GRANT LAKE HYDROELECTRIC PROJECT DETAILED FEASIBILITY ANALYSIS

VOLUME 2
ENVIRONMENTAL REPORT

EBASCO
EBASCO SERVICES INCORPORATED

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ALASKA POWER AUTHORITY

GRANT LAKE
HYDROELECTRIC PROJECT
DETAILED FEASIBILITY ANALYSIS

for the

Alaska Power Authority

by

Ebasco Services Incorporated

Bellevue, Washington

January, 1984

FOREWORD

The Interim Report issued in February 1982 contained the results of a study which investigated the relative technical, economic, and environmental feasibility of alternative arrangements for the development of the Grant Lake Project based on prior studies and the field investigations completed at that time. The conclusion of that investigation was that a development comprising a lake tap, intake, low level tunnel, and penstock leading to a powerhouse on the east shore of Upper Trail Lake was the arrangement that should be further studied. In addition, the diversion of Falls Creek into Grant Lake via a small diversion dam and pipeline to augment the water available for power generation was comparable in cost and should also be investigated.

With the concurrence of the Power Authority, the ensuing geotechnical and environmental field investigations for 1982 were planned and conducted to evaluate both of these alternative Project arrangements. Detailed economic studies, which were performed after the 1982 field investigations were completed, have shown the Falls Creek diversion to be uneconomic and this feature was dropped from further consideration.

The environmental studies reported herein include data on the Falls Creek area since it was included in the Project arrangement at the time the field studies were conducted. The reader should be aware that references to Falls Creek in this report are presented for general information and/or a better understanding of the general area in which the Grant Lake Project lies. However, the diversion of Falls Creek into Grant Lake is not a part of the proposed Project. Falls Creek will not be impacted by the Grant Lake Project and no construction, diversion, or other activity associated with the Project will affect the Falls Creek area.

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This report describes the natural and human environment of the Grant Lake Hydroelectric Project site and vicinity, identifies the Project's environmental impacts, and describes the measures that will be implemented to protect the environment and to mitigate any potentially adverse environmental effects of the Project.

Environmental studies identified a number of positive and adverse environmental impacts of Project construction and operation. Where adverse environmental impacts were identified, efforts were made to formulate appropriate mitigation measures to offset or reduce the severity of such impacts. These measures, all of which were developed in cooperation with local, state, and federal agencies having jurisdiction over the resources, will adequately and effectively mitigate the Project's potential environmental impacts.

This report is organized according to the format of Federal Energy Regulatory Commission rules for major unconstructed projects, effective December 14, 1981 for Exhibit E. The level of detail presented is commensurate with the design of the proposed Project, giving a comprehensive description of the Project site and vicinity's environmental resources and characteristics and the changes that can be expected as a result of Project construction and operation, but focusing on the more significant potential environmental effects and proposed mitigation measures. This report was prepared with the technical assistance of the Arctic Environmental Information and Data Center of Anchorage, Alaska.

