1/ All elevations refer to the Applicant's Project Datum. Mean Sea Level Datum equals Project Datum plus 4.02 feet.

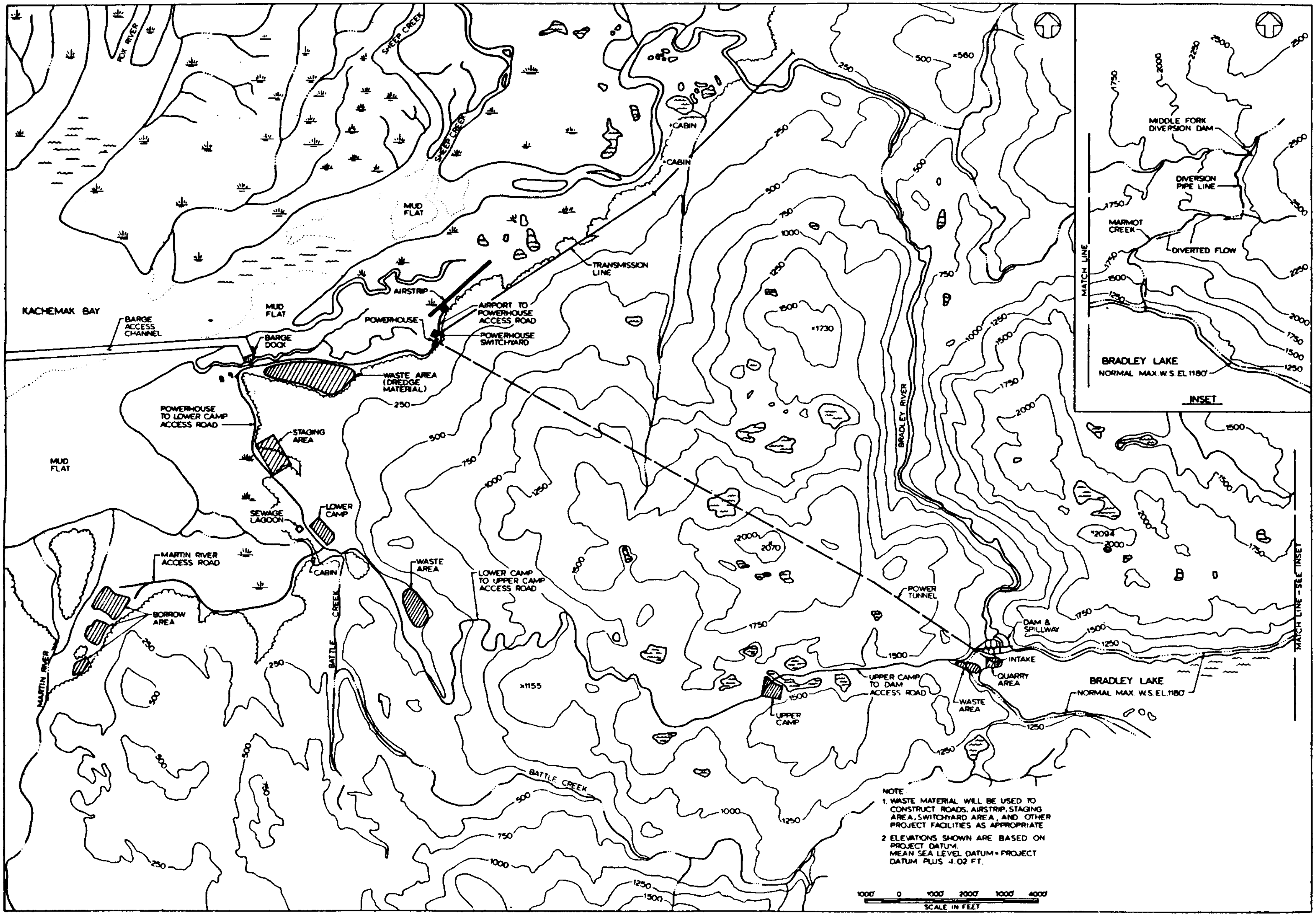

Figure 2-1. General plan of the proposed Bradley Lake Project (Source: Alaska Power Authority, 1984b, Application, Exhibit F).

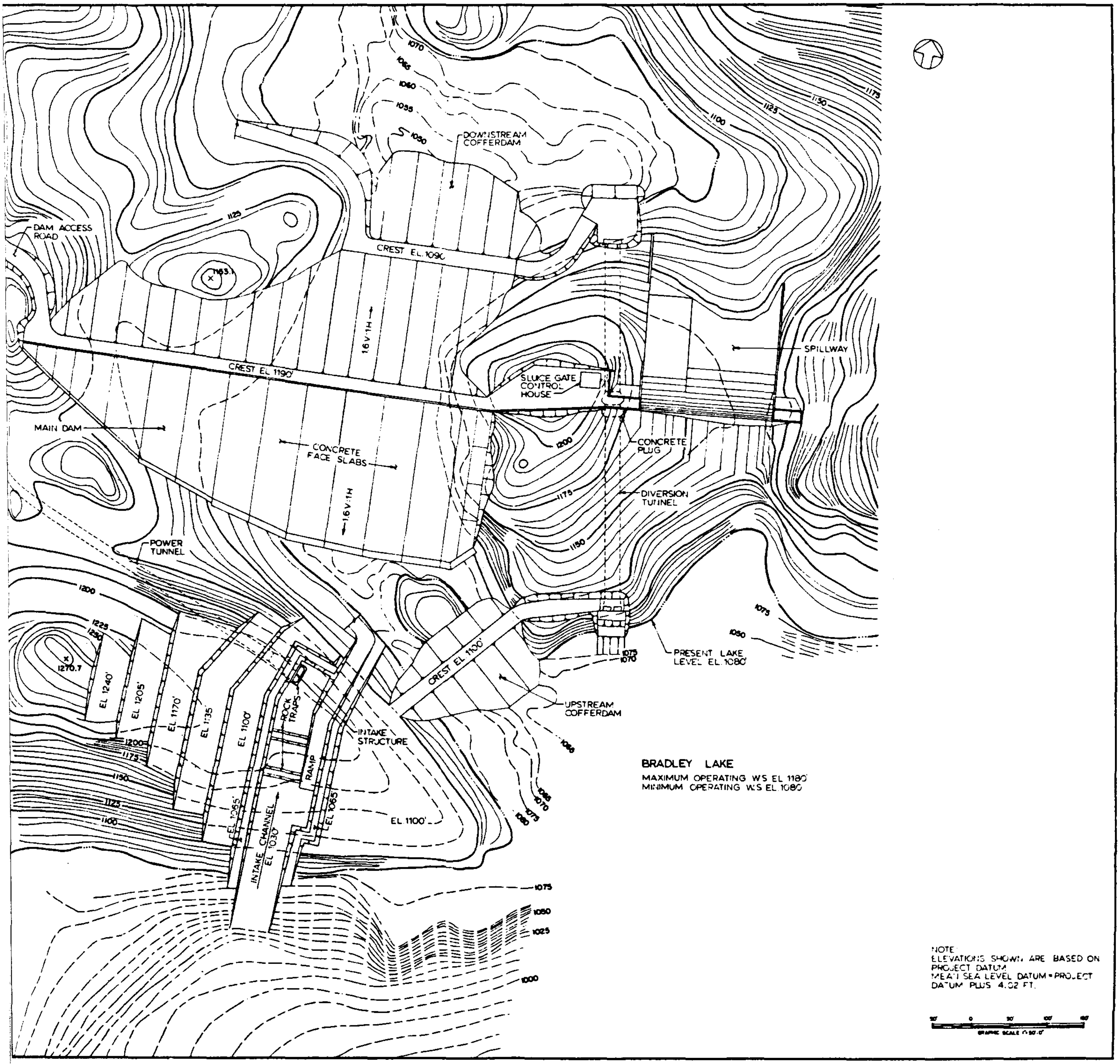

Figure 2-2. Proposed Bradley Lake dam, spillway, and flow structures (Source: Alaska Power Authority, 1984b, Application, Exhibit F).

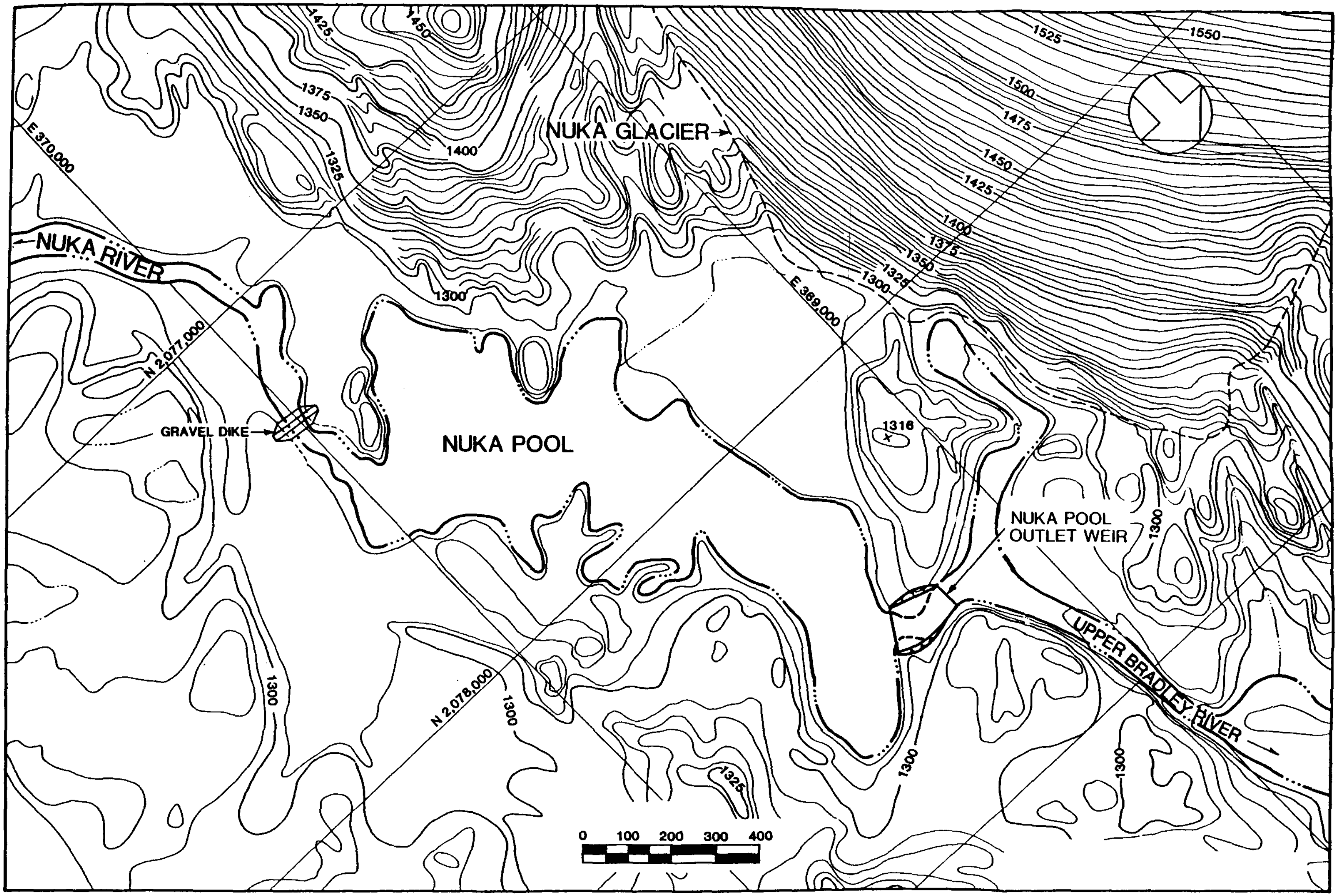

Figure 2-3. Proposed diversion dike and outlet weir at the base of the Nuka Glacier (Source: Alaska Power Authority, 1984d).

2.1.2.2. Power Conduit

The Applicant's proposed 11-foot-diameter, concrete-lined, underground power tunnel consists of a 950-foot-long horizontal section with dual gates near the downstream end, an 810-foot-long inclined section, and a 16,850-foot-long main section, with steel lining on the downstream 2,400 feet. This design would eliminate the need for the surge tank, its access road, and 2,710 feet of surface penstock as proposed by the Corps.

2.1.2.3 Powerhouse

The proposed 138-foot-long, 66-foot-wide, 112-foot-high, steel and reinforced-concrete powerhouse would contain two Pelton 45-MW generating units, with provisions for one additional 45-MW unit. The use of Pelton rather than Francis units, as proposed by the Corps, would result in 17 vertical feet less of rock excavation. The Corps had proposed a full 135-MW capacity.

2.1.2.4 Tailrace

The tailrace channel would be dug from the tidal flats of the Bradley River-Sheep Creek estuary to an elevation of -6.0 feet, with a bottom width of 67 feet, in order to allow free discharges of generating flows into the tidal flats and into Kackemak Bay.

2.1.2.5 Transmission Facilities

Project transmission facilities would consist of a substation, adjacent to the powerhouse, and two parallel, 20-mile-long, 115-kV lines from the substation to a proposed Homer Electric Association line between Fritz Creek and Soldotna. The proposed alignment is discussed in Section 1.3.1.4 (Figure 1-6).

2.1.2.6 Access Facilities

Access facilities would include a barge channel from Kachemak Bay, a barge basin and ramp, an airstrip, and project roads connecting the airstrip, the powerhouse, the lower and upper construction camps, and the dam (Figure 2-1). The barge channel would be 200 feet wide and 1.5 miles long; the airstrip would be 2,200 feet long; and the access roads, which would total about 10 miles in length, would consist of two 12-foot-wide lanes in high traffic areas and one 12-foot-wide lane in lower traffic areas.

2.1.2.7 Recreational Facilities

Recreational facilities would include six camp sites, three near the barge dock and three near Bradley Lake. All the camp sites would have tent pads, picnic tables, and benches, and the three camp sites near the barge dock would have fire pits. There would be two pit latrines, one for each group of camp sites. These facilities would be developed in coordination with the Alaska State Division of Parks. The barge channel and dock would be opened to the public after project construction is complete, and the project roads would be restricted to pedestrian use.

2.1.2.8 Land Requirements

The project would occupy 6,786 acres of BLM land. Almost 2,000 acres within the proposed project boundary are lands of the State of Alaska.

2.1.2.9 Borrow Areas

Gravel or quarried rock would be required for road fill, to build the construction camp and access facilities, for dam construction, and to produce concrete aggregate for the dam and other project structures. The proposed material sources for the project are the Martin River delta and the left dam abutment at Bradley Lake. Material excavated from the powerhouse, the power tunnel, the penstock alignment, and the mountainside portion of the project road to Bradley Lake also would be used in construction, when feasible.

A borrow site with acceptable gravel has been identified on the Martin River delta. Another acceptable site, about 3 miles upstream on the Martin River, would yield material of larger diameter. Either site could be developed with no overburden removal. The delta site, which is the proposed site, would require the addition of 2 miles of haul road to the primary project road. The upstream site would require the addition of about 5 miles of haul road to the primary road.

Material for rockfill, concrete aggregate, or riprap could be quarried from the rock adjacent to either side of the dam at the same time that the dam and power conduit intake structure are built. The quarry would be suitable as a source of high-quality large rock for riprap, dam, and spillway construction and for concrete aggregate. This source would not be available for the earlier stages of construction. The quarry would disturb a maximum of about 8 acres of rock and alpine tundra.

2.1.2.10 Spoil Disposal Areas

Solid wastes from the project construction camp and from project operation would be buried in a 10-acre landfill near the lower construction camp. The landfill would be operated in accordance with state standards and normal landfill practices. Disposal sites are shown in Figure 2-1.

Excess material from cut-and-fill road construction would be placed in a disposal site near the construction camp and in small areas along the road where the material could be stabilized.

Material dug from the upper end of the underground power tunnel would be placed in an upland site of about 5 acres near the dam, where it would be covered by the project reservoir.

Material excavated from the barge channel, the turning basin, and the powerhouse tailrace would be placed on the upper tidal flats between the hillside and the project road connecting the barge dock and the powerhouse. The Applicant proposes to develop this disposal site for waterfowl nesting habitat.

2.1.3 Construction Schedule

Construction of the Bradley Lake Project is expected to require a period of 36 months from the proposed start of the project in December 1985 to its completion in December 1988. The principal activities planned during the construction period are shown in Figure 2-4.

2.1.4 Work-force Requirements

A projection of construction personnel requirements is presented in Section 4, Table 4-5. Peak employment for the project would occur in the 17th month of construction, when 406 persons would be working at the site. The average monthly employment over the 33-month construction term would be 242 persons. An additional discussion of work-force requirements is contained in Section 4.1.11.1.

2.1.5 Operation of the Bradley Lake Project

The primary function of the Bradley Lake Reservoir would be to regulate streamflow and to provide for carryover storage for producing energy, in a peaking mode, throughout the year. The normal maximum operating range of the reservoir would be between elevations of 1,080 feet and 1,180 feet. The project would normally would be operated and monitored by remote control.

2.1.6 Safety Control

If the proposed project is licensed, the Commission staff would inspect the project, both during and after construction, to ensure the physical safety of the project and the safety of the public, including that of recreational users, and to ensure compliiance with any special construction and operating requirements of the license. The constructed project normally would be inspected each year by a staff engineer, who would observe the general condition of the project structures, looking particularly for any evidence of leakage or structural deterioration that might affect safety. Warning signs, protective fencing, and upstream and downstream safety devices would be checked, and suggestions would be

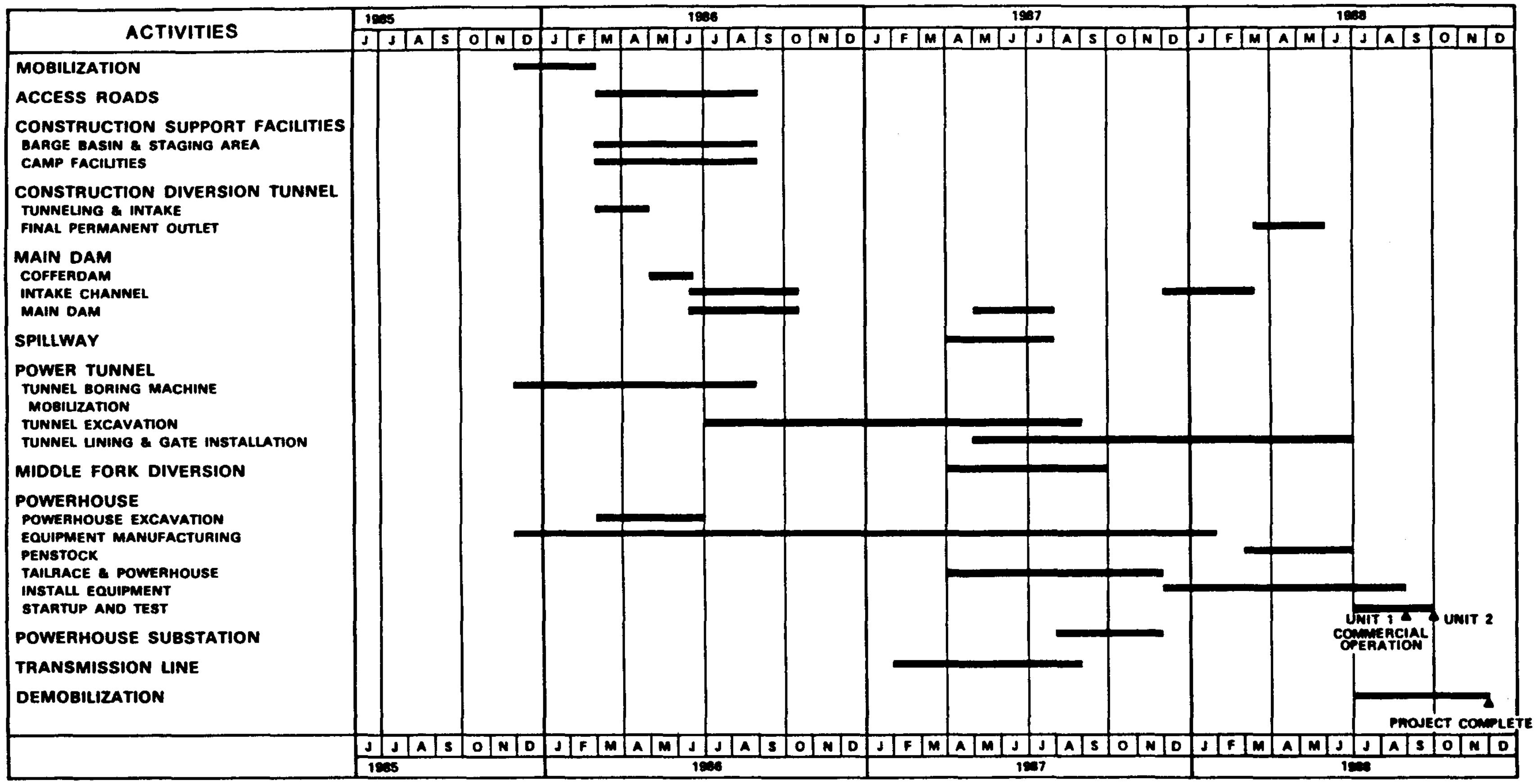

Figure 2-4. Proposed project construction schedule (Source: Alaska Power Authority, 1984b, Application, Exhibit C).

made for any necessary improvements. In addition, every 5 years, an independent consultant, experienced in the design and construction of hydroelectric projects, would inspect and evaluate the structures. The consultant's report, which would be limited to the safety of the project, would be submitted to the Commission for review.

2.1.7 Compliance with Applicable Laws

Prior to construction and operation of the proposed project, the Applicant would review the need for, and would obtain as necessary, the following Federal, state, and local permits and authorization:

Federal

hydroelectric license
Section 404 permit
Section 10 permit
right-of-way grant and temporary use permits
Federal Land Policy and Management Act Section 302 leases, permits, and easements
free use permit for gravel
National Pollution Discharge Elimination System permit
prevention of significant deterioration of air quality
determination of eligibility for the National Register
determination of effect on sites listed on the National Register

State

Section 401 certification
certificate of reasonable assurance
Alaska Coastal Management Program certificate of consistency
anadromous fish protection permit
approval of fishways to mitigate for obstruction to fish passage
land use permits
material sales
water rights permit and certificate of appropriation
land lease
permit to construct a dam
right-of-way for an easement

Local

Kenai Peninsula Borough permits and reviews

2.1.8 Future Plans

The Applicant's proposed project design allows for the future installation of one additional generating unit, should additional capacity be required.

2.2 DESCRIPTION OF ALTERNATIVE PROJECTS

2.2.1 Natural Gas-fired, Combined-cycle Generation Plant

2.2.1.1 Facilities

For the combined-cycle generation alternative, FERC staff assumes that a state-of-the art, 200-MW, gas-fired, baseload, combined-cycle plant would be installed. The assumed combined-cycle plant would include two combustion-turbine generator units; a heat recovery boiler, using the exhaust gases of the combustion turbines to produce superheated steam; and a steam turbine generator. The combined-cycle plant would substantially improve power generation efficiency and would provide operating flexibility. The plant would be able to operate at partial load with one of the gas turbines out of service, and the individual combustion turbines could be operated without the steam cycle.

The technical parameters and economic assumptions used for the combined-cycle units are listed in Table 2-1.

Table 2-1. Technical parameters and economic assumptions of the combined-cycle alternative in 1983 dollars (Source: Alaska Power Authority, 1984b, Application, Appendix F).

Parameters	Combined cycle
Technical	
Unit size (MW)	200
Heat rate (Btu/kWh)	8,000
Planned outages (%)	7
Forced outages (%)	8
Economic	
Unit capital cost 1/ ($/kW)	1,185
Operating and maintanence costs	
Fixed ($/kW yr)	7.76
Variable (mills/kWh)	1.81
Economic life (years)	30

1/ Including interest during construction at 0 percent escalation and 3.5 percent interest.

2.2.1.2 Location

The Staff assumes that the combined-cycle unit would be located close to natural gas distribution pipelines in the western Cook Inlet area.

2.2.1.3 Construction Requirements

The number of personnel required to build a 200-MW, combined-cycle plant would vary over a 32-month construction period and would peak at about 400 persons in the second year. The services needed to support construction of a combined-cycle plant would include access roads; a complete water supply, storage, and distribution system; power lines, to provide electric power for construction activities; and camp facilities, including sewage treatment facilities, a waste incinerator and garbage compactor, sleeping, recreational, and dining quarters, and an airstrip for the transportation of personnel, perishable goods, and medical emergencies.

Transmission line connections would be required to tie the combined-cycle plants into existing transmission networks.

2.2.1.4 Operation and Maintenance

A combined-cycle unit would require 10 to 15 operating personnel and 19 maintenance personnel.

Periodic maintenance would be performed on the combined-cycle plant and equipment under an established maintenance program that would include the complete stripdown and major inspection of the turbines at the intervals required or suggested by the equipment manufacturer. In addition, the maintenance programs would include monitoring the revegetation and erosion-prevention programs begun during the cleanup phase of construction. Major equipment replacement or overhaul functions generally would be performed during a plant's annual scheduled outages.

The operating and maintenance costs assumed in the Staff's analysis are listed in Table 2-1.

2.2.2 <u>Coal-fired Generation Alternative</u>

2.2.2.1 Alternative Facilities

The Staff estimates that a 200-MW coal unit would go into operation in 1991. It would be a conventional state-of-the-art design, equipped with dry, flue-gas, desulfurization scrubbers for the removal of sulfur oxides, baghouse particulate removal, wet-dry, mechanical, draft-cooling towers for heat rejection, and pulverized coal for combustion. The assumed capital cost reflects the state-of-the-art for environmental safeguards and for the ability to meet established performance standards. It is assumed that a 70-MW, combustion-turbine unit would be installed in 1989 to meet load requirements until the coal-fired unit becomes operational in 1991. The combustion-turbine peaking unit would consist of a simple-cycle machine using natural gas fuel. The technical parameters and economic assumptions for capital cost, operating and maintenance costs, and economic life are listed in Table 2-2.

2.2.2.2 Location

The Staff assumes that the coal-fired, steam-electric plant would be located in the Nenana area of the Railbelt. Coal delivery to the plant is assumed to be by unit train from the vicinity of the Usibelli Mine in the Nenana coal fields. The combustion turbine is not specifically sited, but would be located in the Anchorage-Cook Inlet area. Fuel for the combustion turbine presumably would be available from gas distribution pipelines in the area.

2.2.2.3 Construction Requirements

Construction of the steam-electric plant would require about 5 years. The number of construction workers required would vary, but would peak at about 500 by the end of the second year and would drop dramatically near the end of the fourth year.

Construction would include access roads; a complete water supply, storage, and distribution system; power lines to provide electric power for construction activities; a railroad spur to provide fuel and equipment transport; construction camp facilities, including sewage treatment facilities, a waste incinerator, and a garbage compactor; sleeping, recreational, and dining quarters; and an airstrip for the transportion of personnel, perishable goods, and medical emergencies.

Installation of the combustion-turbine would require from 1 to 2 years. Limited construction activities would be required because the installation consists mostly of prefabricated modules. A work force of about 30 people would be required for the installation, and site services would vary with location.

2.2.2.4 Operation and Maintenance

The operation and maintenance of a single, 200-MW, coal-fired, steam-electric plant would require an estimated staff of about 100 persons in support of a three-shift, 24-hour-a-day operation. Operation and maintenance of the gas turbine would require about 12 people.

The staff would perform periodic maintenance on all steam-electric pipes, valves, rotating machines, heat-sensitive equipment, and other items subject to wear, leaks, corrosion, or other deterioration. In addition, the staff would monitor the revegetation and

Table 2-2. Technical parameters and economic assumptions of a coal-fired generation alternative and a combustion-turbine alternative, in 1983 dollars (Source: Alaska Power Authority, 1984b, Application, Appendix F).

Parameters	Coal-fired steam	Combustion turbine
Technical		
Unit size (MW)	200	70
Heat rate (Btu/kWh)	10,000	12,200
Planned outages (%)	8.0	3.2
Forced outages (%)	5.7	8.0
Economic		
Unit capital cost[1] ($/kW)	2,632	683
Operating and Maintenance costs		
Fixed ($/kW yr)	18.01	2.89
Variable (mills/kWh)	0.64	5.18
Economic life (years)	30	30[2]

1/ Including interest during construction at 0 percent escalation and 3.5 percent interest.

2/ The Applicant assumes a 30-year retirement in its studies, but a 20-year retirement in its discussion.

erosion-prevention programs started during the cleanup phase of construction. In general, major equipment replacement or overhauls would be performed during scheduled outages, and would sometimes involve the temporary assignment of specialized personnel. On the average, scheduled outages require approximately 4 weeks per year for plants ranging in size from 100 MW to 300 MW, corresponding to a scheduled outage rate of 8 percent. The operating and maintenance costs assumed in the economic analysis are listed in Table 2-2.

2.3 NO-ACTION ALTERNATIVE

The Commission's denial of a license to construct, operate, and maintain the Bradley Lake Project, as proposed by the Applicant, would constitute the no-action alternative. This alternative would result in the expanded use of the nonrenewable energy resources of coal and natural gas to meet projected Railbelt electric energy requirements in the late 1980's. In the event that the license is denied, the proposed Bradley Lake Project site would remain in its present state, because no alternative developments at the site are currently planned by the Applicant.

3. AFFECTED ENVIRONMENT

3.1 BRADLEY LAKE PROJECT

3.1.1 Meteorology

3.1.1.1 Climate

The climate of the immediate project area is described in Section IV.A. of the Corps' FEIS. In general, the project area is under the influence of maritime weather patterns, characterized by cool summers, moderate winters, and long periods of fog, clouds, and rain.

3.1.1.2 Air Quality

Air quality in the project area is excellent, with few pollutants present because of the relatively pristine nature of the area surrounding the project site. The nearest community to the site, Homer, with a population of about 3,200 persons (Alaska Power Authority, 1984b, Application, Exhibit E), likely has only a minor influence on air quality in the area.

3.1.1.3 Noise

No ambient noise measurements have been made in the proposed project area. The area is undeveloped and relatively isolated.

3.1.2 Land Features

The proposed Bradley Lake Project would be located in the same setting as that considered for the Corps' proposed project at Bradley Lake. The physiography, topography, geology, and soils of the proposed project area are described and discussed in Subsections IV.A and IV.B of the Corps' FEIS.

3.1.3 Aquatic Environment

3.1.3.1 Water Quantity and Quality

Bradley River Basin

A description of the seasonal runoff pattern from Bradley Lake and Bradley River and a description of the quality of project waters is contained in Sections IV.A and B and Appendices B and C of the Corps' FEIS.

Briefly, the runoff pattern from the Bradley River basin is typical of glacial streams in coastal Alaska, with low flows occurring during the winter months and highest flows occurring during the late summer. About 90 percent of the annual runoff from the basin occurs from May through October. A unique aspect of the runoff from the Bradley River Basin, however, is the contribution of flow from the Nuka Glacier, which periodically shifts between the Bradley River and the Nuka River. Before 1971, about 75 percent of the flow from the Nuka Glacier went into the Nuka River; from 1971 to 1983, most of the glacier's flow went into the Bradley River Basin; since 1983, several additional shifts have occurred between the two river basins. The average annual flow at the Bradley Lake outlet, based on historical streamflow records (with the Bradley River receiving only 25 percent of the Nuka Glacier runoff), is 438 cubic feet per second (cfs) [Alaska Power Authority, 1984b, Application, Exhibit E]. Average monthly flows range from 52 cfs in March to 1,170 cfs in August. If it is assumed that all the Nuka Glacier flow is diverted into the Bradley River, as proposed by the Applicant, the average annual flow at the lake outlet is 484 cfs.