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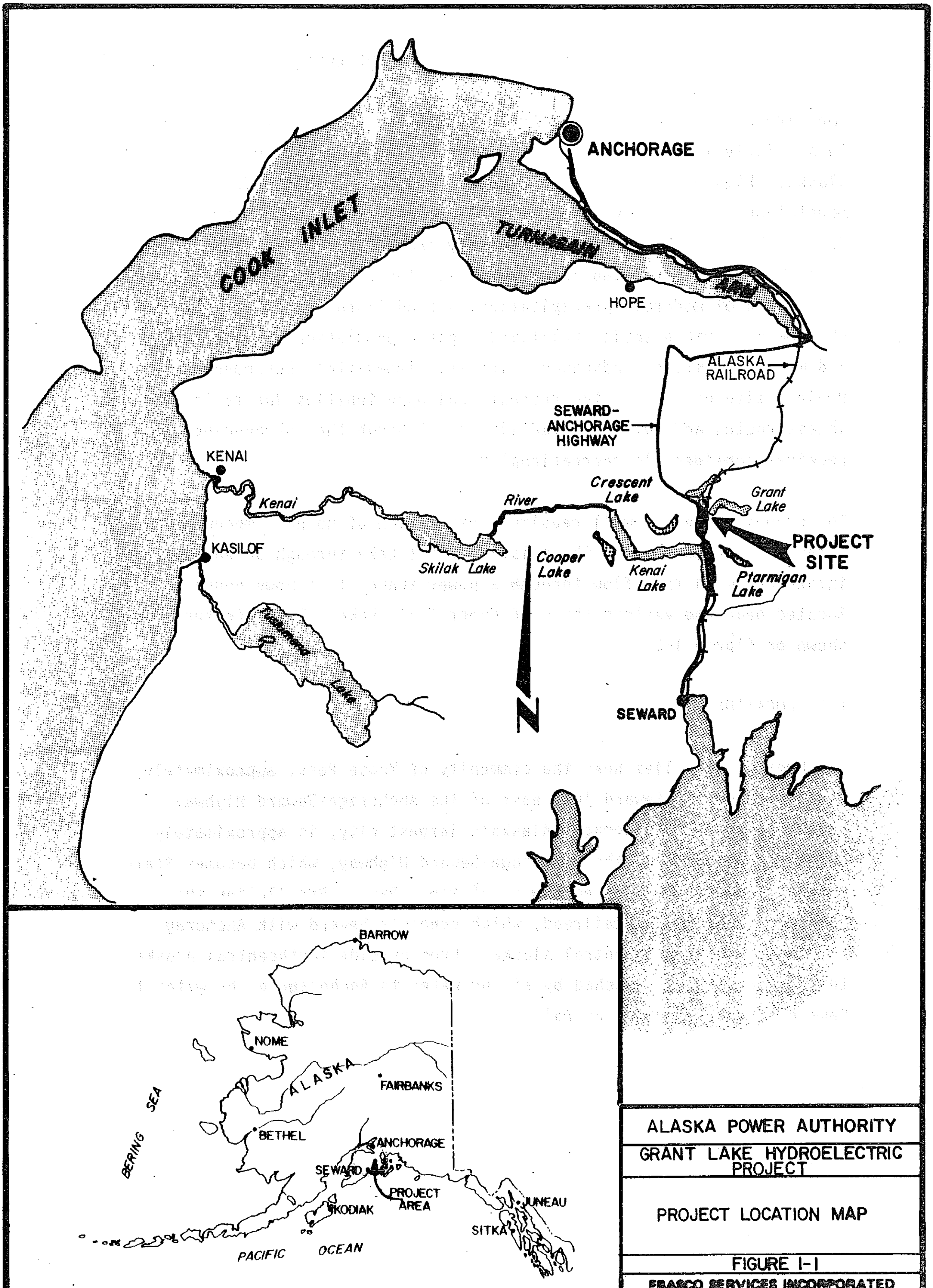
1.0 GENERAL DESCRIPTION OF THE LOCALE

The site of the proposed Grant Lake Hydroelectric Project is situated in a relatively undeveloped part of the Kenai Peninsula in southcentral Alaska. Figure 1-1 shows the regional location of the Project, a mountainous and largely forested area between Anchorage and Seward drained by the Kenai River. A vicinity map of the Project showing the Project site is presented in Figure 1-2. The Project site and vicinity is an area of moderate precipitation, varied flora and fauna, generally shallow and stable soils, relatively sparse population, rich history, and mostly pristine landscapes. The area immediately surrounding the Project site offers limited recreational opportunities due to lack of access routes and developed facilities, although the surrounding region receives considerable recreational use.

The proposed Project will require construction of no new impoundment. Water will be taken from the existing Grant Lake through an underwater intake and will then flow through a power tunnel to a powerhouse located near the eastern shore of Upper Trail Lake. These features are shown on Figure 1-3.

1.1 LOCATION

The Project site lies near the community of Moose Pass, approximately 25 miles north of Seward just east of the Anchorage-Seward Highway, State Highway 9. Anchorage, Alaska's largest city, is approximately 102 miles north along the Anchorage-Seward Highway, which becomes State Highway 1 about 10 miles northwest of Moose Pass. Paralleling the highway is the Alaska Railroad, which connects Seward with Anchorage and central and northcentral Alaska. From outside southcentral Alaska the Project site is reached by air or water to Anchorage or by water to Seward, then by highway or rail.



ALASKA POWER AUTHORITY

GRANT LAKE HYDROELECTRIC PROJECT

PROJECT LOCATION MAP

FIGURE I-1

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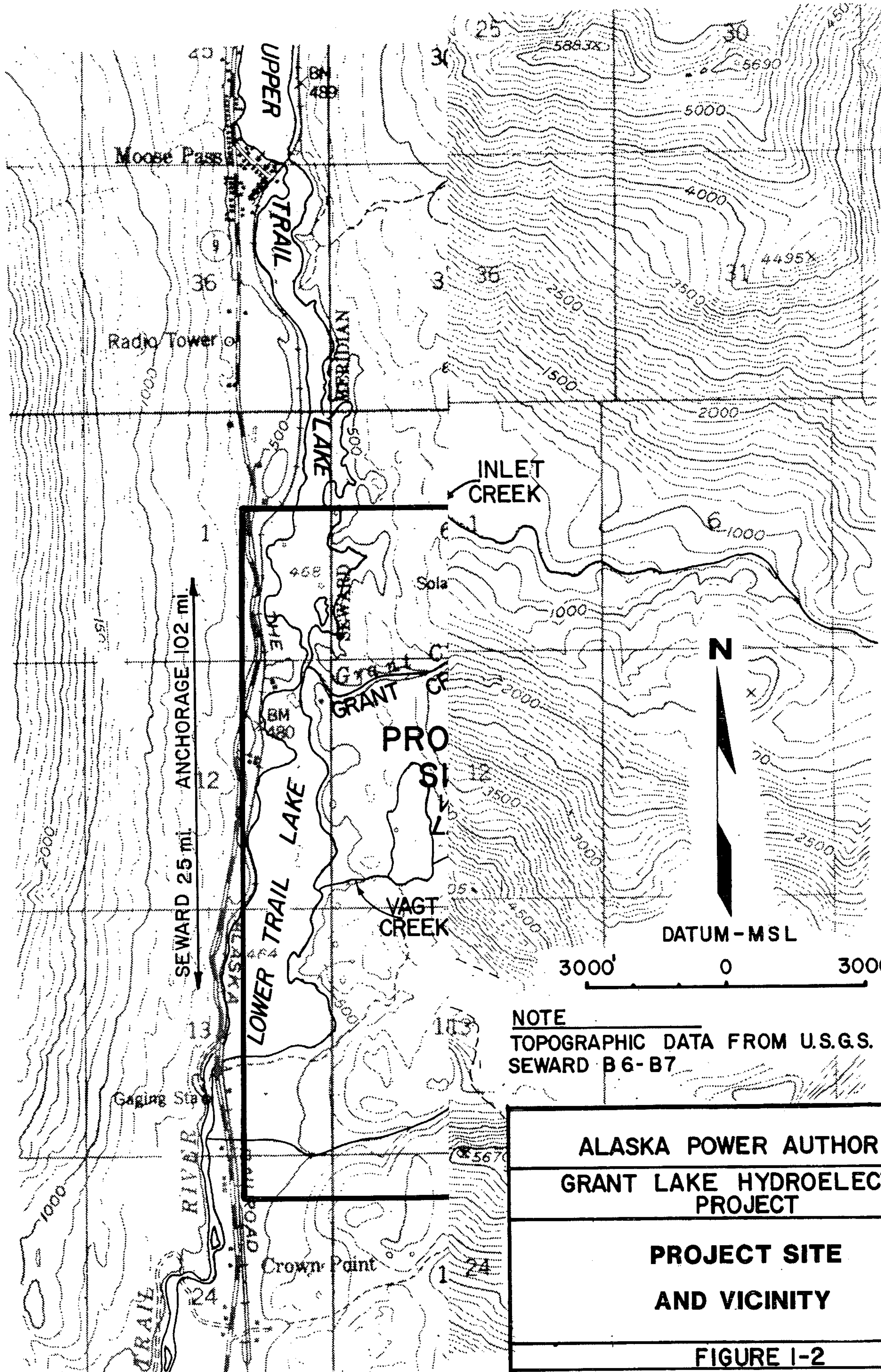