Limited flow data are available from the North Fork and Middle Fork of the Bradley River, the site of the proposed diversion. Based on 3 years of data from the Middle Fork, the Applicant calculates an annual flow of 51 cfs, with monthly average flows ranging from 4 cfs in March and April to 162 cfs in July and August (Alaska Power Authority, 1984b, Application, Exhibit E). The Applicant also estimated the flow available from the North Fork and from the remainder of the unregulated Bradley River Basin, downstream of the proposed Bradley Lake damsite and Middle Fork diversion. An average annual flow of 66 cfs was calculated, with monthly average flows ranging from 24 cfs in March to 174 cfs in June. The estimated mean annual flow at the mouth of Bradley River is 598 cfs.

The water quality of Bradley Lake and Bradley River is typical of glacial streams in pristine areas of Alaska. Concentrations of suspended sediments are seasonally high, ranging from 10 milligrams per liter (mg/l) in the winter to over 150 mg/l during the summer high-flow months. Other water quality parameters, such as dissolved oxygen, organic nutrients, available nitrogen, phosphorus, and fecal coliform counts, indicate high water quality in the basin and no sources of pollution. Bradley Lake generally remains isothermal [6° to 7° Celsius (C)] during the ice-free months, although occasionally the lake exhibits a weak temperature stratification with 8° to 10° C water in the top 20 feet of the water column. During ice cover (November through May), water temperatures range from 0° C near the surface to 2 to 2.5° C at lower depths.

Nuka River

Little information is available on flows or water quality in the Nuka River. The Geological Survey (USGS) attempted to install a stream gage on the river in 1970, but this gage was destroyed by ice within a year. No data were collected, and only occasional spot measurements by USGS are available. It is assumed, however, that the annual runoff pattern of the Nuka River is similar to the Bradley River, since the Nuka River receives glacial runoff from the Nuka glacier, as well as other smaller glaciers. When the Nuka Glacier runoff shifts to the Bradley River Basin, the Applicant has estimated that this results in an average annual reduction in runoff to the Nuka Basin of 158 cfs, ranging from a monthly average of 1.6 cfs in March to 539 cfs in September (Alaska Power Authority, 1984b, Application, Exhibit E). Water quality in the Nuka River is probably excellent, similar to that of the Bradley River, since the basin is pristine, with no human habitation or disturbance.

Unnamed Pond at Upper Camp Site

The 6.9-acre pond located near the proposed upper construction camp site has been investigated by the Applicant as a source of potable water for the camp. The pond receives only precipitation runoff from the surrounding area, and is reported to be of excellent quality, suitable for human use with little treatment (Alaska Power Authority, 1984d).

Battle Creek

Battle Creek, which is located near the proposed lower camp site and which would be crossed by the access road to the Martin River borrow sites (Figure 2-1), has a runoff pattern similar to that of the Bradley River, although the creek apparently receives less glacial runoff than the Bradley River. The estimated mean annual flow at the mouth of Battle Creek is 106 cfs, ranging from a monthly average flow of 13.8 cfs in March to 252 cfs in July. Water quality in Battle Creek is excellent, similar to that in Bradley River, except that concentrations of suspended solids are lower, and low levels of fecal coliform bacteria (5 col./100 ml) have been noted (Alaska Power Authority, 1984b, Application, Exhibit E).

Martin River

The Martin River, located immediately south of Battle Creek, is proposed as the major borrow site for gravel to be used in project construction. The Martin River has a runoff pattern similar to Battle Creek and Bradley River. The estimated mean annual flow is 148 cfs, with monthly average flows ranging from 19.2 cfs in March to 352 cfs in July. Water quality is similar to the Bradley River, except that water temperatures are about 5° C less than the Bradley River in summer and fall, and suspended solid concentrations are higher. Martin River also contains low levels of fecal coliform bacteria (Alaska Power Authority, 1984b, Application, Exhibit E).

Sheep Creek and Fox River

Sheep Creek and Fox River, which would be crossed by the project transmission line, are located to the north of Bradley River (Figure 2-1), and together comprise the largest freshwater inflow to upper Kachemak Bay. Both streams have runoff patterns similar to Bradley River, with the lowest flows occurring during March and highest flows occurring in July. The estimated mean annual flow at the mouths of Sheep Creek and Fox River are 1,075 cfs and 496 cfs, respectively. Water quality in both streams is generally good, similar to other streams in the area, except that the Fox River contains relatively high levels of fecal coliform bacteria, at times exceeding the limits considered safe for drinking water. The source of this bacteria is likely cattle that graze in the watershed (Alaska Power Authority, 1984b, Application, Exhibit E).

Kachemak Bay

Kachemak Bay (the Bay) is a 30-mile-long arm of Cook Inlet that extends to the northeast of Homer, with the head of the Bay immediately adjacent to the Bradley River. A detailed description of the Bay, its tidal patterns, ice formations, salinities, and important resources are described in Sections IV.A and B and Appendices B and C of the Corps' FEIS. Briefly, the Bay in the vicinity of the project area is characterized by extensive mudflats at low tide, with an average daily tidal range of about 11 feet (measured at Seldovia near the mouth of the Bay). During the summer months, the upper Bay receives a strong freshwater inflow from the Bradley River and other nearby streams. This freshwater inflow is dammed up by saline waters on incoming and high tides, but is well mixed within two tidal cycles. At low tide, the outflow from Bradley River forms a well-defined freshwater plume along the south shore of the Bay.

3.1.3.2 Fishery Resources

The fishery resources of the project area have previously been described in Section IV.B and Appendix B of the Corps' FEIS. Studies conducted since the Corps FEIS was published allow further description of these resources. The lower Bradley River, Martin River, Battle Creek, Nuka River, Sheep Creek, and the Fox River all contain populations of Pacific salmon. Of the three streams most directly affected by the project (Bradley River, Martin River, Battle Creek), the Bradley River contains the largest fish runs. About 1,000 pink salmon (*Oncorhynchus gorbuscha*), 50 chum salmon (*O. keta*), 10 sockeye (*O. nerka*), and 6 chinook salmon (*O. tshawytscha*) were observed in the Bradley River in 1983 (Alaska Power Authority, 1984b, Application, Exhibit E). Few fish were observed in either Martin River or Battle Creek in 1983, although past studies have identified sockeye and chum salmon in the Martin River, and sockeye and coho salmon (*O. kisutch*) in Battle Creek. Sheep Creek reportedly contains runs of pink and coho salmon, and Fox River contains runs of sockeye, coho, and pink salmon. The Nuka River also reportedly contains a small pink salmon run in its lower reaches [United States Fish and Wildlife Service (FWS), 1981].

The lower 5.9 miles of the Bradley River, the reach available to anadromous fishes, were studied in detail by the Applicant's consultant in 1983 (Woodward-Clyde Consultants, 1983). This study identified the reach of the river between river miles (RM) 4.25 and 5.2 as that most heavily utilized by salmon and Dolly Varden (Salvelinus malma). This reach contains spawning areas for pink, chum, and coho salmon. Fox Farm Creek, a tributary entering the Bradley River at RM 2.9, also contains spawning areas for pink, chum, and coho salmon.

Rearing areas for chinook and coho were identified in sloughs in the reach of Bradley River between RM 4.5 and RM 5.2; juvenile coho were also collected in Fox Farm Creek, Muka Muka Slough, Slippery Slough, Long Slough, and Short Slough. Dolly Varden juveniles were found in large numbers between RM 4.5 and RM 5.2, and in moderate numbers in the lower river sloughs. Other species identified in the lower Bradley River include eulachon (Thaleichthys pacificus) longfin smelt (Spirinchus thaleichthys), Bering cisco (Coregonus laurettae), slimy sculpin (Cottus cognatus), Pacific staghorn sculpin (Leptocottus armatus), sharpnose sculpin (Clinocottus acuticeps), threespine stickleback (Gasterosteus aculeatus), ninespine stickleback (Pungitius pungitius), and in the lower tidal areas, starry flounder (Platichtyus stellatus).

The marine fishery resources of the Bay have previously been described in Section IV.B and Appendices B and C of the Corps' FEIS. Briefly, the Bay contains significant commercial fisheries for the five species of Pacific salmon, halibut (Hippoglossus stenolepis), Pacific herring (Clupea harengus pallasi), king crab (Paralithedes camtschatica), tanner crab (Chionoecetes bairdi), Dungeness crab (Cancer magister), and shrimp (Pandalus sp.). Little fishing occurs in the immediate project vicinity, although commercial fishing for Dungeness crab does occur at the head of the Bay near the edge of the intertidal mud flats (Alaska Power Authority, 1984b, Application, Exhibit E). The upper Bay is important, however, as a nursery area for herring, crab, and other organisms important to the food web of commercial species. Commercial catch data are unavailable for the Bay alone, since the Bay's catches are included in the Southern District of the Cook Inlet Management Area. Available commercial salmon catch data for the Southern District are summarized in Table 3-1. In 1982, the Southern District Dungeness crab catch was 818,300 pounds. The Southern District commercial halibut catch ranges between 171,000 and 226,000 pounds annually (Alaska Power Authority, 1984b, Application, Exhibit E).

Kachemak Bay also supports an important subsistence fishery and a limited sport fishery. Again, data for the Bay alone are unavailable; Table 3-2 summarizes the subsistence data for the Southern District of Cook Inlet. Little data are available for the Bay sport fishery. The 1983 mail survey conducted by the Alaska Department of Fish and Game (ADF&G) indicates that anglers fished

Table 3-1. Summary of commercial salmon catch data (numbers of fish) for the Southern District of Lower Cook Inlet Management Area, 1954-1983.1/

	Chinook	Sockeye	Coho	Pink 2/	Chum	Total
30-year total	10,720	981,536	116,702	8,901,295	534,500	10,544,753
30-year average	357	32,718	3,890	296,710	17,817	351,492
30-year range	10-1,532	7,720-141,088	485-12,235	9,126-1,451,002	1,517-150,796	72,711-1,561,782

1/ Alaska Power Authority, 1984b, Application, Exhibit E, and Alaska Power Authority, 1984c, adapted from Alaska Department of Fish and Game data.

2/ From 1954-1970, even-year catches were largest; since 1971, odd-year catches have dominated.

Table 3-2. Summary of subsistence fishery catches (numbers of fish) for the Southern District of the Lower Cook Inlet Management Area, 1969-1983.1/

	Chinook	Sockeye	Coho	Pink	Chum	Other species	Total
15-year total	156	456	34,452	9,057	794	867	45,782
15-year average	10	30	2,297	604	53	58	3,052
15-year range	0-43	9-64	376-7,303	38-2,251	0-123	2-153	539-8,474

1/ Alaska Power Authority, 1984b, Application, Exhibit E, and Alaska Power Authority, 1984c, adapted from Alaska Department of Fish and Game data.

Humpy Creek, Fox River, and Caribou Lake, and caught pink, sockeye, and land-locked coho salmon and Dolly Varden (Alaska Power Authority, 1984c). The upper Bay sport fishery is limited due to the limited road access to good fishing areas.

3.1.3.3 Benthic Communities

Freshwater and marine benthic communities in the project area have previously been described in Section IV.B and Appendices B and C of the Corps FEIS. Concentrations of benthic invertebrates are somewhat limited in the Bradley River because of the heavy load of glacial flour carried by the stream, and the deposition of this material in reaches of the stream. Higher concentrations of invertebrates are present, however, in sloughs and tributaries of the river. Orders of insects noted include stoneflies (Plecoptera), mayflies (Ephemeroptera), caddisflies (Trichoptera), beetles (Coleoptera), and midges (Diptera). Marine benthos reported in the Bradley River estuary and mud flats by previous studies (Wapora, Inc., 1981) include polychaete worms, small clams, amphipods, other small crustaceans, and arrow worms. Important species noted include the bivalve <u>Macoma balthica</u>, the blue mussel (<u>Mytilus elegans</u>), the amphipod <u>Eogammarus confervicolus</u>, and the opposum shrimp (<u>Neomysis mercedis</u>). These species serve as important prey for fish and other commercially-valuable invertebrates (crabs) in the Bay.

3.1.4 <u>Terrestrial Environment</u>

3.1.4.1 Plant Associations

General descriptions of vegetation and the major climatic and other biotic and abiotic factors that affect vegetative cover are given in the Corps' FEIS (pages 55-60) for the major habitat areas in the vicinity of Bradley Lake. The major characteristics of the plant communities, that would be affected by the proposed project, are summarized below from the license application for the proposed Bradley Lake Project (Alaska Power Authority, 1984b). The importance of various plant species or cover types to wildlife species is discussed throughout Section 3.1.4.2, Wildlife Resources.

<u>Closed Coniferous Forests</u>

Closed coniferous forests occur below 1,500 feet in elevation on moderately well-drained sites. The overstory is dominated by Sitka spruce (<u>Picea sitchensis</u>), with an average diameter at breast height (DBH) of 14 inches and an average height of 60 feet. The canopy coverage is 60 to 75 percent, and the openings are dominated by tall shrubs, primarily Sitka alder (<u>Alnus crispa sinuata</u>). The ground cover consists of ferns and sphagnum moss (<u>Sphagnum</u> sp.)

Open Coniferous Forests

Open coniferous forests occupy poorly/drained flat areas, such as the Fox River Valley, and moderately well-drained slopes, which occur between the closed coniferous forest zone in the lower elevations and the tall shrub subalpine zone in the higher elevations. The canopy becomes more open as elevation increases, with the dominant spruce giving way to openings dominated by tall alders. Spruce occur only as scattered individuals above 2,000 feet in elevation. The low shrub layer includes rusty menziesia (*Menziesia ferruginea*), willow (*Salix* sp.), and squashberry (*Viburnum edule*). Ground cover includes five-leaf bramble (*Rubus pedatus*), bluejoint grass (*Calamagrostis canadensis*), horsetail (*Equisetum* sp.), and sphagnum moss.

Birch Forests

Birch forests occur on southern slopes adjacent to coastal marshes and river floodplains and are relatively uncommon in the area. The dominant species is paper birch (*Betula papyrifera*) with an understory of alder.

Balsam Poplar Forests

Balsam poplar, or cottonwood, (*Populus balsamifera*) dominates this cover type, which commonly occurs on sandy or gravelly floodplains. These poplars have an average height of 60 to 70 feet and a DBH of 13 inches. The shrub layer consists of thinleaf alder (*Alnus incana tenuifolia*) ranging up to 25 feet in height. The herbaceous layer includes polar grass (*Arctagrostis* sp.) and horsetail.

Mixed Spruce-Birch Forest

Mixtures of Sitka spruce and paper birch occur on moderately well-drained slopes between coastal sedge-grass communities and coniferous forests. This community is relatively uncommon in the project area. Associated species include Sitka alder, thinleaf alder, elderberry (*Sambucus racemosa*), and horsetail.

Mixed Spruce-Balsam Poplar Forest

Moderately well-drained, low-elevation floodplains are commonly dominated by mixed forests of Sitka spruce and balsam poplar, with an average canopy cover of 6 to 25 percent. Associated species include thinleaf alder, devil's club (*Oplopanax horridus*), squashberry, and willow. The ground layer includes mosses, ferns, grasses, fireweed (*Epilobium angustifolium*) and larkspur (*Delphinium glaucum*).

Tall Alder Shrubland

Alder commonly dominates the river floodplains in the project area, alder also occurs between the closed coniferous forests and the lower elevation boundary of shrub tundra. Thinleaf alder characteristically dominates the flat terrain, and Sitka alder dominates the slopes. Balsam poplar is usually scattered throughout the tall alder communities on floodplains. The herbaceous vegetation in this community includes grasses, ferns, horsetail, fireweed, and primrose (Trientalis europaea).

Tall Willow Shrubland

Tall willow shrubland communities are common along rivers and streams. Clumps of alder are often intermixed with the willow. The herbaceous layer includes bluejoint grass horsetail, ferns, lupine (Lupinus nootkatensis), fireweed, and primrose.

Low Willow Shrubland

Willows commonly dominate areas in the subalpine and alpine zones surrounding Bradley Lake. Willows range in height from 2 feet, where strong wind or poor soil conditions limit their growth, to 6 feet in areas with milder conditions. Herbaceous species include sedge, grasses, fireweed, cranesbill (Geranium erianthum), primrose, and wintergreen (Pyrola sp.).

Bog

Bogs are uncommon in the project area. The dominant species is sphagnum moss. Associated species include sedges, and iris (Iris setosa). Sphagnum bogs are generally associated with the coniferous forests along the rivers.

Tall Grassland

Bluejoint comprises 51 to 75 percent of the tall grasslands in the project area. Other species include fireweed, horsetail, and sedges. Tall grasslands are common in flat, poorly-drained areas and on moderately well-drained slopes from the lowlands to the subalpine zone. Tall shrublands are often interspersed with the tall grassland communities.

Mesic Herbaceous Sedge-Grass

This community occupies the subalpine and alpine zones on moderately well-drained, deep soils, which contain stored water or receive water from deep snow patches. Vegetation reaches a height of 1 to 1.5 feet and includes bluejoint grass, fescue (Festuca altaica), wormwood (Artemesia arcticum), yarrow (Achillea borealis), bearberry (Arctostaphylos sp.), crowberry, and marsh violet.

These meadows are common in the project area and are normally interspersed with patches of Sitka alder, shrub tundra, and large boulders.

Freshwater Herbaceous Sedge-Grass

This wetland plant community is relatively uncommon in the project area and is confined primarily to the lower Fox River and the higher elevation of the lower Kachemak Creek Valley. The substrate is poorly-drained hydric soils that contain 3 to 6 inches of standing water during the summer. The dominant species are sedges (up to 50 percent coverage), horsetail, crowfoot (Caltha palustris), marsh firefinger (Potentilla palustris), sphagnum moss (up to 25 percent coverage), willow, and grasses. This plant community is often interspersed with the tall or low shrubland communities.

Saltwater Herbaceous Sedge-Grass

This saltwater wetland community is common in the tidal areas of upper Kachemak Bay. Species composition is influenced by the grey, silty, hydric soil and by the influx of saltwater. Salt tolerent sedges, principally Carex lyngbyaei and Carex ramenski, dominate these tidal wetlands. Pools, which maintain 4 to 6 inches of standing water, contain up to 25 percent coverage of mare's tail (Hippuris sp.)

Shrub Tundra

Shrub tundra communities occur on well-drained, shallow soils in alpine areas. The dominant plant species are less than 6 inches high and include crowberry, bearberry (Arctostaphylos sp.), bog blueberry, Alaska spirea, alpine azalea (Andromeda polifolia), Labrador tea (Ledum palustre), lichens, and sphagnum moss.

Elymus Grassland

Lyme grass (Elymus archarius mollis) is the dominant species in the grassland community, accounting for up to 50 percent of the coverage. Associated species include Pacific silverweed (Potentilla egedii), Lathyrus maritimus (a legume), arrow grass (Triglochin sp.) and other grasses. Lyme grass grasslands occur on flat, poorly-drained, silty soils in coastal areas and are relatively uncommon in the project area.

Floodplains

Floodplains in the project area are primarily unvegetated due to the movement of water. The project area contains three types of floodplains. Floodplains along low gradient, perennial rivers, and streams consist largely of unconsolidated gravel, sand, and boulders. Scattered seedlings of balsam poplar, fireweed, lyme grass, and lupine may occupy these areas. Floodplains of high gradient perennial rivers and streams consist chiefly of unvegetated boulders. Floodplains of tidal rivers and streams are normally mud flats, which may contain some scattered lyme grass along the borders of channels.

3.1.4.2 Wildlife Resources

A discussion of some of the more significant wildlife species is contained in the Corps' FEIS (pages 62-71). The source of information for the following discussion, unless otherwise indicated, is the application for license for the proposed Bradley Lake Project, (Alaska Power Authority, 1984b), which contains study results from four principal sources: the Fish and Wildlife Coordination Act Report [U.S. Fish and Wildlife Service (FWS), 1981], which was prepared for the Corps' study; the results of a Habitat Evaluation Procedures analysis (Rappoport, et al., 1981) conducted by FWS for the Corps' study; an assessment conducted by the ADF&G (Holderman, 1983); and a 1980 avian study conducted by Krasnow and Halpin (1981). Bird densities in the following discussion are from the Krasnow and Halpin (1981) study. Point observation locations are shown in Figure 3-1.

Waterfowl

The upper Kachemak Bay is an important staging area for migrating waterfowl. The proposed project area lies within the state-designated Fox River Flats Critical Habitat Area and the Kachemak Bay Critical Habitat Area.

Tundra (whistling) swans (Cygnus columbianas) and trumpeter swans (Olor buccinator) utilize the proposed project area, primarily at Goose Point near the confluence of Bradley River and Sheep Creek, for feeding during migration. Densities are approximately 2.6 per square mile (sq. mi.). Swans begin staging in the area during mid-August and disburse throughout the herbaceous sedge-grass communities in the upper Kachemak Bay. One nesting was confirmed near Clearwater Slough in the upper Fox River valley. According to FWS (1981), the nesting swans are most likely trumpeter swans.

The occurrence of swans flying through the area of the proposed transmission line corridor is relatively low. Krasnow and Halpin (1981) observed 10 unidentified swans crossing the area of the proposed corridor during 1980 weekly surveys. The 10 sightings were all in the spring. Swans observed flying up the valley were above transmission line height; swans flying down the valley were at transmission line height.

Geese use the Fox River valley primarily for resting and feeding during migration. No nesting geese were reported during spring surveys. Canada geese (Branta canadensis) were the most numerous

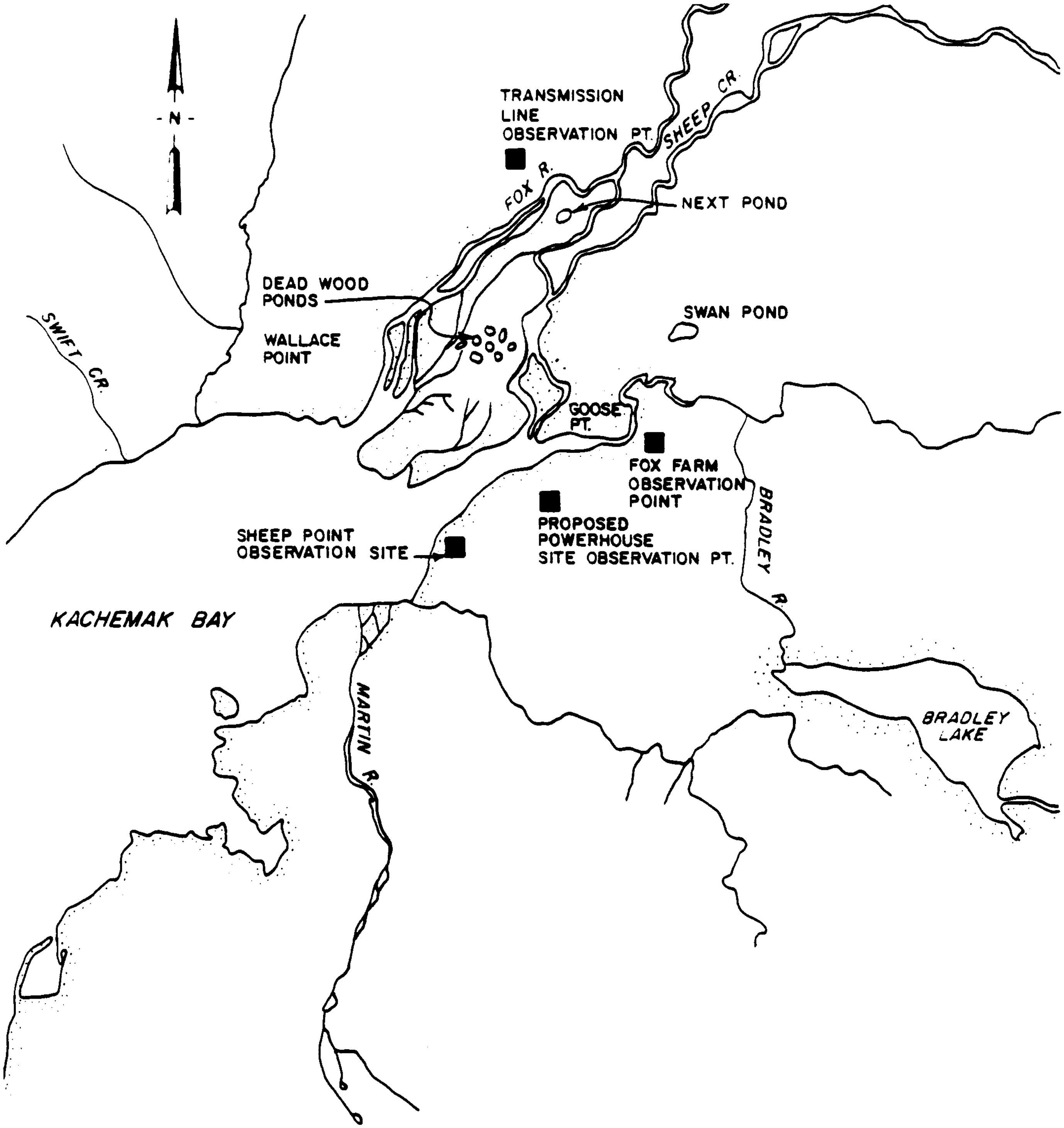

Figure 3-1. Point count stations for the avian survey of April through September, 1980 (Source: Alaska Power Authority, 1984b, Application, as adapted from Krasnow and Halpin, 1981).

geese observed (average daily density of 15.5 per sq. mi. in the Fox Farm area near Goose Point) during the spring. The majority of sightings (83 percent) occurred on the tidal flats at the confluence of Bradley River and Sheep Creek (Krasnow and Halpin, 1981). White-fronted geese (Anser albifrons) arrive in late July, and Canada geese begin staging again in mid-August. Densities in the Fox Farm-Goose Point area averaged 114.0 per sq. mi. for Canada geese and 18.1 per sq. mi. for white-fronted geese during the 1980 autumn survey. Approximately 95 percent of the fall-migrating geese were observed in the upper end of Kachemek Bay, in the sedge-grass wetlands between Swift Creek and Bradley River. These wetlands are dominated by Puccinellia phryganodes, P. Hultenii, and Carex ramenskii, plant species that are preferred foods of Canada geese in Alaska.

Approximately 2.5 percent of the Canada geese observed in the Fox River Valley were observed flying in the vicinity of the proposed transmission line.

Ducks that winter in the study area include mallards (Anas playtyrhynchos), old squaw (Clangula hyemalis), scoters (Melanitta spp.), and red-breasted mergansers (Mergus serrator). Mergansers had the highest density (283.3 per sq. mi.) in the Sheep Point area. As winter ice builds up in the Fox River flats, the ducks move toward the ice-free bays along the southeast shoreline of Kachemak Bay. Wintering ducks also move in response to tides; when the Fox River flats are submerged, dabbling ducks may roost on the Martin River delta.

In late March, migrating pintails (Anas acuta), American wigeon (Anas americana), green-winged teal (Anas crecca), and scaup (Aythya marila) began to move through the project area. The average daily density of dabbling ducks was 212 per sq. mi. in the spring. The highest concentrations were near the Bradley River. Most ducks migrate out of the area in May, with the exception of small breeding populations of mallards, green-winged teal and common mergansers (Mergus merganser).

Post breeding populations of ducks, principally mallards, pintails, green-winged teal, scoters, and red-breasted mergansers, move back into the area in July. Large numbers of red-breasted mergansers (up to 238 per sq. mi.) concentrate in the Sheep Point and Martin River delta areas from mid-August through September. Summer densities of other divers and sea ducks were lowest in the areas of Fox Farm and the proposed powerhouse site.

Dabbling ducks averaged a daily density of 212.4 per sq. mi. in the spring and 108.8 per sq. mi. in the fall in the vicinity of Fox Farm. Fall densities of dabblers averaged 33.7 per sq. mi. at the proposed powerhouse site, compared to 297.9 at Sheep Point. Mallards were the most frequently observed dabbling duck in the vicinity of the proposed transmission line corridor. Eighteen of the 27 spring observations and all 13 of the summer observations were at or below transmission line height.

Shorebirds

Winter observations in the study area consisted of concentrations of rock sandpipers (Calidris ptilocnemis), which never exceeded a few hundred birds. Spring migrants peak in early May (between 50,000 and 100,000) in the upper Kachemak Bay. The mean daily density of small shorebirds in the vicinity of the Bradley River was 10,207 per sq. mi. in the spring. The majority (65 percent) of western sandpipers (Calidris mauri) observed during the spring were on the flats at Goose Point, which are sparsely vegetated with Puccinellia spp. and Carex ramenskii. The birds concentrate at the water's edge and disperse over the flats to feed as the tide goes out. Other shorebirds, including semipalmated polvers (Charadrius semipalmatus), yellowlegs (Tringa spp.), dowitchers (Limnodromus spp.), least sandpipers (Calidris minutilla), and pectoral sandpipers (Calidris mauri) are associated with the shallow ponds and vegetated tidal flats.

Fall migration includes western, least, and pectoral sandpipers, semipalmated plovers, dowitchers, and yellowlegs. Concentrations were lower in the fall of 1980 then in the spring. The highest fall concentration observed was 200 birds per sq. mi.

Nesting is generally unsuccessful in the tidal flats because of inundation by high tides. Potential nesting habitat exists, however, in the Martin River and Fox River Valleys above the tidal zone (Alaska Power Authority, 1984d).

Raptors

The most commonly observed raptor in the project area is the bald eagle (Haliaeetus leucocephalus) (eight eagles per sq. mi. in the spring, three eagles per sq. mi. in the fall). Eagles nest along the Martin River delta, Battle Creek, and the lower Bradley River, and in the Fox River Valley. Bald eagles overwinter in the Fox River Valley and along the Martin River. Nests and potential eagle habitat exist in the vicinity of the proposed lower camp and at the Martin River borrow area.

Bald eagles were observed in the vicinity of the proposed transmission line corridor at an average of 0.1 per hour in the spring, 1980. Approximately 30 percent flew at or below transmission line height. Of 10 summer observations, 60 percent were above transmission line height. Of nine fall observations, 67 percent were at or below transmission line height.

All of the Northern harriers (Circas cyaneus) observed in the proposed corridor during the fall were at or below transmission line height. Harriers observed in the corridor accounted for 33 percent of the total observations of harriers in the study area.

Approximately 43 percent of the sharp-shinned hawks (Accipiter striatus), observed in the study area were recorded flying through the area of the proposed transmission line corridor. Of these, 33 percent were at or below transmission line height.

Other raptors observed in the project area included red-tailed hawks (Buteo jamaicensis), goshawks (Accipiter gentilis), and peregrine falcons (Falco peregrinus). Of these, only the red-tailed hawk was observed in the area of the proposed transmission line corridor. The peregrines were observed over the flats at Goose Point. The subspecies of peregrine in this area has not been determined. (See Section 3.1.5.)

Gulls and Terns

Gulls and terns were most often observed during migration on the flats between Swift Creek and the Bradley River (61 percent) and in the Martin River Delta area (24 percent). Seventy-six percent of the spring observations were of mew gulls (Larus canus). Glaucous-winged gulls (Larus glaucescens) and mew gulls peaked in August, with the largest concentrations along the Martin River Delta. The highest fall density was 712 per sq. mi. Arctic terns (Sterna paradisea) were observed (52 sightings) in the vicinity of Sheep Creek. Of these, 55 percent were observed flying at or below transmission line height.