NOTE
TOPOGRAPHIC DATA FROM U.S.G.S. MAPS, SEWARD B6-B7

ALASKA POWER AUTHORITY

GRANT LAKE HYDROELECTRIC PROJECT

PROJECT SITE AND VICINITY

FIGURE I-2

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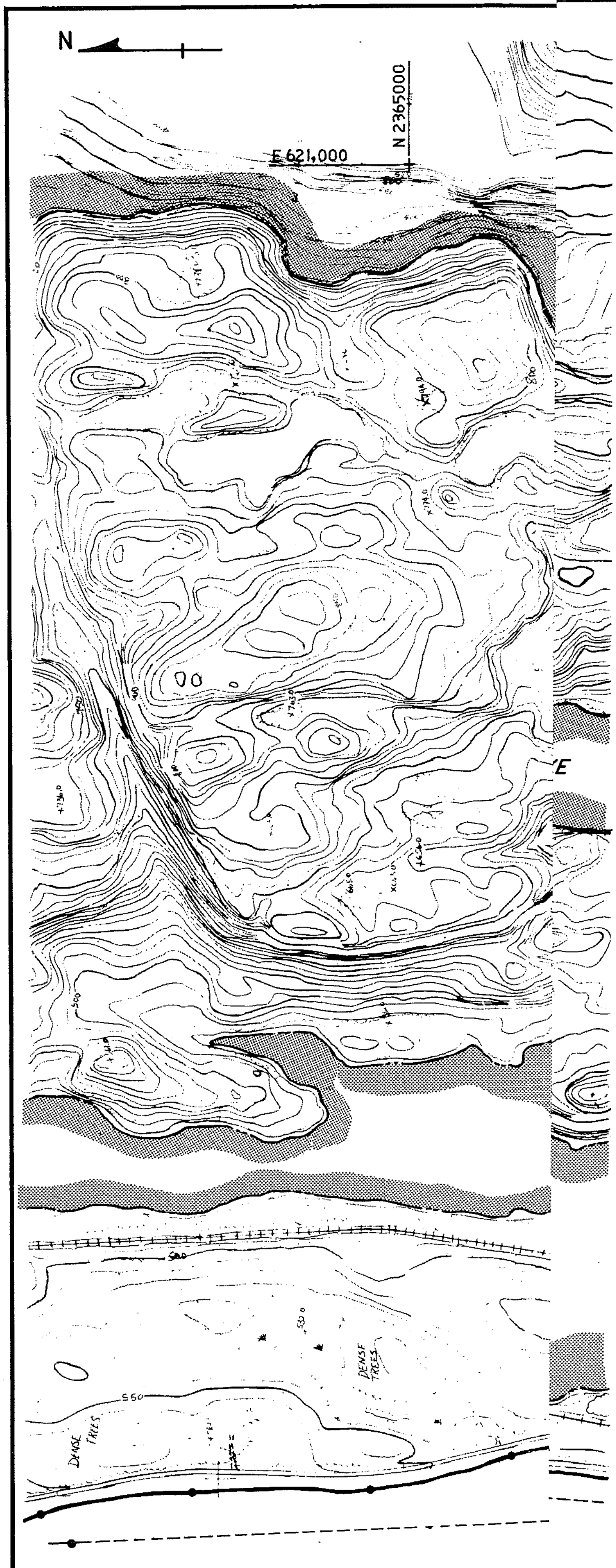

LEGEND:

- PIPELINE AND TUNNEL
- ACCESS ROAD
- NEW 115 kV TRANSMISSION LINE
- EXISTING 24.9 kV TRANSMISSION LINE

NOTES:

1. TOPOGRAPHY IS BASED ON MAPPING PREPARED BY NORTH PACIFIC AERIAL SURVEYS, INC., AND SURVEYS CONDUCTED BY R&M CONSULTANTS, INC., IN 1981 AND 1982.
2. VERTICAL CONTROL IS BASED ON U.S.G.S. DATUM (MEAN SEA LEVEL). HORIZONTAL CONTROL IS BASED ON THE ALASKA STATE PLANE GRID SYSTEM, ZONE 4.
3. ALL ROADS ARE CLASS B EXCEPT THE PRIMAY ACCESS ROAD FROM THE SEWARD-ANCHORAGE HIGHWAY TO THE POWER-HOUSE, WHICH IS CLASS A.

400′ 0′ 400′ 800′ 1200′

SCALE

ALASKA POWER AUTHORITY

GRANT LAKE HYDROELECTRIC PROJECT

SELECTED
PROJECT ARRANGEMENT
SITE PLAN

FIGURE 1-3

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Grant Lake lies approximately one and one-half miles south and east of Moose Pass at an elevation of about 696 ft above mean sea level (MSL). Moose Pass lies slightly above elevation 500 ft. The lake is fed by Inlet Creek at its headwaters and several other glacial-fed, intermittent streams flowing mainly from the east. Grant Lake is drained at its south end by Grant Creek, which flows west about one mile and empties into the narrows between Upper and Lower Trail Lakes. Falls Creek, located about two miles south of the south end of Grant Lake, flows into the Trail River a short distance below Lower Trail Lake. The Trail River then enters Kenai Lake, which empties into the Kenai River. The Kenai River, the largest river on the Kenai Peninsula and the premier sport and subsistence fishing river in southcentral Alaska, flows into Cook Inlet near the City of Kenai.