Other Birds

The densities of passerine birds are highest between Fox River and Sheep Creek. The most abundant species observed during the 1980 survey were water pipits (Anthus spinoletta) and Savannah sparrows (Passerculus sandwichensis). The water pipit inhabits alpine meadows, muddy shores, and open land. The Savannah sparrow inhabits tundra and salt marshes and other open areas with short or sparse grasses (Robbins et al., 1966; Udvardy, 1977).

Spruce grouse (Canachites canadensis), boreal owl (Aegolius funereus), Stellar's jay (Cyanocitta stelleri), golden-crowned kinglet (Regulus satrapa), boreal chickadee (Parus hudsonicas), and pine grosbeak (Pinicola enucleator), are among the birds identified in the project area, which are associated with coniferous forests (Udvardy, 1977). Pine siskins (Carduelis pinus), also recorded in the proposed project area, are associated with coniferous forest, alders, and transition zones between coniferous and broadleaf cover types (Udvardy, 1977). Willow ptarmigan (Lagopus logapus) and rock ptarmigan (L. mutus) inhabit tundra areas (Robbins et al., 1966).

Moose

Biologists conducted a study to determine the seasonal distribution of moose (Alces alces), from October 1983 to June 1984 (Woodward-Clyde Consultants, 1984a). The study included 22 aerial surveys in the proposed project area, which was divided into five segments (Figure 3-2): the Kachemak Creek Flats, which includes the area of the proposed reservoir; the Fox River Valley, which includes portions of the proposed transmission line corridor; the "Bench" (the mountains south and east of Sheep Creek and north of the Bradley River); the Nuka River Valley (extending south from Nuka Glacier to Beauty Bay); and the Martin River delta.

Moose surveyed in the Kachemak Creek Flats during October ranged in number from 1 to 11. Moose utilized both the freshwater wetlands in the proposed innundation zone and higher altitudes. November surveys recorded from 1 to 13 moose, which were inhabiting the subalpine, alder-willow slopes. From 4 to 12 moose were observed during the December surveys. The number of moose remained relatively constant (from four to five) during February through April.

Early October (rutting season) concentrations of migratory moose, ranging from 25 to 35 individuals, were observed in the Fox River Valley. In December, 40 moose were counted within one sq. mi. south of Clearwater Slough. An April survey counted 21 moose in the valley. Moose were also common near the emergency airstrip on the west side of the valley.

Bench surveys revealed from 9 to 12 moose moving into the subalpine, alder-willow zones in early November. They remained through December, but were not observed in this area during surveys conducted between February and June.

Fall counts in the Nuka River Valley, including the upper Beauty Bay area, recorded 11 moose in early November, 10 in late November, and 10 in mid-December. Four moose were observed in late February. FWS (1981) reports that the Bradley Lake area may be an important migratory route between the Fox River area and Beauty Bay.

No moose were observed in the Martin River Delta area during the surveys. Seven moose were observed, however, at the mouth of nearby Battle Creek in late February.

The total number of moose surveyed within the proposed project area ranged from a low of 8 in early June to a high of 110 in mid-December and was directly related to the number of moose in the Fox River valley. Clearwater Slough and Sheep Creek were heavily utilized during the rut, over winter, and during spring. The study concludes that migrants from outside the project area most likely accounted for the bulk of the Fox River Valley population in November and December, and that moose within the project area are probably a subgroup of a larger population, rather than a distinct population (Woodward-Clyde Consultants, 1984a).

In the project area, moose browse year-round on willow, balsam poplar, and birch. Additional factors, which are important components of moose habitat, include the percent coverage of coniferous

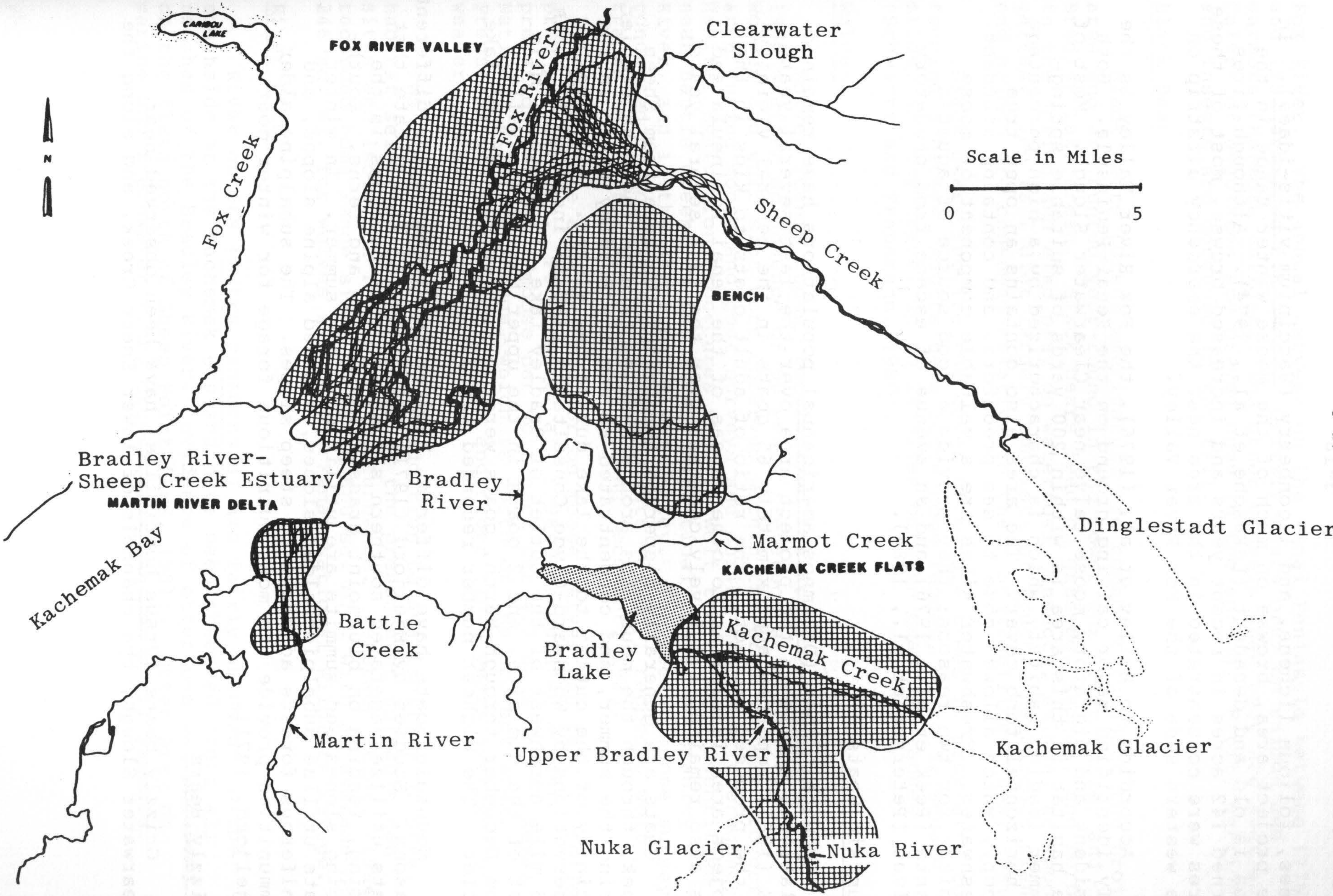

Figure 3-2. Moose survey areas, 1983 - 1984 (Source: Woodward-Clyde Consultants, 1984a). The survey also included the Nuka River valley from the Nuka Glacier to Beauty Bay (not shown).

trees, folious lichens, and ligonberry (Vaccinium vitis-idaea). In the project area, browse on much of the moose winter range in the area is old and decadent (LeResche et al., 1974). Although fires burned 142 acres in recent years and increased browse, most of these fires were concentrated in the area near the emergency airstrip on the western side of the Fox River Valley.

According to Bailey et al. (1976), the Fox River Valley is the only identified major calving ground on the Kenai Peninsula. Both resident and migratory moose calve near Clearwater Slough. Most of the habitat in this area is within 200 yards of suitable spring-summer feeding habitat, which is characterized by a high percentage of horizontal forb cover. The area also contains an open tree canopy, which allows moose to see predators, and contains abundant freshwater. Freshwater sites are a valuable component of moose habitat for two reasons: they provide a food source of aquatic plants (Peek et al., 1976) and an avenue of escape from predatory wolves (Peterson et al., 1984).

Mountain Goats

Mountain goat (Oreamnos americanus) populations have remained relatively stable in the project area over the last several years. FWS (1981) reported approximately 65 goats in the general vicinity of the proposed project. The ratio of adult goats to kids in the project area is similar to other areas of the Kenai Peninsula and has also remained relatively constant over the last several years.

Goats are generally dispersed throughout the area from Sheep Creek, through the mountains around Bradley Lake to the Nuka Glacier during the summer, and concentrated around the Bradley River in the vicinity of the outlet to the lake during the winter. Mid-November observations by Woodward-Clyde Consultants (1984a) included 11 goats 0.5 mile northwest of the outlet of Bradley Lake, 15 goats, 1 mile east of the dam site, and 2 goats in the upper Nuka River Valley. From December through March, goats were only observed near the lake outlet. The highest number recorded was 39.

Mountain goats have different habitat requirements for different seasons. Studies by Hjeljord (1971) and Klein (1953) indicate that goats utilize vegetated southern slopes and rock outcrops in the spring, feeding on bluejoint grass, elderberry, and ferns. South-facing slopes and summits are utilized in the summer. In winter, goats utilize subalpine alder slopes, exposed alpine slopes, and coniferous forests adjacent to steep slopes. The subalpine alder communities provide the most nutritious forage for winter goats (Hjeljord, 1971).

Grizzly Bears

Grizzly bears (Ursus horribilis) have been observed near Clearwater Slough, the channels of lower Sheep Creek, and along the

Fox River. The annual harvest on the Kenai Peninsula between 1975 and 1982 averaged 6.8 bears. Grizzly bears prey on salmon and marmots (Marmota caligata) and other mammals when they are available. Calves of ungulates are preyed upon in the spring. Fruit, carrion, and insects are consumed in the fall.

Black Bear

Black bears (Ursus americanus) are common throughout the project area and are hunted year-round in the lower Fox River Valley and Bradley Lake areas. Black bears feed on grasses, sedges, and forbs in the spring and also prey on waterfowl, insects, salmon, and moose calves. The fall diet largely consists of fruit. Herbaceous plants and salmon are consumed relative to their availability (Shea, 1981).

Black bears require the cover of mature trees in proximity to feeding habitat. Adults have large home ranges, up to 52 square miles, and may travel up to 24 miles between seasonal ranges (Schwartz and Fransmann, 1980).

Wolves

Wolves (Canis lupus) recolonized the Kenai Peninsula in the 1960's after an absence of 50 years (Peterson et al., 1984). Wolves and wolf sign were observed within the Bradley Lake Project area during moose and goat surveys and during the 1980 interagency Habitat Evaluation Procedures Study. Wolf tracks were identified near Battle Creek, on the Sheep Point tidal flats, on Bradley River, and in the upper Fox River Valley. The recent moose survey, conducted by Woodward-Clyde Consultants (1984a), recorded wolf tracks in the Fox River Valley during December, 1983.

Wolves are a major predator on moose calves and tend to follow prey populations. Peterson et al. (1984) calculated a winter predation rate of 1 moose per wolf pack per 4.7 days in the Kenai National Wildlife Refuge, which is north of the project area. Predation was largely on calves and older (10.9 years average) or weaker moose.

FWS (1981) states that, in addition to availability of prey, habitat selection is influenced by the presence of suitable den sites and isolation from human disturbance. Peterson et al. (1984) recorded home range sizes of 68 to 600 sq. mi., with an average of 246 sq. mi. for wolves within the Kenai National Wildlife Refuge.

River Otter

River otters (Lutra canadensis) are fairly abundant in the southside of the Kachemak Bay and have been observed along all reaches of the Bradley River. Evidence of otter use was observed on the flats north of Sheep Point (FWS, 1981). Otter prey on marine and freshwater fish, crustaceans, and on small mammals.

Beaver

Four beaver (Castor canadensis) lodges were recorded at the east end of Bradley Lake. Additional observations were recorded in Kachemak Creek and the Fox River and on the subalpine lakes near the outlet of Bradley Lake. Beaver utilize freshwater aquatic areas, which are bordered by subclimax shrub and forest vegetation. Beaver feed on the bark of willow, balsam poplar, birch, and occasionally alder. The availablilty of these species largely determines the suitability of an area as beaver habitat.

Marine Mammals

Harbor seals (Phoca vitulina), beluga whales (Delphinapterus leucas), and stellar sea lions (Eumetopias jubatus) inhabit Kachemak Bay. Only harbor seals have been regularly observed in the upper bay near the project area. Harbor seals, beluga whales, and sea lions occasionally range into the Bradley River-Sheep Creek estuary. Seals were most abundant during runs of smelt or sand lance (Corps, 1982).

Other mammals

Coyotes (Canis latrans) were observed during the 1983-1984 moose survey in the Fox River Valley and in the Kachemak Creek valley. Lynx (Lynx canadensis) tracks were recorded in the Kachemak Creek area in December 1983 (Woodward-Clyde Consultants, 1984a). Wolverines were observed in the Fox River valley, the Bench (Figure 3-2) and in the Kachemak Creek Valley during the moose survey (Woodward-Clyde Consultants, 1984a).

The project area also provides abundant habitat for muskrat (Ondatra zibethicas), mink (Mustela vison), red fox (Vulpes fulva), red squirrel (Tamiascirurus hudsonicus), snowshoe hare (Lepus americanus), marmot (Marmota caligata), and voles (Microtis sp.). Red Squirrel and snowshoe hare inhabitat coniferous forest areas. FWS (1981) reports extensive squirrel sign in coniferous forests above Sheep Point and in the Fox Farm areas and moderate numbers of snowshoe hares in the project area.

3.1.5 Threatened or Endangered Species

The American peregrine falcon (Falco peregrine anatum) and the artic peregrine (F. peregrinus tundrius) are Federally listed as endangered in Alaska. Peale's peregrine (F. peregrinus pealei) inhabits the coastlines of British Columbia and southern Alaska and is not Federally listed.

FWS biologists reported 6 sightings of peregrine falcons in the vicinity of the proposed project in 1980. It could not be determined, however, if the falcons were of an endangered subspecies. FWS observed one peregrine in early May, 3 in August, and 2 in

September (Corps 1982). The absence of observations during the remainder of the year indicates that the birds were most likely migrating through the area and were not residents.

No other threatened or endangered species or critical habitats have been identified in the project area.

3.1.6 Recreation and Land Use

The existing recreation and land uses are generally described in the Corps' FEIS.

Since the publication of the Corps' FEIS, portions of Kachemak Bay and the Fox River delta in the proposed project area have been identified as critical habitat areas, primarily for waterfowl.

Figure 3-3 indicates the general land ownership and management patterns in the proposed project area.

3.1.7 Visual Resources

The project area has a natural landscape character containing a variety of vegetation, and land and water forms including: Kachemak Bay, Bradley River, and Bradley Lake, and numerous creeks; shorelines, flats, hills and jagged, rocky cliffs; and grassy open spaces and thick forest canopy. The visual quality of the immediate project area is spectacular, although nearby areas on the Kenai Peninsula have sustained impacts caused by rights-of-way for pipelines, transmission lines, survey gridlines, roads, mines, and forest management activities. Viewer sensitivity for the visual resources is very low because of the remoteness of the project area.

3.1.8 Cultural Resources

A portion of the project impact areas was inventoried by the Corps prior to filing of the application (Steele, 1979, 1982). The remaining portion has been inventoried by the Applicant, including the proposed transmission corridor (Alaska Power Authority, 1984b, Application, Exhibit E; Woodward-Clyde Consultants, 1984b). The inventories were based on archeological survey, historical record, and literature searches and interviews with local inhabitants.

Two abandoned fox-fur farms were located in the project area adjacent to Kachemak Bay. Both date to the period of the 1920's and early 1930's. Fox-fur farming was a major economic activity during the period 1910-1935 in the Kachemak Bay area and throughout the coastal regions of southern Alaska, and aided in the settlement and development of the area in historic times. The sites are well preserved and represent excellent examples of the vernacular architecture and the layout of activity areas of such sites. Both appear to have excellent potential for historic archeological research.

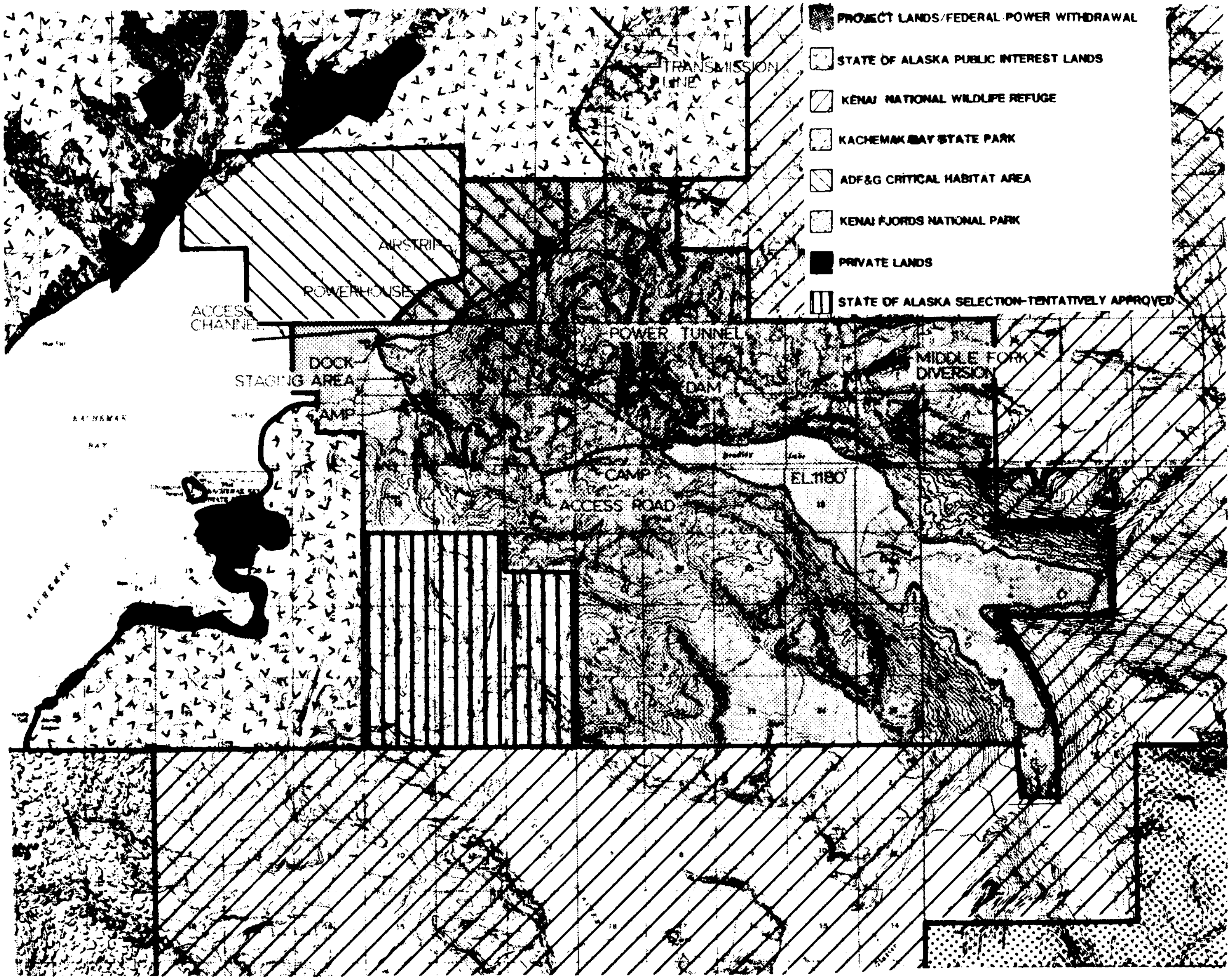

Figure 3-3. Land ownership and use (Source: Alaska Power Authority, 1984b, Application, Exhibit E).

Both farms appear eligible for inclusion in the National Register of Historic Places. Staff has requested eligibility determinations for the two farms from the Secretary of the Interior.

No prehistoric or other historic sites were located during the cultural resources inventory of the project area.

3.1.9 Socioeconomic Factors

Economic, demographic, and fiscal impacts resulting from construction and operation of the proposed project would occur within the Kenai Peninsula Borough (Borough), particularly in the Homer area. The Borough's and Homer's most significant socioeconomic characteristics are summarized below.

3.1.9.1 Demographic considerations

As shown in Table 3-3, the total population of the Borough increased from 16,586 in 1970 to 25,282 persons in 1980. The Bureau of the Census estimates that on July 1, 1982, approximately 32,000 persons resided there. Most recent population gains have resulted from the net in-migration of persons ages 18 to 30 who were attracted by the Borough's employment and outdoor recreational opportunities.

During the 1970-1980 decade, Homer's population more than doubled--from 1,083 persons in 1970 to 2,209 residents in 1980. A special census conducted by the Kenai Peninsula Borough in summer 1982 found that Homer population had reached 2,897. The city's official population estimate as of September 30, 1983, was 3,237. Planners anticipate that Homer's population will total between 4,700 and 6,500 persons in 1990 (Alaska Power Authority, 1984b, Application, Exhibit E).

3.1.9.2 Employment and Income

The Borough's economy is based on oil and natural gas drilling, oil refining, and the manufacture of petrochemicals (which are centered in the Kenai area); commercial fishing and fish processing; tourism, particularly sport fishing; and Federal and state government spending. In 1982, an average of 10,383 persons was employed within the Borough. These included full- and part-time employees of private establishments, self-employed persons, state and local government employees, Federal civilian employees, and Federal military personnel. As shown in Table 3-4, total area employment during the ten-year period, 1972-1982, increased by 5,256 (103 percent).

Table 3-3. Population trends in Homer City and the Kenai Peninsula Borough, 1970-1982.

Date	Total Population: Homer	Total Population: Kenai Peninsula Borough
April 1, 1970	1,083 1/	16,586 2/
April 1, 1980	2,209 1/	25,282 1/
July 1, 1981	- 3/	29,008 2/
July 1, 1982	2,897 4/	31,989 2/
Sept. 30, 1983	3,237 4/	- 3/

1/ Bureau of the Census, 1982.

2/ Personal communication, Richard Downing, Statistical Officer, Bureau of the Census, Suitland, Maryland, November 1, 1984.

3/ Data is unavailable.

4/ Alaska Power Authority, 1984b, Application, Exhibit E.

The per capita personal income of Borough residents in 1982 was $13,394. This amount was 20 percent less than the $16,854 per capita income for the State of Alaska (personal communication, Kathy Albetsky, Statistician, Bureau of Economic Analysis, Washington, D.C., October 31, 1984). In addition to money income, many area households obtain considerable subsistence income from hunting and fishing. For example, a recent study found that Homer area households harvest an average of 222 pounds of meat and fish annually, primarily halibut, salmon, and moose (Alaska Power Authority, 1984b, Application, Exhibit E).

3.2 ALTERNATIVE PROJECTS

3.2.1 Combined-cycle Generation Alternative

3.2.1.1 Land Features

The natural-gas-fired, combined-cycle generation plant would likely be located near the Beluga and Chuitna Rivers in the western Cook Inlet Lowlands. The Beluga area includes poorly drained floodplains and marshy tidal flats. The Chuitna area consists largely of a broad, rounded moraine. Slopes near Chuitna are steeper, but the soils are commonly wet [Federal Energy Regulatory Commission, 1984 (FERC, 1984), draft environmental impact statement for the Susitna, Alaska, hydroelectric project, FERC No. 7114).

Table 3-4. Employment trends by industrial sector, Kenai Peninsula Borough, 1972-1982. 1/

Industrial sector	Full- and part-time employment 2/ 1972	1982	change
Agriculture 3/	64	77	+ 13
Farm services, forestry, and fishing	62	20	- 42
Mining	519	804	+ 285
Construction	439	838	+ 399
Manufacturing	551	1,426	+ 875
Transportation, communications and public utilities	282	961	+ 679
Wholesale trade	109	300	+ 191
Retail trade	390	1,112	+ 722
Finance, insurance, and real estate	81	277	+ 196
Personal, repair, business, medical, Legal, educational, and tourist services 4/	502	1,168	+ 666
Federal civilian government	91	124	+ 33
Federal military personnel	398	445	+ 47
State and local government	935	1,626	+ 691
Non-farm proprietors	704	1,205	+ 501
Total	5,127	10,383	+5,256

1/ Bureau of Economic Analysis, 1984. The data excludes the Seward area.

2/ Excludes volunteer and unpaid family workers.

3/ Includes farm proprietors and employees.

4/ Includes workers employed by privately owned and operated establishments. Excludes public school teachers, persons employed by public hospitals, etc.

3.2.1.2 Aquatic Resources

Since a specific site for a combined-cycle unit has not been selected, a detailed description of potentially affected resources is not possible. Sites for such a project, however, would need to be located on larger streams or bodies of water because of the requirements for water. Potential sites in the western Cook Inlet area would include locations on the Beluga and Chuitna Rivers, lakes in the area, or on Cook Inlet itself. Both of the rivers originate in the Alaska Range and have glacial flow regimes and water quality typical of glacial streams.

Species of fish potentially affected by this alternative would include the five species of Pacific salmon, burbot (*Lota lota*), cottids, Dolly Varden, grayling (*Thymallus arcticus*), northern pike (*Esox lucius*), rainbow trout (*Salmo gairdneri*), sculpin, suckers, and whitefish. If the project is located on Cook Inlet, a variety of marine fishes and invertebrates could be affected.

3.2.1.3 Terrestrial Resources

A combined-cycle plant would most likely be located in the western Cook Inlet area, in proximity to natural gas distribution pipelines. The vegetation in this area largely consists of spruce-hardwood forests and sedge-grass wetlands (FERC, 1984). The principal big game species in the area include grizzly bear, black bear, and moose. Moose concentrate along the lower Chuitna River in the summer and winter eastward from the mouth of the Beluga River. Bears feed along the lower Chuitna River and both grizzly and black bears den in the upland forests. Bald eagles are common throughout the area. Waterfowl include trumpeter swans, loons (*Gavia immer*), Canada geese, and a variety of ducks (FERC, 1984).

3.2.1.4 Threatened or Endangered Species

As discussed in Section 3.1.5, the peregrine falcon is the only Federally listed threatened or endangered species that may occur in the Cook Inlet area. Although peregrines have been sighted, no one has determined whether the peregrines are of a listed or non-listed subspecies.

3.2.1.5 Socioeconomic Factors

Population and employment in the Kenai Peninsula Borough are discussed in Section 3.1.9 of this report.

3.2.1.6 Visual Resources

This alternative would likely be located in an area with natural visual characteristics and high visual quality. The area would involve diversified land and water forms, and vegetative patterns. Sensitivity for the area would vary, however, depending on the location. An area close to population centers and access routes, or an area with recreational importance, would have higher sensitivity than the more remote locations. In most cases, sensitivity for the visual resources are low to moderate, with the exception of locations near Anchorage.

3.2.1.7 Cultural Resources

Few cultural resources have been discovered in the areas that would be affected by the natural gas-fired alternative. Surveys of specific sites would be necessary to adequately assess cultural resources (FERC, 1984).

3.2.1.8 Air Quality and Noise

Air quality data for the western Cook Inlet area is not available but air quality is expected to be high, meeting both National and Alaska Ambient Air Quality Standards. The only probable sources of pollutants are the offshore oil and gas platforms in Cook Inlet, and the industrial area located north of the City of Kenai. Natural dust has been noted as an occasional problem in the vicinity of Kenai.

Ambient noise levels are expected to be low in any of the potential sites for a combined-cycle project.

3.2.2 Coal-fired Generation Alternative

3.2.2.1 Land Features

The coal-fired alternative project would likely be located in the Nenana area on the thick alluvial deposits of the Tanana River floodplains. Soils in low lying areas are poorly drained and have severe use limitations because of permafrost and wetness (FERC, 1984).

3.2.2.2 Aquatic Resources

Specific sites for the coal-fired generation plant and the interim combustion turbine unit have not been identified. The coal-fired plant, however, would be located on a large river or lake because of the water supply requirements of the plant. A probable location in the Nenana area would be on the Tanana River, with the coal being supplied from a mine within the Nenana River Basin. The associated combustion turbine unit could be located anywhere in the Anchorage-Cook Inlet area, but would not require a large water supply for operation.

The Tanana River in the vicinity of Nenana is a large, low-gradient, braided river with an average annual flow of 23,490 cfs. The river carries a high sediment load from glacial runoff, but water quality is generally good. The Tanana contains runs of

Pacific salmon, and other common freshwater species such as burbot, cottids, Dolly Varden, rainbow trout, sculpin, and whitefish.

3.2.2.3 Terrestrial Resources

If a coal-fired alternative were constructed, it would most likely be located in the Nenana area of the Railbelt. The combustion turbine would most likely be located in the Anchorage-Cook Inlet area. Vegetation in the Nenana area is primarily bottomland spruce-poplar forest. Coal would be mined in the vicinity of Healy, along the Nenana River, where the vegetation consists of upland spruce-hardwood forests. The dominate vegetation in the Anchorage area of Cook Inlet is lowland spruce-hardwood (FERC, 1984).

Moose concentrate along the Nenana River in the winter. Waterfowl occur along the river in relatively low densities. The Healy mining area supports species that are characteristic of relatively open habitats, including caribou (<u>Rangifer</u> <u>tarandus</u>) and brown bear. Caribou winter in concentrations near the mine area and along the Nenana River. The Anchorage area provides limited habitat because of urbanization (FERC, 1984).

3.2.2.4 Threatened or Endangered Species

As previously discussed the peregrine falcon is the only Federally listed species in the south-central Alaskan area. Peregrine use of the Nenana area has not been extensively studied.

3.2.2.5 Socioeconomic Factors

The most current census figures indicate that as of July 1, 1982, the City of Nenana had 505 permanent residents, and the Yukon-Koyukuk Census Area's population totaled 8,060 (personal communication, Diane Winters, Statistical Information Assistant, Bureau of the Census, Suitland, Maryland, January 29, 1985). Because employment opportunities in the Nenana area are limited, many area residents commute to jobs in the Fairbanks area.

3.2.2.6 Visual Resources

This alternative probably would be located in an area with natural visual characteristics and high visual quality. The area would involve diversified land forms, water forms, and vegetative patterns. Sensitivity for the area would vary, depending on the location. An area close to population centers and access routes, or an area with recreational importance, would have higher sensitivity than more remote locations. In most cases, sensitivity for the visual resources are low to moderate, except for locations near Anchorage.

3.2.2.7 Cultural Resources

Only limited information on cultural resources is presently available for the areas that would be affected by this alternative. Seven cultural resource sites are currently recorded for the Nenana area. Site-specific surveys, which would likely yield additional sites, would be necessary in order to fully assess existing cultural resources (FERC, 1984).

3.2.2.8 Air Quality and Noise Levels

Limited air quality data are available from the Nenana area. These data indicate that air quality is excellent, with the exception of occasional high levels of total suspended particulates due to natural dust.

Ambient noise levels are expected to be low in any of the potential sites for a coal-fired project.

4. ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTION AND ALTERNATIVES, MITIGATIVE MEASURES PROPOSED, AND UNAVOIDABLE ADVERSE IMPACTS

4.1 BRADLEY LAKE PROJECT

4.1.1 Air Quality

4.1.1.1 Beneficial and Adverse Impacts

Impacts on air quality would occur during the construction period, and would be limited to increased exhaust emissions from construction equipment and increased dust caused by blasting and vehicular movements along access roads and other areas. These impacts would persist throughout the 3-year construction period, although they would be most severe for a shorter time period during the peak of the land disturbing activities. Because the project area is located far from any population centers, only the onsite construction workers and nearby wildlife populations will be subjected to this temporary decrease in air quality.

4.1.1.2 Mitigative Measures Proposed

The Applicant has proposed to implement procedures normally used by construction contractors to minimize dust, such as wetting road surfaces. The construction contractor would also attempt to maintain its equipment in good working order, which would reduce exhaust emissions to some degree.

4.1.1.3 Unavoidable Adverse Impacts

Exhaust emissions and dust, even with the implementation of normal control measures, are unavoidable impacts of a large construction project. These impacts would affect only a small segment of the population, however, and would subside upon the completion of construction.

4.1.2 Noise Levels

4.1.2.1 Beneficial and Adverse Impacts

During the construction phase of the project, increased noise levels would be expected from many sources, including operation of construction machinery, transportation of personnel and materials by air, water and land conveyances, and construction activities such as blasting, wood cutting, and earth moving. Increased noise levels, especially those caused by blasting and aircraft operation, would contrast greatly with the existing low noise levels, and would adversely affect public use and wildlife populations. (See Section 4.1.6.1.2). These impacts would persist in varying degrees of intensity throughout the construction period.

During the operation of the project, short-term, localized increases in noise levels would be expected, primarily as a result of maintenance activities and project-related aircraft and vehicle use. These temporary increases in noise levels should not result in any significant impacts. At other times, increases above background noise levels would be apparent only in the immediate vicinity of the powerhouse.

4.1.2.2 Mitigative Measures Proposed

The Applicant has not proposed any specific mitigation for increased noise levels beyond the scheduling of blasting and aircraft operations as a part of the mitigation for impacts on wildlife. Occupational safety regulations require hearing protection for workers in the vicinity of damaging noise levels. The construction contractor would be expected to maintain engine mufflers and other equipment in good working order.

4.1.2.3 Unavoidable Adverse Impacts

Increases in noise levels, even with the implementation of normal control measures, are unavoidable impacts of a large construction project. These impacts could cause significant adverse impacts on wildlife populations, the magnitude of which can be reduced, but not eliminated by mitigative measures. Considering the remoteness of the project area and the low incidence of public use in the project vicinity, increased noise levels during the construction phases would not appear to have a significant adverse impact on humans.

Increases in noise levels during project operation should be of a local nature, and of short-term duration, except in the immediate vicinity of the powerhouse, where minor increases in noise levels caused by the periodic cycling of the facilities and the discharge of water to the tailrace would continue throughout the life of the installation.

4.1.3 Geology and Soils

4.1.3.1 Beneficial and Adverse Impacts

Such construction activities as dredging the barge access channel, soil and rock excavation, and disposing of spoil, which would disturb soils and other consolidated deposits, would result in erosion and sedimentation. Minor localized unstable conditions would occur on some oversteepened excavated slopes, primarily along access roads in areas of steep terrain. Project operation would cause reduced scouring and sediment load below the dams at Bradley Lake and the Middle Fork Bradley River, minor localized erosion and instability along the reservoir shoreline, and some minor erosion and redistribution of sediment below the tailrace.

The geological and soils impacts of the proposed project would be less than would be associated with the Corps' project because the proposed projects's power tunnel would extend to the powerhouse, thus precluding erosion, sedimentation, and unstable slope conditions that would occur with construction and operation of the above-ground pipeline and associated access road. The proposed project's shortened tailrace would also avoid the majority of the construction impacts that would be associated with the longer tailrace considered by the Corps. Disposal of dredged materials for the proposed project within an enclosed site would avoid the redeposition of sediment in estuarine and marine ecosystems. With these differences, the geological and soils impacts for the two projects would be essentially the same. Project impacts related to geological and soils resources are described and discussed in the Corps' FEIS in Subsection V.B, paragraphs 22, 23, 24, and 25; Subsection V.E, paragraph 36; and the Section 404(b)(1) evaluation.

4.1.3.2 Mitigative Measures proposed

The Applicant proposes to use the rock excavated from the tunnel for construction of the airstrip and as fill for the access road and other facilities, thereby precluding the need for a disposal area for that material, and also avoiding any associated disposal site erosion and sedimentation. Rockbolts and other measures would be used for stabilization, and a retaining wall would be used to contain any eroded materials on the cut slopes, upstream from the powerhouse and switchyard area. Rather than using an exposed marine, estuarine, or tidal flat disposal site, the Applicant proposes to spoil the clayey silt excavated from the barge basin and its access channel (approximately 464,000 cubic yards) in a 40-acre site, enclosed between the powerhouse-to-camp access road embankment and the shoreline.

An outline of the techniques and practices that the Applicant would use to control erosion and sedimentation at the project is contained in the Draft Proposed Outline for Best Management Practices Manual - Erosion and Sedimentation Control attached as Appendix A. The Applicant proposes to have the manual (scheduled for completion in February 1985) formally reviewed by regulatory agencies and other interested parties before its final adoption.

4.1.3.3 Unavoidable Adverse Impacts

Some minor localized erosion and sedimentation would be unavoidable during construction and along the reservoir shoreline during project operation.

4.1.4 Water Quantity and Quality

4.1.4.1 Beneficial and Adverse Impacts

A description of water quality and quantity impacts resulting from the Corps' project is contained in Section V.B and in the Section 404(b)(1) evaluation of the Corps' FEIS.

Construction

Impacts due to construction of the proposed project would be similar to those described by the Corps, and would be primarily limited to Bradley Lake and River, Martin River, Battle Creek, and a portion of the upper end of Kachemak Bay, with some possible effects on Fox River and Sheep Creek from the construction of the transmission line. The major impacts of construction would be the erosion of disturbed areas, resulting in sedimentation in nearby streams, higher turbidity levels, and the runoff of chemical or organic wastes into local water bodies.

Activities likely to produce the greatest impacts on water quality would include: construction of the barge basin and channel; access road construction; and operation of borrow and spoil areas. Construction of the barge basin and channel would directly disturb about 115 acres of upper Kachemak Bay, and would involve the dredging of 464,000 cubic yards of primarily silty and sandy clay material. Since this material is easily re-suspended, it is expected that high turbidity levels would persist in the vicinity of the dredging activities, and would spread to an area greater than the 115 acres directly disturbed. Dredging and construction, and in turn, high turbidity levels, would occur for about a 6-month period, from March through August of the first full year of construction (Figure 2-4). The precise turbidity level expected is difficult to determine, although the level may be similar to the high turbidities that normally occur during the summer months in upper Kachemak Bay.

Construction of about 10 miles of access roads, including a bridge over Battle Creek, would probably result in the erosion of disturbed areas and in sedimentation and increased turbidity in streams close to the construction sites. The stream most likely to receive runoff from construction areas would be Battle Creek, of which about 3,000 feet passes within close proximity of a portion of the access road and the lower construction camp. Construction of the temporary bridge over Battle Creek would result in disturbance of the stream if construction equipment crosses the stream, although the Applicant has proposed to construct the bridge abutments as far away from the streambed as possible. The probable level of turbidity or sedimentation expected in Battle Creek is difficult to predict, and would depend on the success of the contractor's erosion control measures and general construction practices.

As described earlier, Battle Creek experiences high natural turbidity levels from glacial runoff, although it has somewhat lower turbidities than the other streams in the project area. Other water bodies in the area should not receive direct runoff from road construction, except for the unnamed lake at the upper construction camp, through which the road will be built.

Excavation of borrow material and deposition of spoil material may result in the discharge of turbid waters or increased sedimentation into water courses in the project area. The Martin River borrow site has the potential for creating the greatest impacts on water quality of any of the borrow or spoil disposal sites. The proposed borrow pits are located close to active channels of the Martin River (Figure 2-1), with the possibility that runoff from these disturbed areas would enter the Martin River. The quarry site near the outlet of Bradley Lake may contribute highly turbid runoff to the lake, although the high turbidity levels that already exist in the lake may mask this effect. The main disposal site for dredged material, located near the barge dock behind the powerhouse access road, would not likely affect water quality in the tidal flat, since the access road would contain the dredged material. There is the possibility, however, of limited runoff from the spoil areas reaching the flats through the series of overflow culverts.

Other impacts on water quality resulting from project construction would be associated with the runoff of chemicals or organic wastes, such as used motor oil, sewage effluent from the construction camps, and discharge of waste water from the concrete batching plants. Although the Applicant has proposed specific containment areas for storage of chemicals and organics, accidental spills are possible. These, however, would be short-term events, temporarily affecting water quality in a localized areas. The proposed volume of the sewage effluent, which would receive secondary treatment, indicates that this effluent would have little impact on Battle Creek. At the Battle Creek 100-percent-exceedence flow of 10 cfs, the effluent would be diluted at a ratio of 200 to 1. During the summer months, when the construction work force would be the largest and the sewage effluent would peak, the 100-percent-exceedence flow ranges between 40 and 150 cfs (June through September), further diluting the effluent (Alaska Power Authority, 1984d).

The concrete batching plants, to be located near the proposed damsite and powerhouse site, would be constructed with settling ponds to receive the waste water discharge. The powerhouse plant settling ponds would discharge into the nearby main spoil disposal site, while the damsite plant settling ponds would discharge into Bradley Lake. The small volume of waste water from each plant (2 gallons per minute or 0.004 cfs) would likely have minimal impacts on areas receiving this discharge. The main disposal site would easily absorb or dilute the waste water, while Bradley Lake would also dilute any discharge from the settling ponds.

Operation

Project operation would affect water quantity and quality in the Bradley River by reducing river flows in the lower river and by changing the temperature regime of the same reach of river. Minor changes in salinity may also occur in the lower Bradley River and its estuary, and some flow reductions are probable in the Nuka River.

A comparison of the existing and predicted mean monthly flows in the lower Bradley River is contained in Table 4-1. Project operation would result in a more stable, but greatly reduced, flow regime in the lower Bradley River. The average annual flow would be reduced by 87 percent, with monthly reductions ranging from 50 to 94 percent. Reduction of the outflow from Bradley Lake would beneficially affect the water quality of the lower Bradley River by reducing the inflow of highly turbid lake waters during the summer months. Reduction in turbidity levels in the river would increase water transparency and would probably cause an increase in productivity. The total pink salmon spawning habitat in the lower Bradley River would decrease by 55 percent (Woodward-Clyde Consultants, 1983), but the remaining habitat would be better protected by the more stable flow regime.

Table 4 -1. Existing and predicted mean monthly flows (cfs) in the lower Bradley River during proposed project operation. 1/

Month	Existing flow	Predicted flow	Percent change
Oct	634	82	- 87%
Nov	278	62	- 78
Dec	139	40	- 71
Jan	123	40	- 67
Feb	100	40	- 60
Mar	80	40	- 50
Apr	89	40	- 55
May	401	107	- 73
Jun	1,126	174	- 85
Jul	1,486	102	- 93
Aug	1,541	100	- 94
Sep	1,182	75	- 94
Annual	598	75	- 87

1/ Source: Alaska Power Authority, 1984b, License Application, Exhibit E.

Temperature changes expected in the lower Bradley River are summarized in Table 4-2. The postproject temperature regime would likely be slightly warmer during the summer months, cooler during the fall months, and the same as preproject temperatures during the winter and spring months.

Table 4-2. Estimated water temperature regime of the lower Bradley River (river mile 5.1) before and during proposed project operation. 1/

Month	Preproject temperatures		Postproject temperatures		Difference	
	°C	°F	°C	°F	°C	°F
Oct	4°	39.2°	2°	35.6°	-2°	-3.6°
Nov	1	33.8	1	33.8	0	0
Dec	0	32.0	0	32.0	0	0
Jan	0	32.0	0	32.0	0	0
Feb	0	32.0	0	32.0	0	0
Mar	0	32.0	0	32.0	0	0
Apr	1	33.8	1	33.8	0	0
May	2	35.6	2	35.6	0	0
Jun	3	37.4	4	39.2	+1	+1.8
Jul	6	42.8	7	44.6	+1	+1.8
Aug	7	44.6	8	46.4	+1	+1.8
Sep	7	44.6	5	41.0	-2	-3.6

1/ Source: Alaska Power Authority, 1984c.

The greatest potential for salinity changes would occur in the summer months, when the Bradley River flows would experience the greatest flow reduction (Table 4-1). Reduced freshwater discharge from Bradley River may allow more saline water to penetrate farther upstream during high tides. Salinities in upper Kachemak Bay, however, are relatively low during the summer months because of a high freshwater inflow from surrounding streams, and thus any salinity increases would be minor. The Applicant has estimated potential increases to less than 2.0 parts per thousand (ppt) up to river mile 3.5 of the Bradley River (Alaska Power Authority, 1984c).

Diversion of all runoff from the Nuka Glacier to Bradley Lake would reduce flows in the Nuka River by an undetermined amount. Because of the dynamic situation that has occurred over the years, with the glacier's flow alternatively switching between the two basins, the precise impacts are difficult to predict. In a worst-case scenario, if all the glacier's flow was to be diverted from the Nuka River to Bradley Lake, the Nuka River would experience an average annual reduction in flows of 158 cfs, ranging from a monthly average reduction of 1.6 cfs in March to 539 cfs in September (Alaska Power Authority, 1984b, Application, Exhibit E). The impacts of such a diversion on water quality and fisheries habitat can not be quantified, although similar such diversions have occurred naturally in the past.

A water quality impact that could result from reservoir filling would be the development of high levels of hydrogen sulfide (H_2S) as organic matter in the inundated areas decomposes. High concentrations of H_2S can be toxic to fish and other aquatic organisms. It is unlikely, however, that such a problem would occur. H_2S is commonly generated in the hypolimnion of highly eutrophic stratified lakes where dissolved oxygen is absent in the hypolimnion (Ruttner, 1973). Bradley Lake can not be characterized as a stratified eutrophic lake, but exhibits isothermal conditions through the open-water season, with high levels of dissolved oxygen throughout the water column. The enlarged lake will inundate about 2,578 acres, including 1,169 acres of tall alder-low shrub habitat. The Applicant, however, has proposed to clear larger vegetation from inundated areas. If higher concentrations of H_2S were to develop in the lake from the decomposition of the remaining vegetation, H_2S would probably be limited to the deeper areas of the lake, below the level of any of the water intakes.

4.1.4.2 Mitigative Measures Proposed

Construction

The Applicant has attemped to design a project construction plan that would minimize impacts to the surrounding water bodies. In addition, the Applicant is preparing Best Management Practices (BMP) Manuals, containing state-of-the-art measures to protect aquatic resources, for use by project construction contractors (Alaska Power Authority, 1984c). BMP manuals are being prepared for: (1) erosion and sedimentation control; (2) fuel and hazardous materials; (3) contingency planning; and (4) liquid and solid waste management. An outline of the erosion and sedimentation control manual is included as Appendix A.

Specific mitigative measures proposed by the Applicant, some discussed previously, include: (1) containing dredge spoil material behind the access road embankment; (2) establishing a buffer strip between Battle Creek and the access road route; (3) constructing the Battle Creek temporary bridge so that the abutments are placed out of the stream channel; (4) constructing a dike in the Martin River delta to prevent the active channels from breaking into the borrow pits; (5) establishing a buffer zone between the Martin River and the borrow pits to minimize sedimentation impacts; (6) building secondary sewage treatment facilities for the construction camps; (7) constructing hazardous chemical storage and containment areas; and (8) constructing settling ponds near the concrete batching plants to minimize the runoff of cement waste water to the surrounding area.

Operation

The Applicant has proposed to maintain minimum flows in the lower Bradley River to protect fisheries habitat (Table 4-3). These flows are based on an instream flow study conducted by the Applicant's consultant (Woodward-Clyde Consultants, 1983), and have been agreed to by the resource agencies.

Table 4-3. Applicant's proposed minimum instream flows (cfs) for the lower Bradley River, to be measured at river mile 5.1 1/

Month	Minimum flow	Month	Minimum flow
Oct	50	Apr	40
Nov	50	May 1-22 23-31	40 100
Dec	40	Jun	100
Jan	40	Jul	100
Feb	40	Aug	100
Mar	40	Sep 1-15 26-30	100 50

1/ Source: Alaska Power Authority, 1984b, License Application, Exhibit E.

In regard to possible water quality impacts (temperature, H_2S), the Applicant has proposed to monitor water temperatures and water quality before and after project startup, and if water quality problems are identified, to modify project operations to avoid impacting fishery resources. The Applicant has also proposed to install a storm gage the Nuka River to determine the impacts of the proposed Nuka diversion on flows in the lower Nuka River.

4.1.4.3 Unavoidable Adverse Impacts

Construction

Some erosion, stream sedimentation, and higher turbidity levels would be unavoidable during project construction. Activities where such impacts could not be avoided would include the proposed barge channel dredging and other construction within water bodies. Runoff from disturbed land areas, such as roads, staging areas, and construction camps, would also be unavoidable. Such runoff could be highly turbid and could contain chemicals or other wastes.

Operation

Although the Applicant has proposed a minimum flow regime acceptable to the resource agencies, reduction of Bradley River flows would be an unavoidable impact of project operation. An impact that would remain, even with the implementation of an acceptable minimum flow, is the reduction of high flushing flows that act to clean stream gravels of fines. The estimated highest spillway discharge from the Bradley Lake dam during project operation would be 1,522 cfs in August, but a spill of this magnitude would be expected to occur only once every 5 years. The highest average annual spill is estimated to be only 108 cfs (Alaska Power Authority, 1984b, Application, Exhibit E).

Water quality impacts (temperature changes and possibly H_2S increases) would be unavoidable with the project as proposed. The temperature changes, however, are expected to be minor, and it remains to be seen if H_2S actually becomes a problem.

Flow reductions in the Nuka River would be an unavoidable impact of project operation, although the resulting impact on aquatic habitat is yet to be determined.

4.1.5 Aquatic Communities

4.1.5.1 Beneficial and Adverse Impacts

A description of the impacts of the proposed Corps project on aquatic communities is contained in Section V.B and in the Section 404(b)(1) evaluation of the Corps' FEIS. Impacts of the presently proposed project would be similar to those previously described by the Corps, and are summarized below. Additional FERC staff analysis of impacts is also described.

Construction

Construction activities would have the greatest direct impact on benthic communities, since benthic habitat would actually be removed during the dredging activities for the barge basin and would be directly impacted by the sedimentation of stream substrate in the runoff from disturbed areas. Dredging activities would remove about 115 acres of marine benthic habitat in upper Kachemak Bay and would result in a total loss of benthic communities in the dredged area. Recolonization of this area by benthos would begin upon completion of dredging activities, however, and total recolonization would likely be complete within a few years. Stream benthos in Battle Creek and Martin River could be lost if sediment from road construction and borrow activities is deposited in the streams and covers the bottom substrate. The extent of sedimentation and the amount of benthic habitat that would be lost, however, is difficult to predict.

Fish populations could also be affected by stream sedimentation through the direct loss of spawning and rearing habitat and the loss of benthic food organisms. In addition, if sedimentation were to occur in areas containing incubating eggs or fry, mortalities of these life stages would be likely. Adult and juvenile fishes could also experience mortalities if accidental chemical or oil spills were to occur in Battle Creek or Martin River. If the dike and buffer zone between Martin River and the borrow sites were to fail as a result of a flood or other natural event, fish migrating into the Martin River might become entrapped in the borrow pits or experience delay in reaching upstream spawning sites. Both Martin River and Battle Creek, the streams most likely to be affected by project construction activities, do not contain large fish populations, however, so the net effect on fishery resources in the area probably would be minor.

Operation

The effects of project operation on benthic communities is expected to be minor. Benthic habitat would be reduced in the lower Bradley River because flows would be significantly reduced (Table 4-1). The habitat that remains would be better protected by the stable year-round flows. In addition, turbidity levels would decrease because of the reduction of the outflow from Bradley Lake, resulting in higher water transparency and a probable increase in productivity. If H_2S becomes a problem in Bradley Lake, as a result of the decomposition of organic matter in the area inundated, few effects would be expected in the lower Bradley River. No releases would be made from the lake during much of the year, and if releases are made, these would be through an intake located above the layers of the lake expected to contain H_2S, if any. Benthic habitat would also be reduced in the Nuka River by an unknown amount, but would be within the range that has been experienced naturally in the Nuka River.

Available fisheries habitat in the lower Bradley River would be reduced by project operations, and would be subjected to an altered thermal regime. Although a significant amount of available habitat would be lost, the habitat that would remain would be more effectively protected by the more stable flow regime. The Applicant estimates in its instream flow study (Woodward-Clyde Consultants, 1983) that pink salmon effective spawning habitat, which is habitat that would be available to spawning fish and that also would be protected by incubation flows, could increase by up to 400 percent with the Applicant's proposed minimum flow regime (Table 4-3), compared to the existing natural flow regime. It was estimated that 98.6 percent of the pink salmon spawning habitat available at the proposed spawning flow (100 cfs) would be protected at the proposed winter incubation flow (40 cfs). It thus appears that pink salmon production could increase under proposed project flows. The results of the instream flow study also indicate that chum salmon spawning habitat would increase under the proposed flow regime, although few chum salmon now utilize the Bradley River, possibly because of the lack of suitable substrate or upwelling areas normally used by spawning chum salmon. The study indicates that rearing habitat for coho salmon would increase under project flows; this may not be significant since few coho now spawn in the Bradley River, and existing rearing habitat is only lightly utilized. The fishery agencies have accepted the Applicant's proposed minimum flow release schedule. 1/

The altered thermal regime in the lower Bradley River (Table 4-2) could impact the salmon resources of the river by changing the timing of spawning and the rate of incubation, thereby altering the pattern of springtime fry emergence. The predicted temperature regime, on a monthly average basis, is that temperatures would be 1°C warmer in June, July, and August, 2°C cooler in September and October, and the same as the preproject regime the remainder of the year. The warmer temperatures in June through August would not appear significant, since temperatures would remain within a range suitable for the spawning of salmon (Bell, 1973), and in fact, probably would not differ significantly from the natural temperature variations in the river.

The greatest potential impact from the temperature changes would be changing the rate of egg incubation and the timing of fry emergence. It is known that the rate of egg incubation is tied to water temperature, and that each species of salmon has a specific requirement for temperature units (TU) for eggs to hatch and for fry to emerge from the gravel.

FERC staff has assessed the potential for alteration in the timing of pink, chum, and coho salmon fry emergence, using an analysis of TU's available during the incubation period under existing and project operation conditions. The predicted temperatures on Table 4-2 were used as the bases for generating estimated temperature regimes for the first, middle, and last third of each month. These estimated temperature regimes used in the analysis are presented in Figure 4-1. The beginning of the incubation period for each species was the median date of spawning derived from the phenology chart for Bradley River salmonids reported in Woodward-Clyde Consultants (1983). This same chart was used to determine the median date of fry emergence under existing conditions, and in turn the TU requirements for the three species in the Bradley River. The existing median date of spawning was also used for the postproject conditions, since it was assumed that the small temperature difference expected during the spawning season would not shift the timing of spawning.

1/ Letter from Bruce Blanchard, Director, Environmental Project Review, Department of the Interior, Washington, D.C., September 14, 1984.

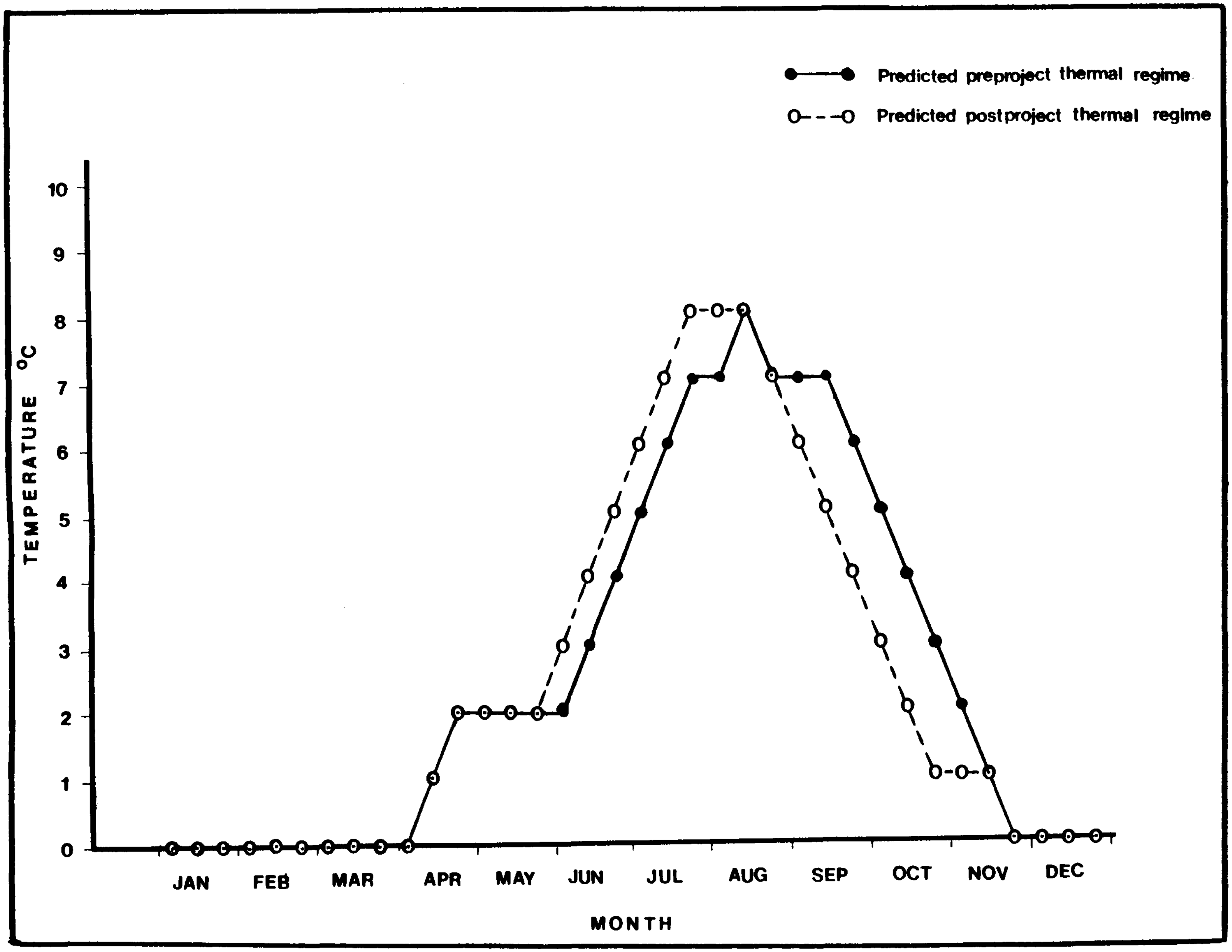

Figure 4-1. Predicted preproject and postproject thermal regime in the lower Bradley River (Source: Staff, based on Alaska Power Authority, 1984c).

Results of this analysis (Table 4-4) indicate that fry emergence may be delayed because of the lower incubation temperatures expected in the fall months (Figure 4-1). The median date of emergence for all three species was extended at least 1 month, with pink salmon indicating a shift of about 7 weeks. Such a shift would place a major portion of the fry emergence period outside of the range of the emergence period reported by Woodward-Clyde Consultants (1983). The effects of such a delay in emergence are difficult to predict, although a delay would likely adversely affect the growth of salmon fry after emerging from redds. A food supply would likely be available to fry that emerge in June, but these fry would be at a disadvantage because of the shortened growing season. Fry not reaching an optimum size for over-wintering or ocean survival would likely experience higher mortality. Increased mortality of Bradley River salmon fry would adversely affect the stock, and may somewhat offset the potential habitat gains resulting from the stabilized flow regime described earlier.

Table 4-4. Analysis of the effects of an altered thermal regime on the timing of fry emergence in three species of salmon in the lower Bradley River. 1/

Species of salmon	Preproject existing conditions			Postproject conditions			
	Median spawning	Median emergence	TU's to emerge. 2/	Median spawning	Median emergence 3/	TU's to emerge.	Delay in emergence (days)
Pink	July 25	April 20	1,310	July 25	June 9	1,313	50
Chum	July 15	April 25	1,448	July 15	June 10	1,452	46
Coho	Sept 1	May 25	946	Sept 1	June 29	948	35

1/ Source: Staff.

2/ Calculated from temperature regime depicted in Figure 4-1. May differ from TU requirements from other rivers as reported in the literature.

3/ Date at which cumulative TU's reached or first exceeded the TU requirements cited in previous column.

Although such impacts appear serious, it should be noted that the Staff's analysis is based on average temperatures likely to occur, and is limited by the lack of daily temperature data. In addition, even if the predicted temperatures are correct, Graybill et al. (1979) report that TU compensation, wherein salmon eggs developing under different temperatures have differing TU requirements, likely occurs in species of Pacific salmon. Thus if incubation temperatures are lower, fewer TU's would be required for hatching and fry emergence, resulting in emergence at a time similar to existing conditions. This may be a mechanism that allows salmon to adapt to varying environmental conditions, while keeping emergence at approximately the same time of the year.

An impact that could result from the powerhouse discharge into the Sheep Creek-Bradley River common estuary would be the attraction of returning Bradley River salmon into the tailrace, resulting in unsuccessful spawning or in a delay in migration to the river. This impact appears probable, based on the location of the powerhouse in relation to the Bradley River estuary (Figure 2-1), the volume of powerhouse discharge, and experiences at other hydroelectric projects in Alaska where salmon have been attracted into tailraces.

The proposed powerhouse would discharge an average flow of 621 cfs during the period of salmon migration into the Bradley River, ranging from a minimum of 444 cfs to a maximum of 1,250 cfs. During July and August, the combined outflow from Sheep Creek and the Bradley River would average 2,661 cfs (July) and 2,336 cfs (August) [Alaska Power Authority, 1984b, License Application, Exhibit E]. Including the powerhouse flow, the total freshwater discharge from the Sheep Creek-Bradley River estuary would range from 3,105 cfs to 3,911 cfs in July and from 2,780 cfs to 3,586 cfs in August. The powerhouse discharge would comprise 14 percent to 32 percent of total freshwater outflow in July, and 16 percent to 35 percent of the total outflow in August.

This significant discharge, entering the Sheep Creek-Bradley River estuary downstream of the point where the Bradley River enters the estuary, would likely attract salmon. It is difficult to predict, however, the behavior of fish entering the tailrace. These fish could attempt to spawn in the unsuitable tailrace habitat, or after some delay, could return to the estuary to continue upstream migration to the Bradley River. The powerhouse discharge could also attract and delay salmon bound for Sheep Creek, although this is less likely, since it is expected that Sheep Creek fish would be able to differentiate between Bradley River and Sheep Creek waters.

4.1.5.2 Mitigative Measures Proposed

The Applicant's proposed mitigative measures to protect aquatic habitat during construction and operation of the project have already been described. In short, the Applicant proposes to: minimize erosion, sedimentation, and other impacts during construction; maintain minimum flows in the lower Bradley River; conduct monitoring studies during project construction and operation; and provide additional mitigative measures depending on the results of the monitoring studies. Monitoring studies proposed specifically for fishery resources would entail an 8-year program that would include: monitoring of adult salmon escapement, monitoring of incubation success to determine embryo and alevin survival, and monitoring of adult salmon usage of the powerhouse tailrace.

4.1.5.3 Unavoidable Adverse Impacts

During project construction, destruction of some benthic habitat in the upper Kachemak Bay, in short reaches of Battle Creek and Martin River, would be unavoidable. This habitat would, however, totally recolonize within a few years.

Project operation would change the thermal regime of the lower Bradley River, which in turn could alter the timing of salmon fry emergence in the river. The powerhouse discharge would likely attract some adult salmon and would cause either the delay of migration and spawning or unsuccessful spawning in the tailrace.

4.1.6 Terrestrial Environment

4.1.6.1 Beneficial and Adverse Impacts

4.1.6.1.1 Vegetation 1/

Roads

Approximately 3,352 acres of vegetation would be removed for the construction and operation of the project. The following discussion gives the acreages of each cover type, discussed in Section 3.1.4.1, that would be affected by each of the proposed facilities. A summary of the total acreages of each cover type affected by the project is presented in Section 4.1.6.3.

Approximately 10 miles of access roads are proposed for the project (Figure 2-1). Roads would be constructed from the airstrip to the powerhouse, past the barge dock, to the lower camp (2.5 miles); from the lower camp to the borrow pits in the Martin River (1.5 miles); and from the lower camp, past the upper camp, to the dam (6.1 miles). The road to the Martin River borrow area would be temporary; all other roads would be permanent.

The roads from the airfield to the powerhouse and from the powerhouse to the lower camp would pass through 0.9 mile of salt-water, herbaceous, sedge-grass vegetation, in the Kachemak Bay Critical Habitat Area, and through approximately 4 miles of coniferous forest. The road leading from the lower camp to the Martin River borrow area would include approximately 0.7 mile through saltwater, herbaceous, sedge-grass communities. The road from the lower camp

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1/ Unless indicated otherwise, the information is taken from the application for license for the proposed Bradley Lake Project (Alaska Power Authority, 1984b). Acreage figures are taken from computer printouts supplied by Michael Joyce, Senior Project Scientist, Woodward-Clyde Consultants, Anchorage, Alaska.

to the upper camp would pass through 1.8 miles of coniferous and deciduous forest types and through 4.3 miles of alpine areas, including intermittently exposed bedrock. Excavated material from bedrock cuts would be placed on an upland disposal area approximately 0.5 mile above the lower camp.

The proposed project access roads would occupy a total of 46.1 acres of project land (Table 4-5), including 0.2 acre of open water. The open water crossing through the unnamed pond near the upper camp site would provide access to the upper camp. This crossing is along a high ridge in the pond, which is exposed during periods of low water levels. Alternative routes around the pond were rejected because of increased length and probable higher siltation into the pond.

Building permanent roads through forested or tall shrub areas would include a right-of-way. The right-of-way would not be maintained following construction and would revegetate naturally over time, primarily to willow and alder. The Martin River borrow-area road would be levelled to preconstruction conditions and would be allowed to revegetate naturally. The remaining lower project roads would be open to the public after construction.

Dust from road construction and from traffic during project operation would reduce the abundance and coverage of flowering herbs (forbs) near the roads. Everett (1980) states that abundance of forbs, mosses, and lichens decrease with exposure to dust along haul roads. Wetland vegetation immediately adjacent to the roads would be adversely affected by sedimentation.

Airstrip

A 2,200-foot-long airstrip would be constructed in the vicinity of the proposed powerhouse, displacing approximately 7 acres of saltwater, herbaceous, sedge-grass flats and 2 acres of coniferous forest vegetation. Two alternative sites for the airfield were considered, one on the Martin River delta and one near Sheep Point. The proposed powerhouse site is within the Fox River Flats Critical Habitat Area and the ADF&G prefers that no permanent facilities should be constructed in this area unless there are no prudent or feasible alternatives. The Martin River delta site was ruled out for safety reasons and because of the high cost and the need for an increased quantity of fill. The Sheep Point site was ruled out because it would be adjacent to the proposed area for waterfowl mitigation, 1/ and was opposed by the ADF&G.

1/ Letter from Robert L. Grogan, Associate Director, Office of Management, Division of Governmental Coordination for the State of Alaska, Office of the Governor, Juneau, Alaska, December 11, 1984.

Table 4-5. Approximate acreages of plant communities displaced by the proposed Bradley Lake Project facilities. 1/

Plant community	Roads	Air-field	Dredge disposal	Borrow area	Lower camp	Upper camp	Dam	Reservoir	Mid. Fork Diversion	Power-house	Transmission line	Waste disposal	Quarry sites	Totals
Closed coniferous	17.1	2.0	0.3	21.9	0.6					0.3	352.4	1.4	6.9	402.9
Open coniferous	13.1					5.2					180.7			199.0
Birch forest	0.3										18.7			19.0
Balsam poplar forest	0.1				29.5							7.7		37.3
Mixed spruce-birch	0.8													0.8
Mixed spruce-poplar											26.0			26.0
Tall alder shrubland	5.9			3.2			3.2	366.9	0.7		39.0	5.0	3.9	427.8
Tall willow shrubland											1.8			1.8
Low willow shrubland								801.5			9.0			810.5
Bog	0.4										78.9		0.7	80.0
Tall grassland											21.2			21.2
Mesic sedge-grass	1.5						0.3	895.4			15.5			912.7
Freshwater sedge-grass								334.2			9.2			343.4
Saltwater sedge-grass	4.5	7.0	42.7							4.7	2.4			61.3
Shrub tundra	0.2						3.8	0.7	1.2					5.9
Elymus grassland	0.1				2.3							0.1		2.5
Gravel floodplains	1.9		1.0	61.1	1.8		1.3	174.0			7.1		0.7	248.9
Open water	0.2					0.6		4.8			0.2			5.8
Total facility acreage	46.1	9.0	44.0	86.2	34.2	5.8	8.6	2577.5	1.9	5.0	762.1	14.2	12.2	3606.8
											- Total unvegetated acreage			254.7
											Total acreage of vegetation removed			3352.1

1/ Source: Staff, from Woodward-Clyde Consultants, 1985, unpublished data.

ADF&G states that, because no feasible and prudent alternatives have been identified, it has no objection to the powerhouse sites. 1/

Barge Basin, Access Channel, and Disposal Site

The barge basin and access channel would be constructed within 26 surface acres of open water and 23.2 acres of unvegetated tidal floodplain. Dredged material from the barge basin and access channel would be deposited on sedge flats between the access road and foothills north of Sheep Point. The total volume of dredged material would be approximately 464,000 cubic yards and would be placed in a 44-acre, confined, intertidal disposal site, which would displace approximately 43 acres of saltwater, sedgegrass flats (Table 4-5).

Alternative dredged-material disposal site locations are discussed in the Corps' FEIS (1982). After reviewing the Corps' study, the Applicant considered four location options; upland, open water, intertidal flat, and the proposed contained intertidal disposal. The Applicant selected the confined intertidal disposal site as the least environmentally damaging alternative (Alaska Power Authority, 1984d).

The Sheep Point disposal site would be rehabilitated and revegetated following construction and used as a waterfowl habitat and nesting area. (See Section 4.1.6.2.) No future maintenance dredging is planned during operation of the project. Additional impacts to tidal-flat vegetation would include siltation from barge traffic and potential spills of the petroleum products that would be handled in this area during project construction.

Borrow Area

The project borrow area would occupy approximately 86 acres in the Martin River area (Table 4-5). The borrow pits would be situated to minimize disturbance to the scattered tall alder communities. Short-term impacts to adjacent vegetation, primarily the herbaceous components of the tall alder communities, would result from the accumulation of dust that would be generated during borrow operations.

Lower Camp and Staging Area

The lower camp and staging area would displace approximately 34 acres of vegetation (Table 4-5). A transmission line would be constructed from the powerhouse to the camp on the saltwater, herbaceous sedge-grass flats. Vegetation disturbance from the

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1/ Letter from Carl W. Yanagawa, Regional Supervisor, Alaska Department of Fish and Game, Habitat Division, Anchorage, Alaska, December 4, 1984.

lower-camp, power-line construction would not be significant because soil disturbance would be minimal. The effects of the lower camp and maintenance building operations on vegetation would be minor.

Upper Camp

The upper camp would disturb approximately 5.2 acres of open coniferous forest and would displace 0.6 surface acre of a small pond, due to the construction of the access road. The alternative of locating the upper camp in an area that would become part of the reservoir after construction was rejected because of the steepness of the terrain at the west end of Bradley Lake (Alaska Power Authority, 1984d). Unlike use of the lower campsite, use of the upper camp would involve no storage of large quantities of fuel or construction of a transmission line. The upper camp would be completely removed after project construction.

Dam

The dam and intake would occupy 8.6 acres (Table 4-5). Concrete mixing, blasting, and other construction activities at the site would create dust that would have a short-term impact on herbaceous cover. Operation of the project would reduce flows below the dam; the downstream portion of the canyon forms a narrow, steep-sided channel, however, so changes in soil moisture would not cause a significant shift in vegetative cover types. Reduced flows on gravel bars would most likely result in a minor increase in the coverage of such alder and herbaceous species as fireweed.

Middle Fork Diversion

The Middle Fork diversion would utilize a buried pipeline, which would cross alder and shrub tundra (Table 4-5). Revegetation would be slowest in the shallow, rocky soils of the shrub tundra zone. Operation of the project would eliminate the vegetation immediately below the outlet of the diversion pipe.

Nuka Glacier Flow Diversion

The Nuka Glacier flow diversion would involve the construction in unvegetated areas, of a gravel dike on the Nuka River and an outlet weir on the Upper Bradley River. Construction equipment would be airlifted to the site. No impacts to vegetation are anticipated from the construction or operation of this facility.

Reservoir

The proposed reservoir would inundate 2,577.5 acres (Table 4-5), including tall alder, low willow shrub, and sedge-grass vegetation where Kachemak Creek and the Upper Bradley River feed into Bradley Lake. In addition to the vegetation killed through innundation, the vegetation immediately above the maximum-fill level (1,180-foot contour) would be lost through erosion in areas that are subject to high wave action. Unlike the Corps' proposal, the Applicant's proposed dam construction would not involve a drawdown of the existing lake. Before the reservoir is filled, trees greater than 1-inch diameter breast height would be removed by mechanical means. During cutting and removal, work crews would minimize disturbances to the vegetation above the inundation zone.

Tunnel

Unlike the Corps' proposed project, the Applicant's proposed tunnel would be constructed underground. Impacts to vegetation would be minimal and would be confined primarily to shrub tundra and tall alder vegetation in the immediate area of the intake, and to closed coniferous forest at the outlet.

Powerhouse and Tailrace

Saltwater herbaceous sedge-grass would be affected by the construction of the powerhouse and tailrace (Table 4-5). Additional, scattered patches of saltwater sedge-grass vegetation would be affected by the tailrace discharge, which would run through the mud flats during project operation.

Transmission Line

Forest vegetation along the 20-mile-long transmission line would be cleared to provide a 225-foot-wide corridor. In addition, selected tall woody vegetation would be removed for 50 feet on either side of the right-of-way. The right-of-way would pass through closed coniferous forest on the east side of the Fox River Valley. The line would then cross the Fox River Valley and would continue west, passing south of Caribou Lake, to a tie-in with the proposed Fritz Creek Soldotna transmission line (Figure 1-6). The corridor area would total approximately 762 acres (Table 4-5). The Applicant would keep vegetative removal on the steep west side of the valley to a minimum to decrease the erosion potential. Vegetation beneath the powerlines in forested areas would be maintained in a shrub stage.

Waste Disposal

Concrete wastes resulting from building the dam, tunnel, and other facilities would be poured onto a gravel pad, allowed to harden, and subsequently removed for disposal onsite at designated solid-waste disposal areas. There would be a 5-acre disposal area at the dam, and incinerated material and clean waste (concrete, non-toxic metals, and other non-combustibles) would go to a landfill adjacent to the staging area and the lower camp (Alaska Power Authority, 1984d).

Forest vegetation would be disposed of in five possible ways: commercial timber would be sold or would be used for onsite construction;

slash would be left on the ground (in areas where it will not interfere with wildlife movements), piled and burned, or transported to a central location for disposal. The estimated acreage of commercial timber would total 356.7 acres. The bulk of the commercial timber would come from the right-of-way clearing for the transmission line (352.4 acres). Two acres would be cleared for the airstrip, 0.6 acre for the lower camp buildings, 1.4 at the organic stockpile area, and 0.3 at the powerhouse site (personnal communication, Paul Hampton, Wildlife Biologist, Woodward-Clyde Consultants, Anchorage, Alaska, January 15, 1985).

Material produced by blasting in the tunnel and by tunnel boring would be used onsite for the airstrip and for the surfacing of access roads and yard areas (Alaska Power Authority, 1984d).

Organic soil material would be stockpiled at the lower camp area on 3.9 acres, which would displace 1.4 acres of closed coniferous forest and 2.5 acres of balsam poplar vegetation.

Batching Plants

The Applicant would operate two concrete batching plants; one located adjacent to the access road, between the powerhouse and the dredged material disposal area, a second approximately 3,000 feet from the proposed site of the dam. The batching plants would occupy 1 to 2 acres (Alaska Power Authority, 1984d). The upper plant would be within a tall alder vegetative community and the lower plant would be within a saltwater herbaceous sedge-grass community.

Quarry Sites

The lower quarry area would be approximately 1 mile up the road from the lower camp and would occupy 7.6 acres. A second quarry site of 4.6 acres would be located near the dam. (See Table 4-5 for the vegetative cover types.)

4.1.6.1.2 Wildlife 1/

The following section discusses species of regional importance that would be affected by each of the major project facilities. Disturbances and minor changes to the distribution and abundance of small mammals, passerine birds, and other common species are not discussed unless they are of some significance.

1/ Unless indicated otherwise, the information has been derived from Alaska Power Authority, 1984b, Application, Exhibit E.

Roads

Construction of the roads from the airport to the powerhouse and from the powerhouse to the lower camp would begin in March of the first construction year and would continue through May. Construction of the upper road to access the dam would begin in March of the first construction year and would continue through August. Construction techniques would require cutting and filling and would involve blasting on a daily basis.

Waterfowl would be affected by road construction in the tidal flat areas through loss of habitat and through disturbances during the March through May construction period. The tidal flats, in the vicinity of the proposed road construction, are used by waterfowl for feeding; nesting is unsuccessful because of tidal inundation. The actual habitat loss is approximately 4.5 acres.

The access road from the lower camp to the Martin River borrow area would be less significant, for waterfowl distribution and density, than the airstrip-to-lower-camp road, because most of the waterfowl concentrate along the tideline. The primary disturbance would result from blasting and the operation of heavy equipment. The peak waterfowl concentrations occur in late August through September, after the completion of the March through May road construction in the tidal flats.

The long-term effects of project roads on waterfowl distribution and abundance largely would involve disturbances by vehicular traffic. These effects are expected to be minor. Waterfowl feeding along the sedge-grass flats tend to move in and out with the tide. The proximity of feeding waterfowl to the road would therefore be limited to short periods each day. In addition, the use of project roads would be limited. Only the airport-to-powerhouse road would be open to visitors; remaining roads would be used by the project staff for inspections and maintenance.

Shorebird distribution and abundance would be more significantly affected by road construction than would waterfowl, because shorebird migration and staging peaks in the spring, and would coincide with the bulk of the lower road construction in the tidal flats. The use of heavy equipment and blasting would be the primary disturbance factors; blasting would be the more significant disturbance because of its sudden impact. Shorebirds would be more likely than waterfowl to adapt to the chronic disturbance of heavy equipment (Joyce and Hampton, 1983).

The disturbance to shorebirds caused by vehicular traffic during project operation is expected to be minor, as it would be for waterfowl, because of the limited use of the access roads. Neither road construction nor operation is expected to have a significant affect on nesting shorebirds, because of the lack of suitable nesting habitat in the immediate area.

Bald eagles are known to nest in the project area and three nests have been identified in the vicinity of the proposed roadways. Road construction near Battle Creek would come within 1,000 feet of a bald eagle nest. Road construction on the Martin River Delta would be no closer than 3,000 feet from a nest. The airstrip road would be over 2 miles from the nearest eagle nest, which is adjacent to the Bradley River. The main disturbance factor would be heavy equipment. Blasting would be used primarily for road construction on the reach from approximately 0.5 mile above the lower camp to the upper camp and dam (personal communication Michael Joyce, Senior Project Scientist, Woodward-Clyde Consultants, Archorage, Alaska, January 15, 1985). The three eagle nests discussed above are in the lower areas where road construction would consist primarily of grading and filling. The distances between the nests and the road construction are expected to provide adequate buffers to minimize the disturbance to nesting eagles.

Road construction would create a short-term disturbance to moose in the upland areas where blasting would be required. Roads do not cross known moose migration routes. The Martin River segment would be constructed between March and May and would not affect potential moose wintering use near the mouth of the river. Operation should have minimal effects because hunters would be restricted from the upper roads.

The road from the upper camp to the dam is the only portion of the project roadways that would affect mountain goats. This portion of the road would create a relatively insignificant long-term loss of range. The use of heavy equipment and blasting would create a short-term disturbance, affecting distribution. Because a small portion of the goat population uses the vicinity of the upper road, it is expected that road construction would constitute only a minor disturbance to the population. Long-term disturbance to goats would be insignificant because of the minimal use of the upper project roads by vehicular traffic.

Construction would displace local bears temporarily. Grizzly bears are not common in the road areas. Any black bears that may be denning in the adjacent coniferous forests would be disturbed by blasting and heavy equipment noise. Any resulting mortality would not significantly affect the black bear population in the area. Hunting pressure is not expected to increase significantly because the upper project roads would not be open to hunters and construction crews would not be permitted to hunt.

Wolf distribution would be affected by project road construction. Wolves tend to avoid areas of human activity (Mech, 1970). Wolf tracks have been observed in the vicinities of both the upper and lower project roads, but wolves would probably avoid these areas during construction. Long-term impacts are not anticipated because only infrequent use of the roads is planned during operation.

Airstrip

Building the airfield would remove wintering waterfowl and shorebird habitat totaling 7 acres, and would disturb species staging in the surrounding sedge-grass flats during construction. The wetlands in the area of the airfield are designated as a critical habitat area by the state. Geese and dabbling ducks disperse over the sedge flats to feed; sea ducks and diving ducks tend to follow the tides, feeding in deeper water (personal communication, Michael Joyce, Senior Project Scientist, Woodward-Clyde Consultants, Anchorage, Alaska, January 8, 1985); shorebirds follow the tideline. Sea ducks and diving ducks and shorebirds are more likely to be concentrated and thus to be more susceptible to displacement by construction activities and aircraft during high tides. Long-term impacts would result from low-flying aircraft and from increased hunter access. The potential hunting pressure would be lessened by limiting use of the airstrip. The airfield would not be lighted and would be posted as "use at your own risk" to discourage heavy use. Airfield use is expected to be lower during project operation than during construction.

During operation of the airfield, fixed-wing aircraft, which would generally approach from the northeast, would pass over a bald eagle nest along the Bradley River. The approach path would occur at an adequate buffer distance, consistent with the requirements of the Bald Eagle Protection Act, which is expected to minimize disturbance to nesting eagles.

Construction of the airfield is not expected to affect moose, wolves, or bears because these species do not regularly use the airfield site. Operation would provide additional hunter access, which would most likely affect black bear. The airstrip is closer to black bear habitat than to areas used by other game species.

Barge Basin and Disposal Site

A 1.5-mile-long access channel and barge basin would be dredged in the tidal flats in the summer during a period of approximately 60 days (Alaska Power Authority, 1984d). As previously discussed, dredged material would be deposited on a 44-acre, saltwater, tidal wetland and would be rehabilitated as a non-tidal freshwater wetland and waterfowl nesting site. The basin would remain open to sportsmen.

Dredging activities would temporarily displace waterfowl, but this impact is expected to be minor because most waterfowl use is near the tideline, and waterfowl densities are lowest in the summer. Barge and boat traffic would constitute minor long-term disturbances. Increased hunting pressure on area waterfowl would constitute a significant, long-term indirect impact, resulting from the improved access.

The loss of the 44-acre tidal flat as feeding habitat is expected to be offset by the creation of a freshwater wetland on the same site. If the site is successfully established as a nesting site, it would increase waterfowl and shorebird production in the project area and would also benefit gulls. Suitable nesting habitat is currently a limiting factor to waterfowl and shorebirds in the project area. The use of the 44-acre saltwater herbaceous sedge-grass site for the mitigation plan was necessary because no other site was suitable or feasible for the disposal of dredged material.

Seals might be disturbed during dredging operations. Dredging would occur during both pupping and molting periods in the summer. Seals would most likely avoid the area during dredging operations. The long-term effects of boat traffic are expected to be minor because boats would not enter the area during low tide when seals are out of the water. During high tide, seals are usually out in the water feeding, and would not be in the vicinity of the barge basin.

Martin River Borrow Pit

The borrow area would consist of three shallow pits in 86 acres of gravel floodplain and coniferous forest. The design of the borrow pits would incorporate feathered edges and littoral zones. The resulting pits would be flooded after project construction. The middle and lower pits would contain vegetated islands.

Borrow pit construction is not expected to significantly affect waterfowl because the active floodplain and tidal flats that these species use would not be disturbed by borrow activities. Similarly, shorebirds utilize the tidal flats and would not be significantly affected by construction. The borrow area would provide additional waterfowl and shorebird habitat after construction, because littoral zones and islands would be incorporated in the design.

Bald eagles are the only raptors known to utilize the Martin River Delta in the vicinity of the proposed borrow area. An eagle nest is located approximately 500 feet from the upper borrow pit. Mining would extend from March through late summer and would coincide with the nesting and brood-rearing period. The operation of heavy equipment would constitute a chronic disturbance. No blasting would occur, however, and the success of fledgling eagles would most likely not be affected. Mining during the following year would occur greater than 2,000 feet away from the nest.

Bald eagles concentrate along the lower Martin River in the fall; typically in balsam poplars, at least 1,000 feet upstream from the proposed borrow area. Because of this distance and the absence of blasting, no significant impacts are expected. In the long-term, the rehabilitated borrow pits would provide a potential food source for eagles, if the pits are used by trout or salmon.

According to Rappoport et al. (1981), the borrow area is adjacent to a high quality moose range. No direct habitat loss to the winter range would occur, although heavy equipment noise would probably displace any moose in the immediate vicinity or discourage moose from moving into the area. A moose survey of the project area from October 1983 until June 1984 recorded no moose observations on the Martin River delta, and no moose sign (tracks, scat, or evidence of browse on vegetation) was encountered (Woodward-Clyde Consultants, 1984a). Any effects on moose utilization or potential utilization of the area would be short term. Habitat disturbance (loss of an estimated 22 acres of conifers and 3 acres of tall alder) is not expected to create a significant long-term adverse impact.

Lower Camp

The lower camp area (including the staging area, buildings, the waste disposal site, the organic stockpile, the sewage lagoon, and the 7.6acre lower quarry site) would displace approximately 51 acres of vegetation, which includes 37 acres of balsam poplar.

The temporary camp would accommodate 240 people. Hunting and trapping by project construction personnel would be prohibited. Permanent housing for four families would remain on the site. Those individuals permanently stationed at the site for project operation would be permitted to hunt according to Federal and state regulations.

Waterfowl use of the Battle Creek area, near the proposed camp, is low compared to the use of the surrounding tidal flats. Construction is therefore expected to temporarily displace small numbers of feeding waterfowl. Shorebirds feed along the Battle Creek tideline during the summer. Camp construction and operation would not affect the shoreline habitat. Waterfowl would most likely move to the adjacent tidal flats.

A bald eagle nest is located over 3,000 feet from the camp site and roughly 2 miles from the lower quarry site; because of this distance, disturbance should be minimal. No other raptor nesting in the lower camp area has been documented.

The potential for raptor collisions with the camp transmission line would be minimized through a raptor-proof pole design and through wide spacing of the transmission wires.

The removal of 37 acres of balsam poplar would constitute a loss of winter habitat for moose and would include several large snags (cavity trees) that provide potential habitat for woodpeckers, owls, and cavity nesting, passerine birds such as chickadees.

Construction noise, especially from quarry minings, would likely displace black bears in the adjacent coniferous forest. Although the four families permanently stationed at the project site would be permitted to hunt, the long-term effects on the regional black bear population would not be significant. Refuse would be stored in "bearproof" containers at the site and would be transported to an incineration area daily in an effort to minimize the occurrence of problem bears. These containers would be large capacity, covered, metal containers with locking devices, and would be located within a fenced area (Alaska Power Authority, 1984d).

Sewage treatment is expected to prevent any significant water quality impacts that would adversely affect wildlife, including beaver and marine mammals. Similarily, any indirect effects on such terrestrial fish-eating species as eagles and bears are unlikely. The lower quarry would be approximately 1 mile up the road from the lower camp. The closest active eagle nest is about 2 miles away.

Upper Camp

The upper camp would be a temporary facility to house 210 people during construction at the lake. Sewage would be transported to the lower camp treatment facility. Hunting would be prohibited.

The upper camp would not be within an area utilized by waterfowl and shorebirds or highly utilized by raptors. Construction materials would be flown to the site by helicopter before the completion of the roadways. This helicopter activity would increase the use of the airstrip, which would most likely displace waterfowl, and shorebirds in the area of the airstrip, and would disturb raptors along the lower portions of the flight path.

Moose would be displaced along the helicopter routes during construction and would be displaced by heavy equipment noise at the site. Mountain goats would be similarly affected, but because only a small percentage of the herd is known to occur in the vicinity, construction and operation of the upper camp is expected to have a minor effect.

The areas in the vicinity of the camp provide good habitat for grizzly and black bears. The actual habitat loss (5.2 acres) would not be significant. Disturbance, from construction and human activities would be short term. In addition, construction crews would not be permitted to hunt. Camp refuse would be stored in "bear-proof" containers, as previously described.

Bradley Lake Dam

Construction of the dam, operation of the concrete-batching plant, and mining at the upper quarry would all begin in March. Blasting would occur on a frequent basis for approximately 8 months. Activities would stop for the first winter, from December through the following March.

Minimum flow releases would protect shorebird habitat along the river during operation. Area raptors would most likely alter their hunting ranges to avoid the construction activity; passerine birds and ptarmigan in the area would be displaced by blasting. Construction would occur during three breeding seasons.

Moose and bear habitat is abundant in the area. These species would avoid the dam site because of blasting, other noise, and human disturbance.

Mountain goats concentrate near the Bradley River and Sheep Creek beginning in late October or early November, and move to summer range, from Sheep Creek to the Nuka Glacier, beginning in late May and June. Goats would be affected by dam construction during the winter when they are generally in poor condition. Construction would be stopped during the first season from December through March. Goats that are in the area during construction would move into adjacent range, where their survival would depend on the size and quality of the range. In addition, goats would be unable to cross the Bradley River near the lake outlet; any goats on the south side of the river would be isolated from the winter range to the north. It is likely that suitable winter range exists south of the river, because goat herds have been documented both north and south of the Bradley River adjacent to the project area (Holderman, 1983). This effect should be short term, because the facility design incorporates a corridor for goats to cross the river. It is expected that use of the corridor would increase as goats become accustomed to the presence of the dam.

Harbor seals, river otters, and small furbearers would not be significantly affected by operation of the dam because of the minimum flow releases, which are intended to protect fisheries. Beaver would gain improved habitat conditions, in fact, because high flows currently limit beaver distribution along the lower portions of the river.

Middle Fork Diversion

The Middle Fork diversion, located 1 mile north of the lake, would include a small dam, a spillway, and two buried diversion pipelines. Construction would occur from April through September, and materials and equipment would be transported by helicopter to the site.

Construction would most likely interfere with the nesting and the brood-rearing of ptarmigans and passerine birds. The construction of the diversion lines from Middle Fork to Marmot Creek would displace moose and would potentially disrupt their spring migration between the Fox River and Kachemak Creek. The shrub tundra and alder vegetation, that provide food and cover for moose would be disturbed during construction and would revegetate slowly because of the alpine climate of the site.

Mountain goats use the site during the summer and would be driven to adjacent range due to the construction noise and helicopter traffic. Goat summer range, however, is fairly extensive and goats are in relatively good condition during summer months. During operation, the diversion lines would not restrict goat movement because the lines would be buried.

Nuka Glacier Flow Diversion

Construction would involve blasting, movement of soil and rock, and the use of helicoptors and would last for 2 weeks.

Because of the short time frame, short-term disturbances are not expected to significantly affect wildlife species. No important habitats would be affected in this area. Goats have been observed on the mountain slopes above the glacier, and moose feed in the upper Bradley River; both species would avoid the area during construction.

During operation, flows in the upper Bradley River would be increased into the reservoir and flows on the Nuka River would be decreased. Because the area is largely unvegetated, the change in water regime is not expected to have a significant effect on wildlife habitat.

Reservoir Operation

The reservoir would begin filling in March and would reach 1,180 feet in elevation by October, inundating 2,577.5 acres that would include 1,230 acres of herbaceous wetlands, 800 areas of low willow, and 367 acres of tall alder. The water level would fluctuate by 60 feet annually.

As water levels rise in the winter, wintering birds would be displaced from the willow and alder thickets around the lake to higher elevations or to adjacent areas. Water levels would rise by about 25 feet during May and June, when ptarmigans and passerine birds would be nesting, resulting in the inundation of any nests within the zone. Eventually, the willow and alder below 1,180 feet would be eliminated by the mechanical disturbance of the ice and by flooding during the growing season, and this zone would be eliminated as a nesting habitat.

The inundation of the wetlands in the Kachemak Creek-Upper Bradley River area would eliminate approximately 1,610 acres of high-quality, spring-to-early-summer, moose range and fair-to-good quality winter range, a significant loss. The highest count of moose in this area, made during a recent survey (Woodward-Clyde Consultants, 1984a) was 13 in November 1983. Displaced moose could move into the Fox River valley or the Nuka River Valley. The Fox River Valley would most likely support the displaced population; the Fox River Valley experiences its highest use from late November to late December, but appears under-utilized during the rest of the year (Woodward-Clyde Consultants, 1984a). The Nuka River Valley would also be able to support additional moose, but the valley is relatively isolated, which accounts for the current low density of moose there. Because tracks were observed on the slopes of the Kachemak Creek and the Upper Bradley River Valleys above the maximum reservoir elevation, it is probable that the reservoir would not impede the movement of moose into or out of the Nuka River Valley (Woodward-Clyde Consultants, 1984a).

The reservoir is not expected to impede the movement of mountain goats which are not normally found in the zone that would be flooded.

The loss of the herbaceous wetlands in the inundation zone would affect the black bear and the grizzly bear. The loss would be significant, because the Kackemak flats provide a habitat, scarce in the area, where bears can feed on grasses and forbs in the early spring.

Inundation of the wetland areas would eliminate the beaver that inhabit this area. Four beaver lodges are known to occur in the proposed inundation zone.

Small mammals would be locally affected and wolves, coyotes, foxes, and other predators would largely lose the inundation zone as a potential hunting area. The abundance of these species would decline in the immediate project vicinity.

Powerhouse and Tunnel

The powerhouse and tailrace would be constructed in the tidal flats. The underground tunnel would be excavated from the powerhouse, through the mountain, and to the lake. Construction would involve drilling, blasting, and the use of a tunnel-boring machine. Construction crews would use the excavated material for the airstrip and the access roads. Excavated material from the upper portion of the tunnel would be piled at the waste site near the intake structure.