1.2 PHYSICAL FEATURES

Grant Lake, with a surface area of approximately 2.6 square miles, reaches depths of nearly 300 ft. During periods of heavy runoff, primarily the summer months, the lake's waters are quite opaque due largely to glacial flour received from glaciers that cap the ring of mountains comprising its watershed. Because the lake is partially divided into two basins by a narrow and relatively shallow channel located near the lake's mid-point, the upper basin is slightly more turbid than the lower basin. The mountains bordering the lake on the north, east, and south are steep and tall, reaching elevations of 4,500 to 5,500 ft. They are part of the Kenai Mountain Range. The total drainage area of Grant Lake is approximately 44 square miles.

The average flow of Grant Creek, Grant Lake's only outlet, is about 200 cubic ft per second (cfs). Water quality is satisfactory for both aquatic life and human usage. Stream waters are soft, neutral in pH, highly oxygenated, nutrient poor, and quite cold with temperatures rarely above 55 degrees F.

The geology of the Project site and vicinity is associated with the upper cretaceous age of the mesozoic era and is 64 to 100 million years old. Most of Grant Lake and other Project waters are underlain by low-grade metamorphozed sedimentary rock, predominantly graywacke and slate. The area is within the general band of earthquake activity called the Pacific Earthquake Zone that extends well into the Aleutian Island range (Hartman and Johnson 1978).

1.3 ECOLOGICAL SETTING

The ecological setting of the Project site and vicinity reflects the area's low average temperatures, prolonged freezing in the winter, and the relative geographic isolation of the Kenai Peninsula from the principal land mass of Alaska. Low overall temperatures limit biological productivity of both plant and animal communities, while the cold and lengthy winters significantly constrain carrying capacity for resident species. The area's geographic isolation has limited the diversity of plant and animal species.

Grant Creek, a tributary of Trail River, and the sole outlet stream of Grant Lake possesses a mixture of resident and anadromous salmonids, including salmon, trout, and char, as well as other fish species. Most fish populations are relatively small. Grant Lake, though lacking salmonids because of an impassable falls at its outlet, possesses an apparently robust population of threespine stickleback and sculpin. The lower reaches of Grant Creek possess small runs of sockeye salmon, chinook salmon, coho salmon, and populations of Dolly Varden char and resident rainbow trout.

The Project lies within a vegetational transition zone between boreal and coastal coniferous forests dominated by Sitka spruce and hemlock as climax species. These and most other plant species occur at relatively low elevations. Timberline lies between 1,000 and 1,500 ft elevation.

Floral species possessing special adaptation to snow avalanches, dessication, and freezing occur at higher elevations. Willow and alder often occupy intervening areas between forest and alpine species.

The dominant herbivores of the Project site and vicinity are moose and mountain goat. Major carnivores are brown and black bear and wolf. No endangered or threatened species are known to occur.

1.4 HUMAN RESOURCES

The Project site and vicinity has been heavily influenced by the historic development of the Alaska Railroad and gold mining activities, both dating from near the beginning of the twentieth century. Near the Project site the Alaska Railroad follows the path of the historic Iditerod Trail, the first overland transportation route from southcentral Alaska to Nome and interior Alaska. Numerous remains of gold mining operations, and some more recent claims, can be found in the Project vicinity.

Seward, a town of approximately 2,000 people, is the nearest incorporated city to the Project. The only other communities in the Project vicnity with significant populations are Moose Pass, less than two miles distant from the Project, and Cooper Landing, located approximately 24 miles northwest of the Project.

The principal outdoor recreational pursuits in the Project vicinity are fishing, hunting, camping, and hiking. While the Kenai River downstream of Kenai Lake is the dominant sport fishing river in southcentral Alaska, the Project vicinity does support limited sport fishing near the mouth of Grant Creek and some hunting, camping, and hiking activity near Grant Lake.