Blasting would disturb wildlife in the vicinity of the powerhouse during the first 100 to 300 feet of tunnel excavation. The boring machine would continue the rest of the excavation. Blasting would occur during late summer and fall when bird densities are low in this area. The only potentially important disturbance would be to denning black bears in the adjacent coniferous forest.

Passerine birds are the most abundant avian species near the dam and the intake and would most likely be displaced by excavation in this area. Construction would also displace any moose, bears, small mammals, fox, coyote, and wolves. The effect would be short-term, and the loss of habitat would be minimal. Mountain goats, distributed throughout the higher elevations, are not expected to move out of the area because of the short-term nature of the disturbance.

Operation of the underground tunnel would not significantly affect wildlife populations. The presence of the powerhouse would not substantially impede the movement of moose through the tidal areas. This site does not constitute important moose feeding or calving habitat (Alaska Power Authority, 1984d).

Transmission Line

The transmission line would be approximately 20 miles long. Most of the 762-acre right-of-way would pass through coniferous forests, totalling approximately 530 acres. Construction would occur between October and May. Helicopters would transport materials except in the Fox River Valley, where tracked vehicles would be used. Construction crews would remove slash in areas where wildlife movements could be impeded. Slash disposal techniques, acreages of cover types affected, and acreages of commercial timber are discussed in Section 4.1.6.1.1., Vegetation.

Helicopters, noise, and construction activities would displace local passerine birds and raptors in the forested areas of the right-of-way and would displace waterfowl, shorebirds, and raptors in the wetland areas near the powerhouse and in parts of the Fox River Valley.

The transmission lines would pose a long-term collision hazard to birds, including waterfowl and raptors. The flight intensities of migratory waterfowl are generally low enough, however, that mortality would not significantly affect resident or migratory avian populations. Resident dabbling ducks that breed near the transmission lines would most likely suffer the highest mortality. An average of 83 percent of the dabblers, observed near the proposed transmission-line corridor during the spring and summer surveys, flew at or below transmission line height. Many were observed in courtship pursuits, which could distract the ducks from seeing and avoiding transmission lines. Factors that affect actual mortality rates include the visibility of the line; the experience of the resident population with the line; the behavioral characteristics of the species; the flight speed of the species; and disturbance or distraction factors, caused by hunters, boats, and aircraft (Thompson, 1978).

Raptor electrocutions on powerlines are largely determined by the behavioral characteristics and the size of the species and the design characteristics of the transmission facility, specifically the distance between phase and ground wires (Olendorff et al., 1981). Sharpshined hawks and goshawks generally perch in the shelter of trees and rarely perch on powerlines or poles. Red-tailed hawks commonly perch on powerpoles. Small raptors are unable to span the distance between phase and ground wires (Olendorff et al., 1981). Bald eagles are the largest raptor species in the project area. The electrocution hazard to eagles and other raptors would be minimized by spacing the lines 15.5 feet apart and by designing the system without an overhead ground wire (Alaska Power Authority, 1984d).

Construction noise would temporarily displace local wildlife populations. Grizzly bears would be displaced from spring feeding areas where the transmission line crosses the Fox River flats. Denning black bears would be displaced where the line crosses through closed coniferous forest habitat.

In general, the long-term effects of the transmission line right-of-way would be beneficial to local mammal populations. The Applicant would maintain the corridor in an early successional shrub stage. Local bear populations, as well as other fruit-eating mammals and birds, would benefit from an increased fruit production of some shrub species. The increased availability of shrub species would also improve moose range in the forested areas along the corridor. The degree of benefit largely depends, however, on the species composition of the forest understory before the overstory spruce is cut. The chief understory component in much of the closed conifer forest is alder, which is not a preferred browse species. The highest quality browse would regenerate in the mixed, spruce-balsam poplar and deciduous stands.

4.1.6.2 Mitigative Measures Proposed

4.1.6.2.1 Vegetation

The adverse effects of road dust would be minimized by spraying the roads with water. Water would not be taken from active fish streams such as Battle Creek or the Martin and Bradley Rivers.

Roads in the upper tidal areas, other than in the containment basin area, would be located along the toe of the uplands to minimize impacts to tidal wetlands. Disturbed sedge-grass areas would be revegetated using native species. The Applicant would develop erosion-control techniques (including detailed revegetation plans) and drainage structure designs in conjunction with the relevant agencies and would finalize the techniques during the final design stage of the project. Proper culvert installation would prevent dewatering or the impoundment of project area wetlands. The pond crossing near the upper camp would include oversized culverts and an embankment of clean rock fill.

The lower project roads would be open to the public. The use of all-terrain vehicles would only be permitted on maintained project roads, however, to protect the saltwater herbaceous sedge-grass community within the Kachemak Bay Critical Habitat Area and the Fox River Flats Critical Habitat Area.

Impacts to the remaining sedge-grass communities in the vicinity of the barge basin would be minimized through the safe handling of petroleum products. The Applicant proposes to develop a "Spill Prevention and Contamination Countermeasures Plan" prior to construction.

The confined dredged material disposal site would be developed as a freshwater wetland. Precipitation and natural drainage would provide the source of fresh water for the site. Salt-tolerant plant species would be used for revegetation because of the initial leaching of salts from the dredged material. Salt leaching is expected to diminish over time because of fresh water infiltration. The selection of plant species would be coordinated with the ADF&G and the Alaska Department of Natural Resources' Plant Material Center (Alaska Power Authority, 1984c).

The impacts of dust on vegetation from the operation in the lower camp, at maintenance buildings, and in the upper camp would be minimized by spraying water. Work crews at the lower camp and at maintenance buildings would store fuel underground to prevent spills. Organic soils from clearing activities and road construction would be stockpiled adjacent to the lower camp (Alaska Power Authority, 1984d), and would be used to rehabilitate and to revegetate the lower and upper camp areas after the camp facilities are removed. Waste disposal areas would be covered with 24 inches of soil, graded for drainage, and revegetated.

The Applicant proposes to maintain the transmission line right-of-way in wooded areas by mechanical methods and to avoid the use of herbicides. The Applicant further proposes several practices to lessen the impacts from transmission line construction in wetland areas. Sensitive wetland and riparian areas would be accessed by helicopter or by rubber-tired, low-ground-bearing-pressure vehicles. Tracked-vehicles would be used only on frozen ground within the wetland areas (Alaska Power Authority, 1984d).

4.1.6.2.2. Wildlife 1/

The Applicant proposes to regrade and revegetate the 1.5-mile-long temporary road to the Martin River borrow area with native sedge and grass species. This mitigative action would aid in restoring the site as habitat suitable for feeding by waterfowl.

The Applicant proposes to construct the 44-acre dredged disposal area as a freshwater marsh for waterfowl mitigation. Material would be pumped in by hydraulic dredge. After the site is dewatered, the Applicant would grade and contour the site to create several shallow water areas and an approximate total of 2.5 acres of islands and peninsulas, which would be suitable for waterfowl nesting (Figure 4-2). The site would be designed to minimize nest predation, the islands, for example, would be constructed at a sufficient distance from the shoreline to decrease the probability of mammalian predators reaching them (Alaska Power Authority, 1984d). This mitigative plan is intended to offset the loss of the 44 acres of feeding habitat, which now exists at the proposed disposal site, and the loss of other feeding habitat (from roadways and the airstrip) by providing nesting and brood-rearing habitat for waterfowl and shorebirds. Nesting habitat is presently very limited in the project area.

To monitor the effects of project construction on eagles, the Applicant proposes to conduct additional field studies to locate, identify, and assess the activity at each bald eagle nest in the pro-

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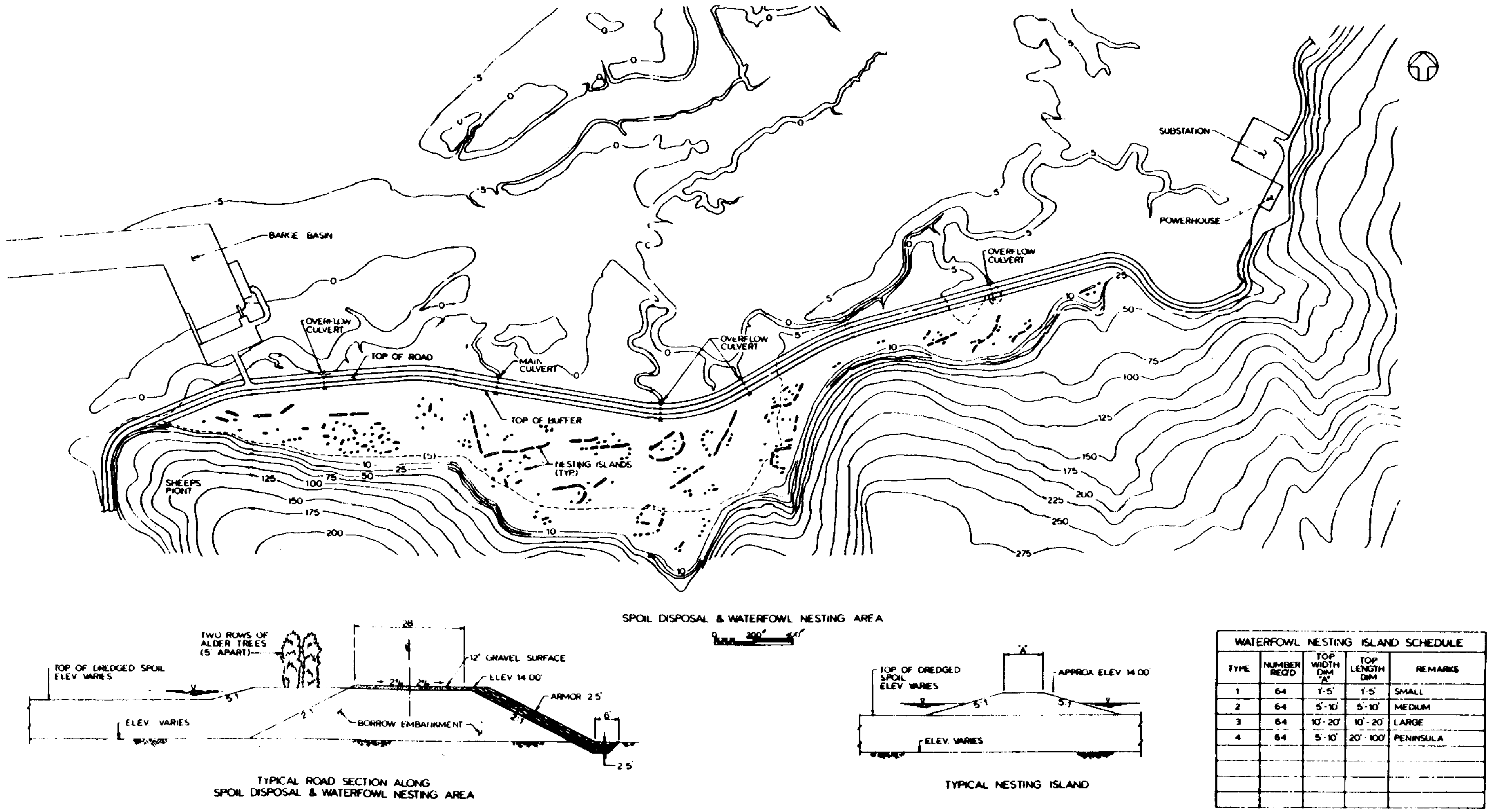
1/ Unless otherwise indicated, the source is Alaska Power Authority, 1984b, Application, Exhibit E.



WATERFOWL NESTING ISLAND SCHEDULE

TYPE	NUMBER REQ'D	TOP WIDTH DIM "A"	TOP LENGTH DIM	REMARKS
1	64	1'-5'	1'-5'	SMALL
2	64	5'-10'	5'-10'	MEDIUM
3	64	10'-20'	10'-20'	LARGE
4	64	5'-10'	20'-100'	PENINSULA

Figure 4-2. Proposed waterfowl nesting area (Source: Alaska Power Authority, 1984 b, Application, Exhibit E).

ject area. The methodologies and study parameters would be developed in consultation with the FWS (Alaska Power Authority, 1984d).

When possible, the Applicant proposes to schedule blasting to avoid or to minimize impacts to wildlife. This includes the potential to schedule daily blasting to coincide with low tides, when waterfowl and shorebirds are farthest from the construction sites (Alaska Power Authority, 1984d).

Proposed mitigation for the airstrip includes: (1) limiting construction and aircraft landings and takeoffs during high tides, when waterfowl are most likely to be concentrated near the powerhouse area; and (2) developing the proposed waterfowl nesting area (dredged disposal site). The expected benefits of the mitigation site over the wetlands lost to project construction are that the mitigation site would be a freshwater wetland, which would be unaffected by tides and would be suitable for nesting.

The Martin River delta borrow area would be rehabilitated to provide vegetated islands and shallow water zones. This rehabilitation would provide additional potential habitat for waterfowl and shorebirds. If fish utilize the ponds, additional feeding habitat would become available to eagles.

Personnel occupying the lower and upper camp sites would not be permitted to hunt during the construction period. After construction, the temporary facilities would be removed, leaving only the permanent facilities in the lower camp areas to accommodate four families.

A travel corridor would be constructed in conjunction with the Bradley Lake Dam. This feature is intended to eliminate the obstacle to seasonal mountain goat movements that would occur from the presence of the dam. The Applicant would prohibit construction personnel from harassing mountain goats by airplane or from the ground (Alaska Power Authority, 1984d).

Proposed mitigation for building the transmission line includes a design to prevent raptor electrocution, the disposal of cut trees from areas where slash might impede wildlife movements, and mechanical maintenance that would avoid the use of herbicides. Maintenance of the transmission line corridor would provide more available browse for moose and would partially compensate for moose habitat losses at the reservoir site.

4.1.6.3 Unavoidable Adverse Impacts

The removal of approximately 3,352 acres of vegetation for the construction and operation of the project would be unavoidable. Total affected acreage for each plant community is given in Table 4-5. The reservoir and transmission line account for the greatest portion of unavoidable acreage losses of the existing plant communities.

The acreage losses within the saltwater sedge-grass community includes approximately 7 acres for construction of the project airstrip within the Fox River Critical Habitat area. This loss would be unavoidable because alternative airstrip sites are either infeasible or would be more environmentally damaging.

The generation of dust from construction and from the heavy use of the access roads would be unavoidable. Dust would accumulate on vegetation adjacent to the roads and construction sites and would reduce herbaceous cover to a minor degree. This would be a short-term effect.

Airstrip and road construction in the tidal flats would decrease waterfowl and shorebird feeding habitat and would disturb those species during seasonal staging in the area. The airstrip would occupy a portion of the Fox River Flats Critical Habitat Area. The airstrip and barge basin would significantly improve hunter access to the wetland areas and would increase the hunting pressure on waterfowl within the state-designated critical habitat area and in the adjacent wetlands in the Upper Kachemak Bay.

Quarrying and construction of the dam, roads, camps, and other facilities within forested areas would disturb denning black bears and would cause raptors, moose, wolves, foxes, wolverines, and other forest species to avoid these areas. The lower camp would displace approximately 37 acres of balsam poplar, which provides winter habitat for moose and reproductive habitat for cavity-nesting birds. Construction of the dam would also affect mountain goats, which concentrate near the Bradley River and Sheep Creek area during late autumn and winter. Construction noise and activity would cause goats to move to adjacent range. Goats normally cross the Bradley River in the vicinity of the proposed dam. Construction would temporarily block the passage of the goats between ranges north and south of the Bradley River.

Reservoir operation would flood 2,577.5 acres, which would include 1,230 acres of herbaceous wetlands and 800 acres of low willow. These cover types provide high quality spring and summer range for moose and are not abundant in the project area. The loss of herbaceous wetlands would also remove spring feeding habitat for black bear and grizzly bear. The reservoir would displace four known beaver lodges and would eliminate the inundation zone as nesting habitat for ptarmigans and passerine birds. Loss of the terrestrial and wetland habitat within the inundation zone would also reduce the quantity and variety of small mammal habitat and of hunting habitat for mammalian predators and raptors within the project area.

Construction of the transmission line would disturb denning black bears and other species over a 20-mile-long, linear area. The transmission line would be located mainly within coniferous forests. Long-term impacts would include transmission line collisions by birds, especially dabbling ducks.

4.1.7 Threatened or Endangered Species

The Corps (1982) conducted a biological assessment of the potential effects of the proposed Corps' project on the peregrine falcon. The assessment states that potential nesting habitat (open, rugged terrain) exists only in the areas of the proposed dam, spillway, and Middle Fork diversion. Site surveys revealed no peregrine nesting activity. The observations of the six peregrines by FWS biologists in 1980 were made during migration; no peregrines were sighted during the breeding season. The Corps therefore concluded that the project would not interfere with peregrine nesting. In addition, the potential loss of habitat suitable for hunting by peregrines was considered insignificant in relation to the amount of suitable habitat in the region. The biological assessment concluded that the proposed Corps' project would not adversely affect the peregrine falcon. FWS concurred with the findings of the biological assessment. 1/

There are few significant differences between the Corps' proposed project and the current proposal. Thus, the proposed Alaska Power Authority project would have no significant effect on the peregrine falcon.

4.1.7.2 Mitigative Measures Proposed

The Applicant has proposed no mitigative measures.

4.1.7.3 Unavoidable Adverse Impacts

No unavoidable adverse impacts to Federally listed threatened or endangered species or to critical habitat are anticipated.

4.1.8 Recreation and Land Use

4.1.8.1 Beneficial and Adverse Impacts

Hunting opportunities for waterfowl and big game, primarily moose and mountain goat, would be adversely affected by project construction and operation. The game populations would be displaced from the areas of immediate disturbance, and the small moose population would probably be reduced through a loss of habitat. These impacts and mitigation proposals are discussed in the pertinent sections on terrestrial resources. Hunting by construction personnel would be prohibited, and hunting activity by others would be restricted for safety reasons. These reduced hunting opportunities are expected to extend over a period of approximately three years.

1/ Letter from Jon M. Nelson, Assistant Regional Director, Alaska Regional Office, U.S. Fish and Wildlife Service, Anchorage, Alaska, May 19, 1982.

The project features, including the barge basin, the airstrip, the project roads, and the transmission line rights-of-way (ROW) would improve access for hunters in the project area. For a number of reasons, however, including the limited number of moose in the project area, the availability of other hunting areas with good success rates on the Kenai Penisula, and the existing lack of hunter interest in the Bradley Lake area, it is not expected that improved access would result in increased moose-hunting pressure. Also, mountain goat hunts are controlled by a permit system. The improved access might encourage more hunters to try the Bradley Lake herd, but there should be little change in the populations under such a controlled situation. The improved access afforded by the barge basin and airstrip could increase hunting pressure on the waterfowl populations in the area.

Sport fishing is not a significant activity in the area that would be affected by the project, because of the poor availability of fish. The proposed mitigative plan could result in improved conditions for salmonid production; however, the generally excellent sport fishing opportunities available throughout the Kenai Peninsula, contrasted with those available in waters affected by the project, indicate that fishing activity in the project area would be limited to anglers in the vicinity for reasons other than only fishing.

The project would alter the undeveloped character of the recreational setting. Recreational use that depends on a natural environment, such as wilderness camping, would be directed to other locations on the Kenai Peninsula. Since such use of the Bradley Lake area is relatively limited in terms of numbers of users, other lands should be able to absorb any increase in visitors who decide to stop using the project area. Conversely, a number of recreationists would be attracted to the area to view the project and to take advantage of the improved access to the Bradley Lake Basin. In terms of numbers of users, such induced demand for public use at the project is not expected to be significant.

The project would be constructed on lands identified for hydropower development, but would conflict with the use of other lands reserved or managed for other purposes. The powerhouse, the tailrace and the airstrip would intrude into the Fox River Flats Critical Habitat Area, designated as a waterfowl and shorebird staging area by the State of Alaska. The state has agreed to this use of the lands subject to restrictions on aircraft use during the spring waterfowl staging period from April 15 to May 15. 1/ The alignment of the transmission line ROW across state-managed public interest lands appears to conflict with a number of leases and dedications

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1/ Letter from Robert L. Grogan, Alaska Office of Management and Budget to Roy Taylor, Alaska Power Authority, December 11, 1984.

to public purposes such as future road construction. The proposed alignment appears to avoid private property. The state has agreed to resolve any potential conflicts during the issuance of the required state permits. 1/

4.1.8.2 Mitigative Measures Proposed

The Applicant has proposed the recreational development described in Section 2.1.2.7 to provide for any recreational demand induced by construction and operation of the project; the Applicant has agreed to work with the state in resolving any potential land-use conflicts along the transmission line ROW.

4.1.8.3 Unavoidable Adverse Impacts

The natural undeveloped recreational setting of the Bradley Lake Basin would be altered by the presence of the project features.

The powerhouse, the tailrace, and the project airstrip would intrude upon the Fox River Flats Critical Habitat Area.

4.1.9 Visual Resources

4.1.9.1 Beneficial and Adverse Impacts:

The proposed project has area few important scenic viewing areas. The size of the project and the vastness of the area impacted would allow only small portions of the project to be seen from any roads or recreation areas, existing or proposed. When within view, those portions of the project that would be seen would be dwarfed by the surrounding area. This low viewing sensitivity could increase as access to the area is made easier by project development, but it would not increase beyond a moderate level.

The countryside in Alaska, however, is viewed most often from the air. This panoramic view of many unobstructed miles would make the repetitive qualities of the access road and the transmission line corridors more significant than when viewed from the ground. The impact caused by the cleared vegetation for the access road would be minor because of the narrow width and curvilinear route which generally follows the natural topographic contours. The cleared vegetation and support structures of the transmission line would have a more significant adverse impact. The corridor would consist of: a 225-foot-wide clear-cut and an additional 100 feet of selective cutting on either side of the clear-cut; a length of over 20 miles,

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1/ Letter of Comment from the Alaska Office of Management and Budget, Attachment I, p. 3, September 28, 1984.

with straight-line segments up to 5 miles is length; and sharp angles, regardless of topographic forms or vegetative patterns. The total clear-cut area would be approximately 545 acres. The wood support structures would be located at approximately 1000-foot intervals. The proposed transmission line would degrade the visual quality of the area and would contrast strongly with the natural character of the area when seen from the air.

4.1.9.2 Mitigative Measures Proposed

The Applicant does not consider visual impacts to be significant enough to require specific mitigation. Some mitigation is included in the overall project proposal, however. This would include: the removal of construction-related facilities and the rehabilitation of those areas impacted by the construction camp, the Martin River haul road and borrow pit, and the dredge spoil-disposal site; the design of project facilities to blend with the forest setting, and to be set back from the tidal flats to reduce contrast with the surroundings; and the use of colors and building materials to reduce reflection and to blend with the natural landscape.

4.1.9.3 Unavoidable Adverse Impacts

The project facilities at the lake and on the bay would have a minor impact on the visual quality from the ground; the limited population and land use and the vastness of the area would provide some mitigation to make those impacts acceptable. The transmission line, however, would create a significant impact to the visual quality when viewed from the air.

4.1.10 Cultural Resources

4.1.10.1 Beneficial and Adverse Impacts

Two historic fox-fur farms are located near a proposed access road and the proposed transmission corridor, but would not be directly impacted by construction or operation of project facilities. The farms, however, could be affected by acts of vandalism, the potential for which would increase with the influx and maintenance of personnel in the area for construction and operation of the project.

Any archeological or historic sites discovered during construction could also be impacted by the project.

4.1.10.2 Mitigative Measures Proposed

The Applicant has proposed the following measures to avoid impacts to the fox-fur farms, to avoid vandalism, and to protect any archeological or historic sites discovered during construction (Woodward-Clyde Consultants, 1984b). (1) The fox-fur farms would be designated "off-limits" to all personnel associated with the construction and operation of the Bradley Lake Project. Entry into the "off-limits" area would be grounds for immediate employment termination. (2) The personnel associated with construction and operation would be monitored by the Applicant's environmental field officer to enforce the "off-limits" regulations. (3) Should there be an emergency discovery found during construction, a management plan would be prepared in compliance with the historic preservation guidelines of the Department of the Interior and the State of Alaska.

4.1.10.3 Unavoidable Adverse Impacts

No such impacts should occur.

4.1.11 Socioeconomic Factors

4.1.11.1 Beneficial and Adverse Impacts

The project's major socioeconomic impacts would occur during the proposed 33-month construction period, when an average of 242 persons would be employed at the project site. Because almost all construction machinery and materials would be purchased from outside the Kenai Peninsula Borough, expenditures for these items would not impact the local economy.

The number of all on-site personnel would range from 19 to 406, averaging 242 workers. As shown in Table 4-6, employment would be seasonal in nature, with peak levels occurring from May through August. These manpower estimates are based on the assumption that personnel would work 60 hours per week (i.e., a 10-hour daily shift and 6 days per week). Project construction would require approximately 8,000 man-months of onsite labor and would generate wages and salaries totaling $50 million in 1984 dollars (Alaska Power Authority, 1984b, Application, Exhibit E). The numbers of onsite personnel are significantly greater than the labor force projected by the Corps in its FEIS because the Corps' project involved a considerably longer (6-year) construction period. The Corps' projected peak number of onsite personnel was significantly less (250 persons).

Although the project site would remain inaccessible by vehicle, the proposed onsite landing strip would permit small passenger planes to transport personnel. The Applicant indicates that daily scheduled flights between the Homer Airport and the construction site airfield would be initiated by a local air service, and that the price of a one-way ticket would be approximately $20 (Alaska Power Authority, 1984c). Because few workers would be willing to pay $40 per day to commute to and from the project site, the Applicant has proposed to provide dormitory-style housing for all onsite personnel. Current plans call for two separate construction camps with a total of 450 beds. Each camp would include: modular sleeping quarters that accommodate one or two persons per room; bathroom and shower facilities; laundry rooms; a separate, centrally located cafeteria; a first-aid

Table 4-6. Projected number of monthly onsite construction personnel at the Bradley Lake Hydroelectric Project. 1/

Month	Direct construction personnel and camp workers	Contractors' supervisory personnel	Construction management and engineering personnel	Applicant's personnel	Agency personnel	Total number of onsite personnel
March	165	14	17	3	1	200
April	270	18	17	4	2	311
May	300	20	18	5	2	345
June	320	20	20	5	2	367
July	330	20	22	5	2	379
August	320	20	22	5	2	369
September	230	18	24	5	2	279
October	200	18	25	5	2	250
November	155	18	25	5	2	205
December	145	18	25	5	2	195
January	120	24	25	5	2	176
Feburary	155	28	26	5	2	216
March	200	32	26	5	2	265
April	245	32	26	5	2	310
May	300	32	26	5	2	365
June	335	36	26	5	2	404
July	335	38	26	5	2	406
August	290	44	26	5	2	367
September	230	36	26	5	2	299
October	215	30	27	5	2	279
November	210	24	27	5	2	268
December	195	24	28	5	2	254
January	185	24	25	5	2	241
February	180	24	25	5	2	236
March	170	22	25	5	2	224
April	155	20	26	5	2	208
May	150	18	26	5	2	201
June	120	18	26	5	2	171
July	20	12	16	5	2	55
August	15	10	15	5	2	47
September	10	8	14	5	2	39
October	5	6	10	5	2	28
November	5	4	6	3	1	19

1/ Source: Alaska Power Authority, 1984b, Application, Exhibit E.

room; recreation rooms; and a small store that would sell newspapers, magazines, work clothing, laundry supplies, and snack foods. Construction workers would not be charged for room or board. Consequently, virtually all onsite workers are expected to reside at the project site.

The self-contained nature of the construction site, the 6-day work week, and the expense of flying to Homer would minimize the project's socioeconomic impacts. Spending by project personnel at retail establishments in Homer on days off-work would benefit proprietors, and could create a few additional employment opportunities. Although 70 to 80 percent of all construction personnel would be hired from outside the Kenai Peninsula Borough, mainly from Anchorage, few workers would relocate their family to the Homer area. Based on experience at comparable projects, Staff projects that the project would result in the in-migration of 40 households at most. Given Homer's recent dramatic population gains, the influx of 40 project-related households would not represent a significant impact.

Following the completion of construction, the project would employ four permanent onsite personnel. These persons and their families would reside in houses constructed at the project site by the Applicant.

4.1.11.2 Mitigative Measures Proposed

The proposed project would not cause any significant adverse socioeconomic impacts, and consequently, mitigative measures have not been proposed.

4.1.11.3 Unavoidable Adverse Impacts

The proposed project is not expected to produce any significant unavoidable adverse socioeconomic impacts.

4.2 ALTERNATIVE PROJECTS

4.2.1 Combined-cycle Generation Alternative

4.2.1.1 Geology and Soils

Excavation and other soil-disturbing activities during construction would result in increased soil erosion. More erosion would occur on the steeper slopes near the Chuitna River than on the flatter topography near the Beluga River. Implementation of erosion prevention programs, however, would be expected during project construction, as would regrading, revegetation, and other site-restoration measures designed to prevent erosion during project operation.

4.2.1.2 Aquatic Resources

Construction of a 200-MW, combined-cycle plant in the western Cook Inlet area would likely result in adverse impacts on water quality in water bodies close to construction areas. The number of water bodies and wetland areas affected by construction of the project, the access facilities, and the construction camp could be significant, depending on the specific site. Increased sedimentation and turbidity in these water bodies would be likely, and would adversely affect benthic communities and fish populations.

Operational impacts are expected to be minor, since the facility would require only a minimal supply of water (less than 2 cfs per generating unit). Localized impacts on water quality could occur because of increased dissolved solids in the cooling system discharge. An indirect, but serious, impact of the development of this alternative in remote areas would be the increased accessibility of nearby fishery resources resulting from the new access roads and airfield. This could result in increased fishing pressure on streams that have never supported a significant sport or subsistance fishery, and in turn could place an additional source of mortality on fish populations in these streams.

4.2.1.3 Terrestrial Resources

Because no specific site has been selected for a combined-cycle plant, any impact analysis is speculative and cursory. Several general conclusions, however, can be drawn. The plant would require access roads, transmission lines, camp facilities for 400 people, and an airstrip. Construction of these facilities would require the substantial removal of forest vegetation and the filling of sedge-grass wetlands. Blasting and the operation of heavy equipment would displace moose and disturb denning black bears. Construction in the wetland areas would displace staging waterfowl. The airstrip would increase hunter access to the area in the long term.

4.2.1.4 Threatened or Endangered Species

No specific site has been selected for a combined-cycle alternative, so any impact analysis is speculative and cursory. If the peregrine falcon information for the Bradley Lake area (Section 4.1.7) can be considered valid for the surrounding area, it is unlikely that an endangered subspecies would be significantly affected by development.

4.2.1.5 Socioeconomic Factors

Construction of a gas-fired, combined-cycle alternative located in the western Cook Inlet area would have impacts similar to those of the proposed hydroelectric project. Because personnel would reside in a self-contained construction camp, impacts would be relatively minor, consisting of spending by off-duty workers at retail stores and at personal service establishments in Kenai. This alternative would employ 30 permanent operations and maintenance workers who either would be provided onsite housing or free commuting between the project and Kenai. Their salaries and spending would represent a favorable impact on the Kenai economy.

4.2.1.6 Visual Resources

The combined-cycle alternative would have varying visual impacts, based on the length of any pipeline and the transmission lines. If the power plant could be located near the fuel source, impacts could be negated and might be equal to those one of the proposed Bradley Lake Project.

4.2.1.7 Cultural Resources

Impacts to cultural resources would probably be limited. Most impacts to significant sites likely would be avoided or mitigated through data-recovery investigations. Site-specific surveys and significance assessments would be necessary to determine the extent of the required protection measures (FERC, 1984).

4.2.1.8 Air Quality and Noise

Construction activities would result in localized increases in noise levels and dust, which would subside upon completion of construction. Project operation would result in small increases in various air pollutants close to the project, including nitrogen oxides, sulfur dioxide, and total suspended particulates. Air quality standards, however, would probably continue to be met. Impacts on noise levels in the area would also be minor, provided a buffer zone of at least 0.5 to 1.5 miles is provided between the plant and any noise-sensitive areas.

4.2.2 Coal-fired Generation Alternative

4.2.2.1 Geology and Soils

Increased erosion that would occur during construction would be minimized by the relatively level terrain. The project would be affected by the thawing of permafrost. Approximately 15 acres of land per year would be disturbed by the surface mining of coal for the plant. Impacts from surface mining would include modification of surface drainage and topography, slope failures from excavation, increased sedimentation and wind erosion of soils from spoil piles, and permafrost thawing resulting from vegetation stripping (FERC, 1984).

Implementation of erosion prevention programs would be expected during construction of the plant, as would regrading, revegetation, and other site-restoration measures designed to prevent erosion during project operation. Appropriate erosion, sediment, slope stability, and dust control measures would be expected to be utilized during surface mining operations. These would also be expected to include appropriate measures for temporary stockpiling of stripped topsoil and for regrading, revegetation, drainage control, and other measures for the immediate restoration of stripped lands.

Minor erosion and permafrost impacts would be unavoidable at the plant site during construction. Minor, continuing erosion, sedimentation, and windblown soil losses would be unavoidable during surface mining and would require the restoration of stripped lands.

4.2.2.2 Aquatic Resources

Construction of a 200-MW, coal-fired project on the Tanana River in the vicinity of Nenana would likely result in adverse impacts on water quality in water bodies and wetlands potentially affected by construction of the project, the access facilities, and the construction camp, but would depend on the specific project site selected. Construction activities would likely result in adverse effects on benthic communities and fish populations.

Operation of a coal-fired project on the Tanana River would likely have only minor impacts on water quality and aquatic resources. A 200-MW project with closed-cycle cooling (cooling towers) would have a consumptive water use of only 4 cfs, with makeup water being required only during the months of June, July, and August. This minimal withdrawal would have an imperceptible impact on flows or aquatic resources in the Tanana River. Because a closed-cycle cooling system would be used, thermal impacts to the Tanana River would be negligible. Localized impacts on water quality could occur from cooling system blowdown, the discharge of chemical cleaning solutions, ash pond overflow, and coal pile drainage.

A long-term impact of this alternative, if constructed in a remote area, would be the increased accessibility of nearby fishery resources from the new access roads and airfield. This could result in increased fishing pressure on streams that have never supported a significant sport or subsistence fishery, and in turn could place an additional source of mortality on fish populations in these streams.

4.2.2.3 Terrestrial Resources

Construction of a coal-fired facility would include access roads, transmission lines, camp facilities for 500 people, and an airstrip. Construction of those facilities would require a substantial removal of bottomland spruce-poplar forest in the Tanana River area. Mining of an upland spruce-hardwood area would be required to support the facility. Mining would create substantial long-term impacts to local wildlife populations because of habitat removal and noise. Species that would be adversely affected by construction and operation of the facility include caribou, brown bear, and waterfowl. Impacts to wintering caribou in the mining areas could be significant.

4.2.2.4 Threatened or Endangered Species

As discussed in Section 4.2.1.4, it is unlikely that alternative developments in the area would significantly affect peregine falcons.

4.2.2.5 Socioeconomic Factors

Construction of a coal-fired, steam-electric plant in the Nenana area would involve a self-contained construction camp, and therefore relatively modest socioeconomic impacts. Spending by off-duty workers would benefit retail stores and personnel service establishments in the Fairbanks area. This alternative would employ approximately 100 permanent operating and maintenance personnel, whose salaries and spending would represent a favorable impact to the Fairbanks economy.

Installation and operation of a combustion-turbine facility would not have any significant impact on the local economy.

4.2.2.6 Visual Resources

The coal-fired alternative would create the most adverse impact with the mining operation, requiring many hundreds of acres to be committed to coal-mining operations. The location of the power plant and other facilities and the clearing of vegetation for the transmission line corridor would also be highly visible.

4.2.2.7 Cultural Resources

Impacts to cultural resources would probably be limited. Most impacts to significant sites would likely be avoided or mitigated through data-recovery investigations. Site-specific surveys and significance assessments would be necessary to determine the extent of the required protective measures (FERC, 1984).

4.2.2.8 Air Quality and Noise

Construction activities would result in localized increases in noise levels and dust, which would subside upon completion of construction. Project operation would result in some increases in air pollution in the immediate project area, including higher levels of nitrogen oxides, sulfur dioxide, and total suspended particulates. Air quality standards, however, would likely continue to be met. A concern with the siting of a coal-fired plant in the Nenana area would be the effects on the Denali National Park, which is located about 60 miles to the south. A single, coal-fired, 200-MW project at Nenana would not likely violate air quality standards in Denali Park, but could produce a noticeable plume that would be visible from Denali in some conditions (FERC, 1984).

Impacts on noise levels in the area would likely be minor, provided a buffer zone of at least 0.5 to 1.5 miles is provided between the plant and any noise-sensitive area. The major sources of noise would be the coal-handling equipment, the cooling towers, and the transformers.

4.3 NO-ACTION ALTERNATIVE

Denial of a license for the Bradley Lake Project would result in the maintenance of the environmental resources and values of the Bradley Lake Basin and the surrounding areas, as described in Section 3.1.

License denial, however, would force the Applicant to pursue alternative energy sources, which could include the combined-cycle or coal-fired alternatives discussed above. General impacts from these alternatives are described in Section 4.2.

4.4 COMPARISON OF ALTERNATIVES

The no-action alternative, denial of a license for the proposed Bradley Lake Project, would result in no changes in the environmental resources of the Bradley Lake Project area.

Comparison of the proposed Bradley Lake Project, the combined-cycle alternative, and the coal-fired alternative can only be done in a general way, since specific sites for the combined-cycle and coal-fired alternatives have not been identified. Construction of any of these alternatives in a remote, undeveloped area of Alaska, however, would have similar impacts in the areas of geology and soils, water quality, terrestrial resources, recreation and land use, visual resources, and socioeconomic factors. Construction of any large electrical generation project, with associated access roads, construction camps, airfields, transmission lines, and related facilities, in a remote area would: disturb large tracts of land; increase sedimentation and turbidity in water bodies associated with the project; permanently change the land use pattern of the area; increase human access to the area; potentially impact a wide range of vegetative and wildlife resources; and permanently change the visual character of the immediate project area. The severity of each of these impacts would depend on the specific project site, the total area affected, and the importance of the specific resources affected. The provisions of an onsite construction camp for the construction workforce, common to all the alternatives, would result in minimal socioeconomic impacts on nearby communities. Operational impacts of the three alternatives would differ in the areas of air quality and noise, water quantity, aquatic resources, cultural resources, geology and soils, and are discussed below.

4.4.1 Air Quality and Noise

Long-term operational impacts on air quality and noise would differ in that the combined-cycle and coal-fired alternatives would produce air pollutants through the burning of natural gas and coal, while the proposed Bradley Lake Project would not affect air quality during operation. The combined-cycle and coal-fired alternatives would also have a greater long-term impact on noise levels than the Bradley Lake Project, which would have only a relatively low noise level eminating from the powerhouse and transformers. The coal-fired alternative would likely have the greatest impact on noise levels as a result of the delivery of coal by train, and the use of onsite coal-handling equipment. The combined-cycle and coal-fired alternatives would also affect atmospheric conditions in the immediate project area by producing plumes of steam from the cooling towers, which would produce the greatest plumes during the winter months.

4.4.2 Water Quantity

The Bradley Lake Project would have the greatest impact on streamflow patterns of the three alternatives. The project would, in effect, divert the entire outflow from Bradley Lake out of the Bradley River, while the combined-cycle and coal-fired alternatives would have only minimal water supply need (to a maximum of 4 cfs consumptive use). This rate of withdrawal would likely have minimal impacts on any water body used as a water supply source. The Bradley Lake Project would provide for a minimum flow in the lower Bradley River, however, which would protect the more important fishery habitat.

4.4.3 Aquatic Resources

The Bradley Lake Project would have a greater potential for affecting aquatic resources during operation than the combined-cycle and coal-fired alternatives, based on the volume of streamflow to be used by the project. This would depend, however, on the specific sites for the alternative projects, and on whether important resources would be located near the project sites. The proposed minimum flow in the lower Bradley River would protect benthic and fish habitat in the river, and thus may not result in significant losses of fishery resources.

4.4.4 Cultural Resources

The Bradley Lake Project would be located in close proximity to two sites potentially eligible for listing in the National Register of Historic Places. The project, however, would not likely significantly affect these sites. Since specific project locations have not been identified for the combined-cycle and coal-fired alternatives, it is impossible to predict the impacts on cultural resources associated with these projects. Staff assumes, however, that the operators of an alternative project would attempt to avoid any significant cultural resources and to mitigate any impacts to such resources.

4.4.5 Geology and Soils

Operation of a coal-fired project and the associated coal-mining operation would have a greater long-term impact on geologic and soil resources than either the proposed Bradley Lake Project or the combined-cycle alternative. A coal-mining operation would disturb about 15 acres per year for the life of the project, and would result in continued erosion and associated impacts for an equal time period. Neither the proposed Bradley Lake Project nor the combined-cycle alternatives, once constructed, would result in such disturbances for the life of the project.

4.5 RELATIONSHIP TO LAWS AND POLICIES

The evaluation of the license application and assessment of environmental impacts has been conducted in accordance with the National Environmental Policy Act, the Fish and Wildlife Coordination Act, the Endangered Species Act, the Clean Water Act, the Clean Air Act, the Archeological and Historic Preservation Act, the National Historic Preservation Act, and the Coastal Zone Management Act.

4.6 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

4.6.1 Bradley Lake Project

There would be no irreversible or irretrievable commitment of resources associated with the Bradley Lake Project as proposed, other than those materials required for construction. Natural resources such as the terrestrial and wetland habitat occupied by project facilities would, however, be committed for the life of the project.

4.6.2 Combined-cycle Alternative

Construction of the combined-cycle alternative would result in the irreversible and irretrievable commitment of materials used in construction. This alternative would also commit terrestrial and wetland habitat for occupation by project facilities for the life of the project. Project operation would consume a non-renewable resource, natural gas, for the life of the project.

4.6.3 Coal-fired Alternative

The coal-fired alternative would irretrievably commit materials used for construction of the project, would occupy terrestrial and wetland habitat for the life of the project, and would consume a nonrenewable resource, coal.

4.7 SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

Operation of either the Bradley Lake Project, the combined-cycle alternative, or coal-fired alternative would provide dependable electrical power to the Kenai Peninsula area for the life of the project (at least 30 to 50 years), but would be at the expense of environmental resources directly affected by project facilities and operation. Adverse impacts on these resources would be long-term and in fact, permanent, unless project facilities are retired at some future date and are totally removed from the area.

5. STAFF CONCLUSIONS

5.1 SIGNIFICANT ENVIRONMENTAL IMPACTS

5.1.1 Bradley Lake Project

Construction and operation of the proposed Bradley Lake Project would result in the following significant environmental impacts:

(1) erosion of disturbed land areas and increased sedimentation and turbidity in Battle Creek, Martin River, Bradley River, Sheep Creek, and the Fox River;

(2) temporary loss of 115 acres of marine benthic habitat in upper Kachemak Bay;

(3) removal of 3,352 acres of existing vegetation, including inundation of 2,578 acres of terrestrial and wetland habitat by the enlarged Bradley Lake;

(4) disturbance of wildlife usage of affected portions of the tidal wetlands, forested, and other upland areas, to include mountain goat movement and moose migration in the vicinity of Bradley Lake;

(5) disruption of a relatively pristine viewscape by large-scale construction activities, transforming the existing, unspoiled area into one with obvious signs of disturbance by man;

(6) long-term alteration of the flow regime of the lower Bradley River by reducing peak summertime flows and increasing and stabilizing winter low flows;

(7) long-term alteration of the thermal regime of the lower Bradley River, by increasing early-summer water temperatures and decreasing late-summer and fall water temperatures;

(8) alteration of the pattern of freshwater inflow to the Bradley River-Sheep Creek estuary and upper Kachemak Bay, with probable disruption of salmon migration patterns within the estuary; and

(9) permanently opening the Bradley River Basin to human access, subjecting fish and wildlife resources of the basin to long-term, increased harvesting pressures.

5.1.2 Combined-cycle Generation Alternative

Construction and operation of the combined-cycle alternative somewhere in the western Cook Inlet area would result in the following significant environmental impacts:

(1) erosion of disturbed lands areas and increased sedimentation and turbidity in water bodies associated with project construction activities;

(2) loss of large areas of vegetation resulting from the construction of project facilities and associated access roads, construction camp, airfield, and transmission line, with disturbance of wildlife usage of the area;

(3) disruption of a relatively pristine viewscape by large-scale construction activities and placement of project facilities, resulting in permanent alteration of the area to one with obvious signs of man's activities; and

(4) permanently opening the project area to human access, with probable increased hunting and fishing pressure on local fish and wildlife resources.

5.1.3 Coal-fired Generation Alternative

Construction and operation of the coal-fired alternative in the Nenana area of the Railbelt would result in the following significant environmental impacts:

(1) erosion of disturbed lands areas and increased sedimentation and turbidity in water bodies associated with project construction activities;

(2) loss of large areas of vegetation resulting from the construction of project facilities and associated access roads, construction camp, airfield, and transmission line, with disturbance of wildlife usage of the area;

(3) disruption of a relatively unspoiled viewscape, permanently changing the area to one with obvious signs of man's activities;

(4) permanently opening the project area to human access, with probable increased hunting and fishing pressure on nearby fish and wildlife resources;

(5) long-term degradation of air quality in the area because of the release of the byproducts of burning coal, with possible minimal impacts on Denali National Park; and

(6) long-term impacts on land features and use, and water quality, as a result of mining coal for the life of the project.

5.1.3 No-action Alternative

Denial of the license for the Bradley Lake Project would result in the maintenance of the existing environmental resources and values of the Bradley River Basin and the nearby areas.

5.2 MITIGATIVE MEASURES RECOMMENDED BY STAFF AND AGENCIES

5.2.1 Geology and Soils

The Department of the Interior (Interior) has recommended a list of stipulations to be included as binding articles in any project license for the purpose of protecting biological resources. These "Biological Stipulations," included in this statement as Appendix B, include general guidelines for erosion and sedimentation control, the aquisition and deposition of materials (borrow and spoil disposal), the clearing of vegetation, site restoration, and road construction at the project. Interior also recommends that the stipulations become part of project contract agreements. Recommended stipulations for geological and soil resources would be requirements that: (1) the project design provide for control of erosion and the production, transportation, and deposition of sediment in accordance with state water quality regulations (18 AAC 70); (2) specific erosion control methodologies be delineated in a project erosion control plan to be developed by the Applicant and approved by concerned state and Federal agencies before construction; (3) the erosion control plan be incorporated into project technical specifications; (4) a detailed mining plan be prepared for each borrow operation and no materials be removed until mining plans are reviewed and approved by concerned resource agencies; (5) specific restoration and revegetation methodologies be delineated in a project restoration-revegetation plan to be approved by appropriate state and Federal agencies prior to construction; (6) the approved restoration-revegetation plan be incorporated into project technical specifications; and (7) a layout for each proposed road be approved by the resource agencies.

Staff recommends that the Applicant prepare detailed plans to control erosion, sedimentation, and slope stability at the project and at any areas that would be directly or indirectly affected by the project. This would also include any project-related preconstruction and post-construction activities. The plan should include functional design drawings and map locations of control measures, an implementation schedule, monitoring and maintenance programs for project construction and operation, and provisions for periodic review of the plan and for making any necessary revisions to the plan. Appropriate state and Federal resource agencies should be consulted during preparation of the plan, and should also be allowed sufficient opportunity to review the plan after it is prepared.

5.2.2 Aquatic Resources

Resource agencies that commented on the application for license recommended several general mitigative measures for protection of water quality and fisheries resources in the project area. These proposals can be generally grouped into:

(1) measures to prevent or control erosion during project construction;

(2) measures for avoiding impacts during construction;

(3) monitoring programs during project construction and operation; and

(4) mechanisms for modifying mitigative measures during both project construction and operation. (See Appendix B.)

Interior recommended that an interagency team be established, including onsite representation by FERC staff, to resolve issues and design an acceptible mitigative plan.

Staff believes that those measures recommended by the commenting agencies should be implemented. The Applicant, in fact, has already generally proposed to implement many of the measures recommended, although the Applicant has not worked out the final details. A significant mitigative measure, instream flows in the Bradley River, has been agreed to by the Applicant and agencies. Significant remaining issues in regard to water quality and fisheries include the potential temperature changes in the lower Bradley River and the effects of tailrace discharges on the migration of salmon. The extent of these potential impacts can not be determined prior to project licensing, although Staff believes that the impacts would likely be minor. Thus a monitoring program should be implemented to verify if impacts are minor; if impacts are found to be serious, the Applicant would be required to mitigate these impacts.

Potential mitigative measures that could be implemented for fishery resources affected by the above impacts would include:

(1) changes in project operations, such as additional flow releases from the Bradley Lake Dam, or stopping project generation for short periods of time;

(2) structural modifications, such as tailrace barriers; and

(3) compensation measures, such as artifical propagation and release of salmon into the Bradley River.

5.2.3 Vegetation

The Applicant should develop a detailed revegetation plan after consultation with the FWS and the ADF&G. The selection of native species for revegetation should be coordinated with these agencies.

5.2.4 Wildlife Resources

The Applicant should determine the peak seasonal concentration periods and daily concentration periods of waterfowl and shorebirds in the tidal flats and the peak seasonal usage of moose, mountain goats, denning bears, nesting raptors, and other important species to develop periodicity charts for these groups. The Applicant should use these data, in coordination with the wildlife agencies, to develop blasting schedules and other construction schedules so as to minimize disturbance to wildlife species near the construction zones.

The Applicant should develop and conduct an environmental training program for all project field supervisors and personnel to ensure minimal impact to wildlife species and vegetation during construction of the project. The program should include periodic environmental briefings and on-the-job instruction by supervisors. The program should be coordinated with the resource agencies.

All debris resulting from clearing operations that may block or impede wildlife movement, block streamflow, contribute to flooding, or contribute to erosion should be immediately removed. Excavated material from road construction should not be sidecast on roadside slopes that exceed a grade of 10 percent.

5.2.5 Threatened or Endangered Species

If peregrine falcon nesting is observed in the project area, or within peregrine hunting range of the proposed project, the sub-species should be determined by a qualified ornithologist and the Applicant after consultation with FWS, should undertake appropriate measures to protect the species.

5.2.6 Recreation and Land Use

The Applicant's proposals for recreational development and use at the project appear to adequately provide for the initial recreational needs at the project. Staff believes that the Applicant should provide the details of a monitoring program to ensure orderly development of the recreational opportunities at the project as the need occurs.

The Applicant has not yet established management responsibility for project lands and recreational facilities. The management of the lands and facilities would be the responsibility of the Licensee until the management responsibility is assumed by another party. If another party agrees to assume responsibility for management of the project lands and recreational facilities, a copy of any agreement should be filed with the Commission.

The Applicant should consult with the Alaska Department of Natural Resources to ensure that the proposed alignment of the transmission line ROW is consistent with the State's management of the public interest lands. Should any change in the alignment be required, an amendment of the application should be filed with the Commission.

5.2.7 Visual Resources

The Applicant should prepare a comprehensive plan to avoid or to minimize damage to the environment and to protect and enhance the visual, cultural, and related natural resource values of areas that would be affected by the proposed transmission facilities.

5.2.8 Cultural Resources

The Applicant should ensure that construction and permanent operational personnel are prevented from disturbing or vandalizing the two historical fox farms-potentially eligible for listing in the National Register of Historic Places.

5.2.9 Socioeconomic Factors

Since project construction and operation would have minimal impacts on local communities, no specific measures are recommended.

5.3 UNMITIGATED ENVIRONMENTAL IMPACTS

5.3.1 Bradley Lake Project

As previously described, the major impact of construction and operation of the Bradley Lake Project would be the placement of a large electrical generation facility in a previously undeveloped remote area of Alaska. This would result in a loss of important wildlife habitat, some impacts on water quality, increased human access and possible intensified hunting pressure on wildlife populations in the area, and a permanent change in the visual character of the area.

5.3.2 Combined-cycle Generation Alternative

Development of the combined-cycle alternative in a remote area of western Cook Inlet would have unmitigated impacts similar to the proposed Bradley Lake Project, although this alternative would have minor long-term effects on air quality through the burning of natural gas. This alternative would involve the use of a non-renewable energy source.

5.3.3 Coal-fired Generation Alternative

Development of the coal-fired alternative in a remote site in the Nenana area of the Railbelt would have unmitigated impacts similar to those described above for the Bradley Lake Project and the combined-cycle alternative. This alternative, however, would have long-term effects on air quality through the burning of coal, and would require the long-term disturbance of land areas by the mining of coal. This alternative would also involve the use of a non-renewable energy source.

5.4 STAFF RECOMMENDATIONS ON ALTERNATIVES

Based on the consideration of the long-term environmental impacts, economic factors, and long-term energy needs, Staff believes that the proposed Bradley Lake Project would be the preferred alternative for meeting the electrical energy requirements of the Kenai Peninsula area of the Alaska Railbelt for the period beginning in the late 1980's.

6. LITERATURE CITED

Alaska Power Authority. 1983. Application for license for a major unconstructed project, the Susitna Hydroelectric Project, FERC No. 7114, Alaska, filed February 28, 1983.

____________________. 1984a. Response to the Commission's draft environmental impact statement for the proposed Susitna Project, FERC No. 7114, Alaska, filed August 23, 1984.

____________________. 1984b. Application for license for a major unconstructed project, the Bradley Lake Project, FERC No. 8221, Alaska, filed April 4, 1984.

____________________. 1984c. Additional information in support of the application for license for the proposed Bradley Lake Project, FERC No. 8221, Alaska, filed September 21, 1984.

____________________. 1984d. Responses to agency comments on the application for license for the proposed Bradley Lake Project, FERC No. 8221, filed November 13, 1984.

Bailey, T.N., A.W. Franzman, P.D. Arneson, J.L. Davis, and R.E. LeResche. 1976. Kenai Peninsula moose population identity study. Alaska Department of Fish and Game. Final report. P-R project W-17-2 through W-17-7. Job no. 1.7R. Cited in Alaska Power Authority, 1984b.

Bell, M.C. 1973. Fisheries handbook of engineering requirements and biological criteria. Fisheries-engineering research program. Department of the Army, North Pacific Division Corps of Engineers, Portland, Oregon.

Bureau of the Census. 1982. 1980 census of population, number of inhabitants, Alaska. Table 4, population of borough and census area subdivisions. Department of Commerce.

Bureau of Economic Analysis. 1984. Regional economic information system. Table 25, unpublished. Department of Commerce.

Corps of Engineers. 1982. Bradley Lake Hydroelectric Project, Alaska, Final Environmental Impact Statement. Department of the Army, Alaska District Corps of Engineers, Anchorage, Alaska. August 1982. 184 pp. with appendices.

Everett, K.R. 1980. Distribution and properties of road dust along the northern portion of the haul road. In: Brown, J., and R.L. Berg (eds.), Environmental engineering and ecological baseline investigations along the Yukon River-Prudhoe Bay Haul Road. Department of the Army, Alaska District Corps of Engineers. CRREL report no. 80-19. Cited in Alaska Power Authority, 1984b.

Federal Energy Regulatory Commission. 1984. Draft environmental impact statement, Susitna Hydroelectric Project, FERC No. 7114, Alaska. Washington, D.C. May 1984.

Fish and Wildlife Service. 1981. Appendix B: Bradley Lake Hydroelectric Project, Homer, Alaska. Final Coordination Act Report. U.S. Fish and Wildlife Service, Western Alaska Ecological Services, Anchorage, Alaska. 131 pp. Department of the Interior. In: Corps of Engineers, 1982.

Graybill, J.P., R.L. Burgner, J.C. Gislason, P.E. Huffman, K.H. Wyman, R.G. Gibbons, K.W. Kurko, Q.J. Stober, T.W. Fagnan, A.P. Stayman, and D.M. Eggers. 1979. Assessment of the reservoir-related effects of the Skagit Project on downstream fishery resources of the Skagit River, Washington. Fisheries Research Institute. College of Fisheries, University of Washington, Seattle, Washington. Report for the City of Seattle, Department of Lighting. Seattle, Washington. 602 pp.

Hjeljord, O. 1971. Feeding ecology and habitat preference of the mountain goat in Alaska. Master's thesis. University of Alaska, Fairbanks, Alaska. 65 pp. Cited in Alaska Power Authority, 1984b.

Holdermann, D.A. 1983. An assessment of the impact of the Bradley Lake Hydroelectric Project on selected wildlife populations. Unpublished report. Alaska Department of Fish and Game, Homer, Alaska. 78 pp. Cited in Alaska Power Authority, 1984b.

Joyce, M.R., and P.O. Hampton. 1983. Avifauna. In: Oliktok Environmental Studies. Prepared by Woodward-Clyde Consultants for ARCO Alaska, Inc. Cited in Alaska Power Authority, 1984b.

Klein, D.R. 1953. A reconnaissance study of the mountain goat in Alaska. Master's thesis, University of Alaska, Fairbanks, Alaska. 121 pp. Cited in Alaska Power Authority, 1984b.

Krasnow, L.D. and M.A. Halpen. 1981. Potential impacts of the Bradley Lake Hydroelectric Project on birds; a preconstruction study. U.S. Fish and Wildlife Service, National Fisheries Research Center, Marine Bird Section, Anchorage, Alaska. Department of the Interior. Cited in Alaska Power Authority, 1984b.

LeReseche, R.E., R.H. Bishop, and J.W. Coady. 1974. Distribution and habitats of moose in Alaska. Naturaliste Canadian 101: 143-178. Cited in Alaska Power Authority, 1984b.

Mech, L.D. 1970. The wolf: the ecology and behavior of an endangered species. Natural History Press, New York. 384 pp. Cited in Alaska Power Authority, 1984b.

Murray, D.F. 1961. Some factors affecting the production and harvest of beaver in the upper Tanana River Valley, Alaska. Master's thesis, University of Alaska, Anchorage, Alaska. Cited in Alaska Power Authority, 1984b.

Olendorff, R.R, A.D. Miller, and R.N. Lehman. 1981. Suggested practices for raptor protection on powerlines, the state of the art in 1981. Raptor research report no. 4. Raptor Research Foundation, Inc., St. Paul, Minnesota. 111 pp.

Peek, J.M., D.L. Urich, and R. J. Mackie. 1976. Moose habitat selection and relationships to forest management in Northeastern Minnesota. Wildlife Monographs, no. 48. 65 pp.

Peterson, R.O., J.D. Wollington, and T.N. Bailey. 1984. Wolves of the Kenai Peninsula, Alaska. Wildlife Monographs, No. 88, 52 pp.

Rappoport, A., L. Shea, and L. Halpin. 1981. Application of the U.S. Fish and Wildlife Service's Habitat Evaluation Procedures to the proposed Bradley Lake Project, Alaska. U.S. Fish and Wildlife Service, Western Alaska Ecological Services, Anchorage, Alaska. 31 pp plus appendices. Department of the Interior. Cited in Alaska Power Authority, 1984b.

Ruttner, Franz. 1973. Fundamentals of limnology. University of Toronto Press, Toronto, Ontario. 295 pp.

Schwartz, C.C., and A. W. Franzmann. 1980. Population ecology of the Kenai Peninsula black bear. Alaska Department of Fish and Game. Federal aid wildlife restoration project progress report, project W-17-11. Cited in Alaska Power Authority, 1984b.

Steele, Julia. 1979. Bradley Lake Hydroelectric Project survey report. Manuscript on file with the Department of the Army, Alaska District Corps of Engineers, Anchorage, Alaska.

______________________. 1982. Appendix D, Cultural resource survey, Bradley Lake Project. Manuscript on file with the Department of the Army, Alaska District Corps of Engineers, Anchorage, Alaska.

Thompson, L.S. 1978. Transmission line wire strikes: mitigation through engineering design and habitat modification. In: M.L. Avery (ed.) Impacts of transmission lines on birds in flight. FWS/OBS-78/48. U.S. Fish and Wildlife Service, Ann Arbor, Michigan. 151 pp. Department of the Interior. Cited in Alaska Power Authority, 1984b.

Udvardy, M.D.F. 1977. The Audubon Society field guide to North American birds, Western region. Alfred A. Knopf, Inc. New York. 852 pp.

Woodward-Clyde Consultants. 1983. Bradley River instream flow studies. Prepared for Alaska Power Authority, Anchorage, Alaska. 75 pp. with appendices.

________________________. 1984a. Moose survey report. Prepared for Stone and Webster Engineering Corporation for the Bradley Lake Hydroelectric Project. Anchorage, Alaska. 22 pp.

________________________. 1984b. Bradley Lake Hydroelectric Project, Alaska Power Authority, historic and cultural pedestrian survey. Anchorage, Alaska. December, 1984.

7. LIST OF PREPARERS

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PETER FOOTE--EIS Coordinator (B.S., Wildlife Biology, M.S., Fisheries Biology). Thirteen years of experience in fields of fisheries biology and impact assessment.

JAMES HAIMES (B.A., Economics, 60 semester hours for Ph.D.). Seven years experience in private economic consulting, eleven years experience as government economist.

JAMES O. HUNTER, JR. (B.S., Civil Engineering; P.E.). Two years' experience in construction of civil works facilities; six years' experience in analysis and impact evaluation of water resource projects; and three years' experience in analysis of hydroelectric projects.

PETER LEITZKE (B.S., Geology; M.A., Geological Sciences). Eleven years experience.

J. TIMOTHY LOONEY (B.S., Engineering). Three years experience with the U.S. Bureau of Reclamation in planning and design of water resource projects. Four years experience with FERC performing studies related to hydroelectric project safety, adequacy and economics.

JOHN MITCHELL (B.S., Social Science; graduate studies in Broadcasting). Eight years' experience as a public information specialist, and eleven years' experience writing and editing environmental impact statements.

MARY NOWAK (B.S., English). Four years' experience assisting in preparation of environmental impact statements.

EDWIN D. SLATTER (B.A., M.A., Ph.D., Anthropology). Seven years experience in North American archeology and teaching archeology and cultural anthropology (college-level).

JOHN STAPLES (M.S., Wildlife Management). Six years experience in terrestrial impact assessment.

DAVID STARKIE (B.L.A., Landscape Architecture). Eighteen years of experience in landscape architecture, including four years of visual resource management.

MARTIN J. THORPE (B.S. electrical engineering). Fourteen years of experience in electric power system planning in the electric utility industry, 16 years with the government in regulatory analysis of electric power system planning and operation.

E. GORDON WARREN, JR. (B.S., Conservation; B.S., Natural Resources Recreation Management; two years postgraduate work in Recreation Resources Administration). Eleven years experience in the planning and management of public use of land and water resources.

8. LIST OF RECIPIENTS

The following agencies, organizations, and individuals are being provided copies of the Draft Supplemental Environmental Impact Statement.

Federal

Department of Agriculture
Department of the Army, Alaska District Corps of Engineers
National Oceanic and Atmospheric Administration
Department of Energy, Alaska Power Administration
Department of the Interior
Department of Transportation
Department of Health and Human Services
Environmental Protection Agency
Advisory Council on Historic Preservation

State

Alaska Public Utilities Commission
Alaska State-Federal Coordinator
Alaska Department of Fish and Game
Alaska Department of Natural Resources
Alaska Department of Commerce and Economic Development
Alaska Department of Environmental Conservation
Alaska Department of Public Safety
Office of the Governor
State Historic Preservation Officer
Alaska Power Administration
Office of Coastal Management

Local

Mayor, City of Anchorage
Mayor, City of Seward
Mayor, Kenai Peninsula Borough
City Manager, City of Homer
Mayor, City of Homer
Mayor, City of Soldotna
Town Supervisor, Town of Seldovia
Anchorage Municipal Library
University of Alaska at Anchorage Library
Homer Public Library
Soldotna Public Library
Kenai Public Library
Seldovia Public Library

Others

Senator Ted Stevens
Senator Frank H. Murkowski
Representative Donald E. Young
State Senator Paul A. Fischer
Mr. Phil Nash
Mr. Kent Wick
Ms. Sue Carter
Mr. Ronald Rice
Mr. Leo Rhode
Sierra Club
National Wildlife Federation

Applicant

Alaska Power Authority

9. APPENDICES

A. Applicant's draft proposed outline of Best Management Practices Manual, for erosion and sedimentation control.

B. Department of the Interior's recommended biological stipulations for a license for the proposed Bradley Lake Project.

Appendix A. Applicant's draft proposed outline of Best Management Practices Manual, for erosion and sedimentation control.

DRAFT

PROPOSED OUTLINE

FOR

BEST MANAGEMENT PRACTICES MANUAL

EROSION AND SEDIMENTATION CONTROL

I. INTRODUCTION

A. Purpose

1. Prepared by Alaska Power Authority as one of a series of "best management practices" manuals to be used in pre-design, design, construction, and maintenance of hydroelectric projects in Alaska.

2. Presents general guidelines and commonly recommended techniques to address environmental concerns and mitigate adverse environmental impacts.

B. Limitations

1. Recognition that project impacts and techniques are site specific. Manual should be used only as a guide to develop appropriate site-specific techniques.

2. Manual not all-inclusive; concentrates on commonly accepted practices.

C. Organization

1. Chapter 2 presents summaries of general guidelines for projects during pre-design, design, construction, and maintenance phases.

2. Chapter 3 presents description of acceptable practices and their advantages and disadvantages.

3. Chapter 4 lists applicable permits, authorities and agencies.

II. GENERAL GUIDELINES - SUMMARIES

A. Pre-Design

1. Planning

- Utilize a planning team comprised of multidisciplinary specialists experienced in Alaska conditions.

- Fully consider long-range land use management problems and assess surrounding resources.

- Maintain an open dialogue among management, engineers, environmental specialists, planners and government agencies, as well as solicit public input.

- Assemble all available data concerning water quality, soils, topography, climate and biology to determine erosion potential and other related problems.

- Consolidate related facilities to minimize environmental damage. Utilize existing rights-of-way whenever possible

- Identify all alternative routes and construction requirements and prepare a projected life/cost (benefit) analysis.

- Avoid, when possible, siting facilities in areas of unstable permafrost soils, seepage zones, landslide areas, dissected terrain, ponds, natural channels, and wetlands.

- Minimize cut and fill approaches to streams and encroachment on streams.

2. Reconnaissance

- When possible, conduct exploration on frozen ground to minimize surface disturbances.

- Reconnaissance surveys should be sufficiently intensive to close gaps in existing data and determine potential problems. Recommended procedures include use of preliminary aerial photo and map studies followed by extensive ground-truthing programs.

- Collect sufficient data on surface and subsurface soils, geology, vegetative type and cover, fish and wildlife, climate and topography not only to satisfy engineering design requirements, but also to estimate erosion potential and risk, and requirements for plantings. (Attachment showing examples of resource mapping)

- Areas disturbed by reconnaissance activities should be treated to prevent degradation.

- Clearing for surveys should be kept to a minimum. Avoid the use of convenience routes.

3. Economic Evaluation

- The amount and type of erosion protection should be cost justified with alternate sites, routes and configurations.

- Erosion and sedimentation control techniques should be considered as capital costs. Projected maintenance costs of these items should be evaluated.

B. Design

1. Configuration

- When possible, locate facilities on upland areas and away from stream courses and wetland areas.

- Avoid seepage areas, clay beds, alluvial forms and geologic features which may result in instability.

- When possible, make cuts steeper to minimize surface area. In erodible soils, balance the gradient with slope stabilization measures.

- In permafrost areas, overlay is preferred to conventional cut and fill. Design for stabilizing frozen, unstable cuts.

- Fills or embankments should be well compacted and built in lifts. Design for less than the angle of repose for greater stability.

- Design to reduce the amount of clearing required for cuts and fills.

- Design to prevent accumulation of water on surfaces of pads.

- Provide buffer strips of vegetative or other materials on downhill sides of facilities as well as adjacent to streams, drains and critical areas.

2. Drainage Design

- Design to provide immediate interception and removal of runoff waters. Incorporate temporary measures to protect disturbed areas.

- Use culverts large enough to carry snowmelt runoff. Provide for clean-out or use debris collectors to prevent clogging.

- Provide sufficient cross-drainage to prevent excess accumulation on uphill sides of pads.

- On low-use routes, use water bars and low-water crossings for reduced maintenance. Consider fish passage requirements through the use of such techniques as low-flow channels.

- Provide adequate protection for inlets and outlets of drainage structures.

- Approach stream crossings at right angles, and when possible leave a buffer strip along the stream bank until actual construction of the structure is ready to begin.

- In permafrost areas or erodible natural soils, avoid concentrated discharges from drainage structures onto undisturbed terrain. Attempt to convert to sheet flow to prevent headward cutting.

- Consider bridging where fish passage is critical. Provide clearance for debris and to avoid icing, and stabilize banks.

- Provide means to remove or control groundwater and seepage waters to prevent 'aufeis' buildup.

- Consult federal and state agencies for fish requirements and other habitat features.

3. Permafrost Design

   - Whenever possible use overlay construction as opposed to cut and fill.

   - When using overlay, avoid stripping of the organic layer.

   - Consider winter construction to avoid melting and thermal degradation.

   - Provide for immediate stabilization of cut slopes.

   - Avoid induced drainage or standing water over permafrost areas which can result in rapid thermal degradation.

4. Borrow and Disposal Areas

   - Design for staged development whenever possible.

   - Conserve stripped topsoil for respreading over completed areas.

   - Consider traffic routes along with mining requirements.

   - Provide perimeter dikes, diversions and other techniques to prevent sediment movement from mining areas into streams and drainages.

   - Incorporate sediment removal techniques into disposal site plans.

   - As required by Federal, State or local requirements, prepare comprehensive site plans which in detail outline mining and disposal techniques, applicable erosion procedures, traffic routes and final restoration measures. (Example of mining plan to be attached.)

   - Stabilize all slopes and embankments. Grade to stable slope angles.

5. Erosion Control Design

   - Based on design and construction requirements, incorporate temporary erosion control procedures into design provisions.

   - Give special attention to immediate control of runoff waters.

   - Revegetate erodible areas which are to be left uncompleted for next season work.

   - Consider work schedules and local climatological events to insure adequate erosion protection is provided.

   - Take advantage of natural erosion control features such as vegetative and brush buffer strips.

   - Attempt to use materials available on the project such as brush, logs, straw, etc. for erosion control.

   - Provide for adequate right-of-way to perform erosion-related work.

6. Design Documentation

   - Specifications should clearly detail measures to prevent erosion.

   - Insure correlation between plans, specifications and other contract documents.

   - Incorporate all temporary and permanent erosion control measures into a design plan.

   - Allow flexibility to project engineers and contractors to improve upon design or methods.

   - Provide contingency to allow for unforeseen circumstances.

   - Contract scheduling should specify the appropriate time to perform all seasonally-effected work, to result in minimal impact.

C. <u>Construction</u>

1. General

   - A preconstruction conference should educate and coordinate all involved parties towards the goals of erosion control and protection of water quality.

   - Equipment operators and other personnel should clearly understand and participate in safe and proper practices.

   - Inspection teams should be given sufficient authority to be effective. Timing is critical to avoid rework.

2. Surveying, Clearing and Grubbing

- Identify boundaries on the ground prior to initiating clearing operations.

- Apply techniques which minimize on-ground traffic and disturbances. All trees, snags and other wood material cut in connection with clearing operations should be felled within the clearing boundaries and away from water courses.

- Avoid destroying the organic mat in permafrost areas. Immediate treatment should follow any disturbances.

- Keep clearing and grubbing operations closely in line with subsequent activities. Avoid clearing beyond the present season's schedule.

- Dispose of slash and debris in accepted manners. Utilize available materials for brush barriers and ditch checks.

- Utilize hand clearing in permafrost locations, wetlands and in areas such as along tops of cut banks.

3. Earthwork

- Avoid mixing organic matter with fill materials. Compact fills in lifts to reduce infiltration and settling.

- Provide temporary protection such as berms to the tops of erodible cut and fill slopes.

- Dispose of waste spoils in approved areas away from water courses. Preferred methods include disposal in the future inpoundment area of the dam, or retention for rehabilitation of material sites or for solid waste disposal site maintenance.

- Minimize earthwork in wet weather.

- Dependent upon material quality and availability, borrow areas should be located in the future impoundment area of the dam. Other preferred material source sites are abandoned access roads, camp pads, and airstrips.

- Stabilize borrow areas with perimeter dikes and ditches and provide for sediment removal from mining operations.

- Apply measures immediately to control runoff waters throughout construction areas.

4. Drainage

- Establish permanent drainage structures as early as possible.

- Keep sediment and debris out of all structures. Stablize at inlets and outlets.

- Begin all drainage installations at the downstream end, working upstream.

- Use low water crossings for both temporary and permanent cross-drains on low traffic volume routes.

- Exercise care in rerouting streams during bridge and culvert installation. Provide a non-erosive temporary channel or sediment removal measure such as silt curtains.

- Avoid sedimentation of water courses when removing temporary structures.

5. Support Activities

- Maintain camp pads and other disturbed project areas in a stable condition.

6. Erosion Control and Revegetation/Rehabilitation

- Schedule rehabilitation activities to closely follow final construction.

- Utilize temporary techniques to protect slopes until ready for final treatment.

- Surfaces left exposed for extended periods should be temporarily revegetated with fast-growing native species. Encourage reinvasion by native species from surrounding undisturbed areas.

- Establish permanent erosion control items. Give consideration to critical areas and erodible soils.

- Abandon and block unused access roads, borrow and disposal sites and other low-use areas. Stabilize cross-drains by either removal or adequate inlet and outlet protection.

- Inspect abandoned facilities periodically to correct any erosion problems.

D. Maintenance

1. General

- Organize a planned, regularly scheduled maintenance program providing inspection and expeditious repair.

- Provide complete design, construction and maintenance documentation. Develop dialogue among maintenance and design personnel.

2. Drainage Systems

- Inspect all structures prior to wet seasons or before winter. Clean out debris and sediment.

- Clear transportable debris upstream and downstream of structures.

- Clean out ditches, sediment basins and other sediment retention structures periodically. Dispose of sediments in approved fashions.

3. Surface Maintenance

- Treat rills and gullies on slopes by filling, mulching and revegetation.

- Avoid damaging treated areas with maintenance equipment.

- Direct special attention to frozen cuts until stabilized.

- Keep non-paved surfaces crowned or sloped. Avoid windows along edges to provide lateral drainage.

- Water and fertilize revegetated areas to promote growth.

- Dust control chemicals, herbicides and pesticides should be used carefully and only with accepted techniques according to local, state and federal regulations.

4. Winter Maintenance

- Prior to breakup, remove or level snow berms along road edges to prevent accumulation of meltwaters.

- Use salts and other chemicals prudently, especially near any streams containing aquatic life.

- Attempt to divert aufeis-forming flows away from drive surfaces. Prior to breakup, thaw culverts susceptible to erosion from ice-buildup.

III. RECOMMENDED PRACTICES (INCLUDES APPLICABILITY, DESCRIPTIONS, ADVANTAGES, DISADVANTAGES, MAINTENANCE REQUIREMENTS)

A. Earthwork

1. Clearing, grubbing and slash disposal

a. Minimizing disturbed areas
b. Conservation of topsoil
c. Temporary stabilization
d. Slash and timber disposal
e. Stream crossings

2. Surface preparation

a. Scarification
b. Serrated cuts
c. Topsoiling
d. Aggregate cover
e. Surface configuration
f. Compaction
g. Crowning or sloping
h. Temporary seed or mulch

3. Borrow and disposal practices

a. Mining plan
b. Phased development
c. Sediment impoundment
d. Conserving topsoil and revegetation
e. Floodplain sites
f. Fish entrapment
f. Restoration
h. Disposal areas
i. Side borrow and balanced

B. Drainage Structures

1. Culverts

a. Size
b. Placement
c. Fish streams

2. Low-water crossings

3. Grading, cross-drains

4. Vegetated channels

5. Ditch checks, check dams

   a. Straw bale checks
   b. Wire fence check with straw bales
   c. Wire fence with brushwood bundles
   d. Stakes and brush
   e. Dumped rock
   f. Sandbags

6. Mechanical channel liners

   a. Nettings
   b. Fiberglass erosion checks
   c. Stone center drains
   d. Drop structures and check dams

7. Outlet protection

   a. Plunge pools
   b. Protective aprons
   c. Drawdown and sediment basin
   d. Log/rock crib
   e. Paved chute or flume

8. Inlet protection

   a. Debris deflectors
   b. Debris racks
   c. Debris risers
   d. Debris fins
   e. Debris cribs
   f. Debris dams and basins

C. <u>Sediment Retention</u>

1. Sediment basins

   a. Size
   b. Storage
   c. Spillways
   d. Embankments
   e. Temporary basins

2. Buffer strips, barriers and fences

   a. Mounds or depressions
   b. Brush barriers
   c. Sod strips
   d. Straw bales
   e. Sediment fences
   f. Buffer strips

3. Traps and filters for inlets

4. Silt curtains

D. <u>Slope stabilization</u>

1. Non-permafrost areas

   a. Serrated cuts
   b. Pavement or riprap
   c. Diversion ditch
   d. Benches or fill berms
   e. Slope drains
   f. Diversion berms
   g. Sodding
   h. Seeding or mulch
   i. Woody vegetation
   j. Temporary cover

2. Temporary drawdrains

   a. Sectional drawdrain
   b. Paved chute
   c. Flexible drawdrain

3. Permanent drawdrains

4. Diversions and benches

   a. Diversion channel
   b. Diversion leaves
   c. Benches

5. Level spreaders and interceptor dikes

E. <u>Revegetation</u>

1. Grasses, herbaceous and woody plants

   a. Site preparation
   b. Timing
   c. Application methods
   d. Fertilization
   e. Mulching

2. Organic mulches

3. Nettings, mattings and mulch blankets

4. Chemical stabilizers and soil binders

F. <u>Stream Protection</u>

1. Protection during crossing and construction

a. Construction dikes
b. Coffer dams
c. Temporary channel changes
d. Fluming
e. Temporary culverts
f. Low-water crossings

2. Bank stabilization - mechanical

a. Obstruction removal
b. Clearing
c. Bank sloping
d. Revetments
e. Gabions
f. Jetties, groins

3. Bank stabilization - vegetative

a. Willow jetties
b. Brush revetment

G. <u>Thermal Erosion Control</u>

1. Prevention/treatment of disturbed surfaces

a. Overlay construction
b. Drainage control
c. Revegetation
d. Insulation

2. Cut slope stabilization

a. Vertical cut
b. Filter buttress
c. Insulation and revegetation

H. <u>Icing Control</u>

1. Specialized drainage structures

a. Dual culverts
b. Subsurface drains

2. Culvert thawing

a. Thaw cables
b. Steam thawing
c. Fire pots

3. Channel maintenance

a. Frost belts
b. Air-ice covers
c. Ice fence

I. <u>Final Restoration</u>

J. <u>Monitoring</u>

IV. Applicable Permits, Authorities, and Agencies

V. References

Appendix B. Department of the Interior's recommended biological stipulations for a license for the proposed Bradley Lake Project.

Biological Stipulations

We recommend that these stipulations be incorporated into the FERC license as a binding exhibit. They should then become part of project contract agreements.

Preamble

Implementation of these stipulations are appropriate during the construction, operation, and maintenance of the Bradley Lake Hydroelectric Project. Sound engineering practices shall be employed to preserve and protect fish and wildlife resources and their habitats.

The Licensee, through guidance to the Designer, Engineer, and Construction Contractor, shall balance environmental values with economic considerations and technical capabilities, consistent with State and National policies. This evaluation shall include benefits or detriments to people, property, or environmental resources resulting from the Bradley Lake Project.

1. Environmental Briefings

   The Licensee shall develop, in consultation with resource agency representatives, and provide environmental briefings for all supervisory and field personnel directly related to the project prior to construction or during new-hire orientation.

   Environmental Briefings shall be held to familiarize project personnel with environmentally sensitive features of the project area, Federal and State regulations, agency permit stipulations, and specific project policies and restrictions relating to protection of vegetation, fish, wildlife, and cultural resources. Briefings shall explain why certain habitats or organisms are vulnerable to disturbance and why protective measures are needed.

2. Pollution Control

   The Licensee shall construct, operate, maintain, and terminate the project in a manner which adheres to all State and Federal air, land, and water quality standards, laws and regulations relating to pollution control or prevention.

   The liquid waste treatment system shall be operated by personnel accredited by the State of Alaska. Gray water shall be treated along with other liquid wastes. A program of periodic effluent testing shall be followed to ensure compliance with the National Pollutant Discharge Elimination System (NPDES), permit State of Alaska Wastewater Disposal Regulation (18 AAC 72), and State of Alaska Water Quality Regulations (18 AAC 70). Effluent testing shall be conducted by a certified water quality laboratory. Effluent discharge into streams shall be located to achieve maximum dilution.

   Mobile ground equipment shall not be operated in wetlands or other bodies of water.

   Temperature ranges of natural surface or ground waters, as determined by pre-project baseline studies, shall not be altered by the project design or construction activities.

   The Licensee shall use only State and federally approved non-persistent and immobile types of pesticides, herbicides, and other chemicals. Each chemical (including fuels and oils) to be used, its storage, application and clean-up, shall be addressed in the project Oil and Hazardous Substances Control Plan prior to arrival of such substances on site.

   Solid waste disposal sites shall be established in stable, well-drained locations. Siting shall utilize existing excavations such as depleted upland borrow pits. Deposited material shall be covered daily with non-silty excavation spoil stockpiled for this purpose at the site. Solid waste disposal site design and operation shall conform with guidelines established by the Alaska Department of Environmental Conservation.

   Incinerators for the daily burning of putrescible and combustible wastes shall be installed at each camp and in operating condition prior to construction camp occupation.

   To minimize scavenging by birds and mammals (with resulting human/animal conflicts) all putrescible kitchen waste shall be stored indoors in sealed containers and incinerated on the same day they are produced.

   Camp incinerators shall be properly sized, operated by trained personnel, and be specified to accommodate peak camp capacity.

   Camp perimeters and incinerators shall be protected by fencing designed and built to specifications subject to review and approval by the monitoring team.

3. Buffer Strips

   Unless permitted on a site-specific basis, a minimum 500-foot wide buffer of undisturbed vegetation shall be maintained between project features and streams, lakes, or wetlands.

4. Erosion and Sedimentation Control

   The design of the project shall provide for control of erosion and sediment production, transport, and deposit in accordance with State of Alaska Water Quality Regulations (18 AAC 70).

   Design of erosion control measures shall accommodate a 50-year flood and shall be implemented to limit induced and accelerated erosion, limit sediment production and transport, and limit the formation of new drainage channels.

   Specific erosion control methodologies shall be delineated in a project Erosion Control Plan developed by the Licensee and approved by concerned State and Federal agencies prior to construction. The approved project Erosion Control Plan shall be incorporated into project technical specifications.

If otherwise permitted, roads or equipment crossing wetlands, other waterbodies, or active (25-year flood events) floodplains shall not result in erosion or sedimentation in excess of the State of Alaska Water Quality Regulations (18 AAC 70).

Excavated material in excess of the amounts required for backfilling and restoration shall be disposed in a manner as delineated in the Erosion Control Plan.

Excavated material shall not be stockpiled in wetlands or in other waterbodies.

Overburden and exavated materials from the construction of access roads shall not be side cast on road slopes exceeding a grade of 10 percent.

Where gravel pads are used, provision for cross-drainage shall be made to prevent barriers to sheet flow.

5. Fish and Wildlife Protection

All project personnel shall be governed by appropriate State and Federal rules and regulations pertaining to fish and wildlife resources; such rules and regulations shall be incorporated into project technical specifications by reference.

A condition of employment for all project personnel will be immediate termination for violating said rules and regulations.

Pump intakes shall be screened to prevent harm to fish. Screening requirements as stipulated by the Alaska Department of Fish and Game (ADF&G) shall be incorporated into project design.

The Licensee shall design, construct, operate, maintain, and terminate the project in a manner to assure free passage and movement of fish. Temporary blockages of fish, not to exceed 24 hours, necessitated by instream activities may be allowed, subject to conditions imposed by ADF&G's Title 16 permit.

The Licensee shall not unnecessarily disturb fish spawning beds, fish rearing, and overwintering areas. Where disturbance is inevitable as a result of approved project design, proposed modifications and mitigation measures shall be included as part of project bid documents.

The Licensee shall protect fish spawning beds and rearing and overwintering areas from sedimentation/siltation resulting from construction activities. As provided in the Erosion Control Plan, settling basins and other sediment control structures shall be constructed and maintained to intercept sediments and silts before they reach fish habitat.

The Licensee shall not take water from fish spawning beds or rearing and overwintering areas, or from waters that replenish those areas, during critical periods identified by ADF&G.

The Licensee shall design the project to accommodate the time and location of fish and wildlife breeding, nesting, spawning, rearing, calving, overwintering, denning, and migration. State and Federal resource agencies shall review and approve fish and wildlife periodicity charts prepared and used in construction scheduling.

The Licensee shall design, construct, and maintain the project to assure free passage and movement of big game animals.

6. Acquisition and Disposition of Materials

The Licensee shall make application to the United States for the purchase of mineral materials on Federal lands in accordance with 43 CFR Part 3610 and shall submit a mining plan in accordance with 43 CFR Part 23. No materials may be removed until mining plans are reviewed and approved by concerned resource agencies.

Material sites shall blend with surrounding natural land patterns. Primary emphasis shall be placed on the prevention of soil erosion and damage to vegetation, and the protection of fish and wildlife habitat.

Design shall minimize gravel requirements by avoiding wet areas, consolidating structures, and balancing cuts and fills to the extent practicable.

A detailed mining plan shall be prepared for each borrow operation. Mining plans shall identify all associated roads, facilities, mining techniques, schedules, rehabilitation procedures, the type of borrow material, and quantities expected to be mined.

Abandoned access roads and camp pads shall be used as material sources whenever feasible in lieu of expanding existing borrow sites or initiating new ones.

7. Clearing

All trees, snags, and other woody material removed for road construction shall be felled within clearly identified boundaries and away from water courses.

All slash shall be disposed of as directed by the Project Engineer. Slash shall be disposed of prior to the end of the first winter after cutting.

Disposal of vegetation, non-merchantable timber, overburden, and other materials removed during clearing operations shall be in accordance with the project Erosion Control Plan.

Siting of project facilities shall minimize requirements for clearing and removal of vegetation.

Where removal of vegetation is required, organic overburden shall be segregated and stockpiled for use in subsequent rehabilitation. Stockpiles shall be placed in well-drained locations and bermed to contain runoff.

Structures shall be consolidated to minimize necessary ground surface disturbance.

8. Disturbance or Use of Natural Waters

If wet processing is required for borrow material, water withdrawal and discharge locations shall be sited to preclude fish and wildlife disturbance. Water intake structures shall be designed to preclude entrapment or entrainment of fish eggs and small fish. Settling ponds shall be designed, operated, and monitored to ensure that discharge standards are achieved. Settling ponds shall be designed and sited to avoid fish entrapment. Water discharge shall be designed in a manner that precludes erosion. Energy dissipators shall be used as appropriate.

9. Off Right-of-Way Traffic

The Licensee shall not operate mobile ground equipment off the right-of-way, roads, or other authorized travel routes except as necessary to prevent immediate harm to any person or property.

10. Use of Explosives

Blasting shall avoid times and locations which are sensitive for fish and wildlife. Blasting procedures and schedules must be sufficiently flexible to allow alteration at short notice for the protection of wildlife. ADF&G blasting guidelines shall be followed.

11. Restoration

Specific restoration and revegetation methodologies shall be delineated in a project Restoration/Revegetation plan approved by appropriate State and Federal agencies prior to construction. The approved Restoration/Revegation plan shall be incorporated into project technical specifications by reference.

Upon completion of use, the Licensee shall restore all lands disturbed by project activities in accordance with the Restoration/Revegetation Plan.

Restoration includes erosion and sediment control, revegetation, re-establishment of native species and stabilization. All disturbed areas shall be left in such stabilized condition that erosion will be controlled through such means as water bars, berms, ditching, revegetation, and other techniques included in the Erosion Control and Restoration/Revegetation Plan. Culverts and bridges shall be removed and slopes shall be restored.

Revegetation of disturbed areas shall be accomplished in accordance with the Restoration/Revegetation Plan and approved schedules. The parameters to determine the success of revegetation shall be included in the plan.

The Licensee shall dispose of all materials from roads, berms, dikes and other earthen structures in accordance with the project Restoration/Revegetation Plan.

Pending the restoration/revegetation of a disturbed area, the Licensee shall contour grade and stabilize each area prior to the end of the growing season and/or prior to the onset of the freezing season immediately following the time of disturbance.

Upon completion of restoration/revegetation of an area, the Licensee shall remove all equipment and material from the area in accordance with approved plans.

Organic overburden, slash, and debris stockpiled during clearing shall be distributed over the excavated area prior to fertilization.

Once operational material sites are depleted or no longer required, they shall be rehabilitated by the end of the next growing season following last use.

Erosion-prone slopes shall be fertilized and dry seeded with a fast-growing native grass.

12. Oil and Hazard Substances

The Licensee shall submit an oil and hazardous substance control, cleanup and disposal plan that shall be approved by concerned State and Federal agencies prior to initial construction activities. The approved Oil and Hazardous Substances Plan shall be incorporated into project technical specifications by reference. As a minimum the plan shall address fuel distribution systems, storage and containment, containerized products, leak detection systems, handling procedures, training programs, provisions for collection, storage and ultimate disposal of waste oil, cleanup methods and disposal sites. The plan shall outline all areas where oil and/or hazardous substances are stored, utilized, transported, or distributed. The Licensee shall demonstrate its capability and readiness to execute the plan to the satisfaction of the Project Engineer and concerned State and Federal agencies.

Storage containers for fuels and hazardous substances shall be located away from water bodies and bermed to contain 110 percent of the maximum volume to be stored. Containment areas shall be lined with impervious material.

13. Standards for Roads

The licensee shall submit a layout of each proposed road for approval by the resource agencies and the Project Engineer. As a minimum, the layout shall include areas of fills and cuts, the locations of culverts, bridges and low water crossings, spoil disposal, dimensions and roadside ditching necessary for runoff water control.

Maintenance grading shall be done in a manner that cross drainage culverts and side ditches will not be blocked with road material. Drainage ditches and culverts shall be inspected weekly and cleaned out as needed during the seasons of surface grading and snow removal.

Road design speeds shall be kept to the minimum consistent with project requirements. Lower design speeds allow greater flexibility for alignment adjustments to avoid environmentally sensitive features and reduce requirements for major road cuts. Lower design speeds also enable routing to follow higher, drier terrain, thereby reducing requirements for gravel extraction and fill placement in wetlands.

Routes shall avoid wetland and riparian areas whenever possible, and minimize stream crossing and encroachments.

Where stream crossing cannot be avoided, they shall be aligned at right angles to the stream and located to preclude bank cutting and streambed disturbance. Fish spawning and overwintering areas shall be avoided by route adjustments.

Where stream crossings are planned for winter construction, the thalweg, banks, and other locational features shall be identified and staked in the field prior to snowfall or freeze-up. Overwintering areas of fish or aquatic mammals shall not be disturbed during winter construction.

All access roads not required for project operation shall be "put to bed" as soon as they are no longer required, if possible during the same season. Drainage structures shall be removed and the roadbed recontoured to a stable configuration providing proper drainage. Rehabilitation shall include scarification, fertilization, and blockage with a berm followed by a cut. Erosion-prone locations shall be stabilized by contour grading, water control structures or seeding with fast-growing native species. Where impoundment of sheet flow has occurred, non-operational roads shall be structurally altered to restore normal flow.

Road dust control shall utilize water rather than oil or other synthetic compounds. Water withdrawal procedures and sources for dust control shall be approved on a case-by-case basis by project environmental monitors following site-specific inspection.

14. Culverts, Bridges, Low Water Crossings

Culverts and bridges necessary for operation and maintenance of the project shall be designed at a minimum to accommodate a 50-year flood in accordance with criteria established by the American Association of State Highway Officials and the Federal Highway Administration and endorsed by the Alaska Department of Transportation and Public Facilities.

Culverts necessary for construction or operation of the project shall be installed with the culvert invert a minimum of six (6) inches or 20 percent of the culvert diameter, whichever is greater, below the thalweg in fish streams.

All bridge abutments and culvert inlets and outlets will be rip-rapped or armored at the time of installation.

Culverts installed in fish streams shall be designed to provide fish passage at the Q_2 flood, with the following parameters:

a) No fish passage culvert shall exceed 100 feet in total length.

b) Maximum average allowable velocity of water flow through a fish passage culvert shall not exceed 4.52 feet per second (fps) for culverts up to 40 feet in length (ft). For culverts in excess of 40 feet in length, the following average velocities are not to be exceeded:

Ave. Velocity (fps)	Culvert Length (ft)
4.0	50
3.6	60
3.3	70
3.0	80
2.8	90
2.5	100

All culverts installed in fish streams shall be inspected and maintained to allow fish passage in accordance with the design specifications above. The inspection and maintenance schedule shall be subject to approval by ADF&G.

Low water crossings (fords across moving waters where any mobile ground equipment is moved on the water course) shall be designed, constructed, maintained and restored to standards contained in the project Erosion Control Plan.

Low-water crossings shall be used only where a stream will not be subject to construction traffic. Such crossings shall conform to the slope of the undisturbed streambed and shall be constructed of materials that will preclude water percolating through rather than over them.

15. Transmission Corridors

In all locations where clearing is not required for access, winter construction or access shall not commence until a frost depth of six inches (6") has occurred and vehicles not exceeding four (4) psi shall be used. Transmission corridor development shall not create an alternate access route for all-terrain vehicles.

Transmission towers shall not be placed in active floodplains and shall avoid streams and lakes by a minimum of 500 feet.

Herbicides shall not be used for vegetation control along transmission corridors.

16. Implementation

Nothing contained in the preamble and body of stipulations shall prohibit the Licensee form applying for a waiver or modification to any stipulation on a site specific, case-by-case basis. Such application shall be submitted in writing to the concerned State and Federal resource managing agencies for review and comment.