The Project site is characteristic of most undeveloped lands along the highway between Anchorage and Seward and offers a relatively pristine and unspoiled landscape to travellers along the highway and recreationists using the area. There are few roads of any length leading from the highway, and little major development away from the highway and the railroad.

At the present time the Project site lies within the Chugach National Forest. However, in the near future, much of the western portion of the Project site will be deeded to the state and, subsequent to that action, conveyed to the Kenai Peninsula Borough. While land uses in the conveyed lands may be altered from their present forest and multiple use functions, necessary Project easements will be retained by the United States Government for the operation of Forest Service facilities and by the State of Alaska for the operation and maintenance of the Grant Lake Hydroelectric Project.

1.5 PROPOSED PROJECT DEVELOPMENT

The proposed Grant Lake Hydroelectric Project, depicted in Figure 1-3, is composed of the following principal facilities:

- Grant Lake intake
- Power tunnel and penstock
- Gate shaft
- Powerhouse
- Tailrace
- Transmission line
- Recreation area
- Access roads to powerhouse, gate shaft-intake area, and recreation area
- Fisheries facilities

The earliest Project construction could begin is the spring of 1985, with completion in the spring of 1987. The Project will generate an average of approximately 25,400,000 kilowatt-hours of electric power annually, possessing a peaking capacity of approximately 7 megawatts.

2.0 REPORT ON WATER USE AND QUALITY

This section summarizes the available information on water use and water quality in the Project vicinity, the expected impacts of the Project on water use and water quality, and mitigating measures to minimize these impacts. For purposes of discussion, the water quality study area is defined as waters of Grant Creek, Grant Lake and Falls Creek.

2.1 EXISTING AND PROPOSED WATER USE

Streamflow data for Grant Creek are based on an 11.5-year record of U.S. Geological Survey (USGS) gage 15246000. Streamflow data for Falls Creek are based on a 0.5-year record of a gage near the mouth of the creek, and on statistical relationships between the Grant and Falls creek watersheds. Information on water use was obtained from review of water rights and mining permits, field reconnaissance, aerial photographs, and published maps.

2.1.1 Existing Water Use

2.1.1.1 Grant Lake

A seasonal mining operation located on the north shore of Grant Lake's lower basin (see land-use map, Figure 9-1) uses lake water from May through November. Most of the water is used for placer mining, although presumably a small amount is used for domestic purposes. Limited use of Grant Lake water is also made by hunting parties that occasionally occupy the cabin at the eastern end of the upper basin (Figure 9-1). Recreational uses of Grant Lake are discussed in Chapter 7.

2.1.1.2 Grant Creek

Recreational use of Grant Creek consists primarily of fishing along the lower one-half mile. No domestic use is made of Grant Creek water.

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2.1.1.3 Falls Creek

Falls Creek is used extensively for placer mining during the summer months. Land adjacent to Falls Creek is almost continuously claimed for placer mining from elevation 1300 ft to the mouth of the creek, as shown in Figure 9-1. Several cabins located within two miles of the creek confluence with Trail River operate under Forest Service special use permits that identify no domestic water use. Because most of these cabins are used only on weekends or for vacations, it is likely that most of the water used is carried in from outside the Project vicinity (Quilliam 1982).

2.1.2 Water Rights

Under Alaska state law, water rights can be obtained only by applying to the Alaska Department of Natural Resources, and receiving either a Permit to Appropriate Water or a Certificate of Appropriation. "The use of water without a permit or certificate does not give the user defensible legal rights to the water, no matter how long the water has been in use or continues to be in use" (Alaska Department of Natural Resources 1981). Two Permits to Appropriate Water have been issued for the Project vicinity. The first is for a placer mining operation on Falls Creek at approximately elevation 1200 ft. The appropriated amount is one cubic foot per second (cfs). The second appropriation is for the mining operation located on the north shore of Grant Lake's lower basin and consists of 160 gallons per minute (0.36 cfs) to be taken from Grant Lake and an unnamed stream flowing into Grant Lake. The appropriation does not specify how the water right is divided between the stream and the lake.

2.1.3 Proposed Uses of Project Waters

The Alaska Department of Fish and Game (ADF&G) has constructed a salmon hatchery on Upper Trail Lake, well outside the Project vicinity. The hatchery uses groundwater as its water supply. ADF&G is planning to use Grant Lake as rearing habitat for salmon originating from the hatchery, as discussed in Chapter 3.

2.2 EXISTING WATER QUALITY

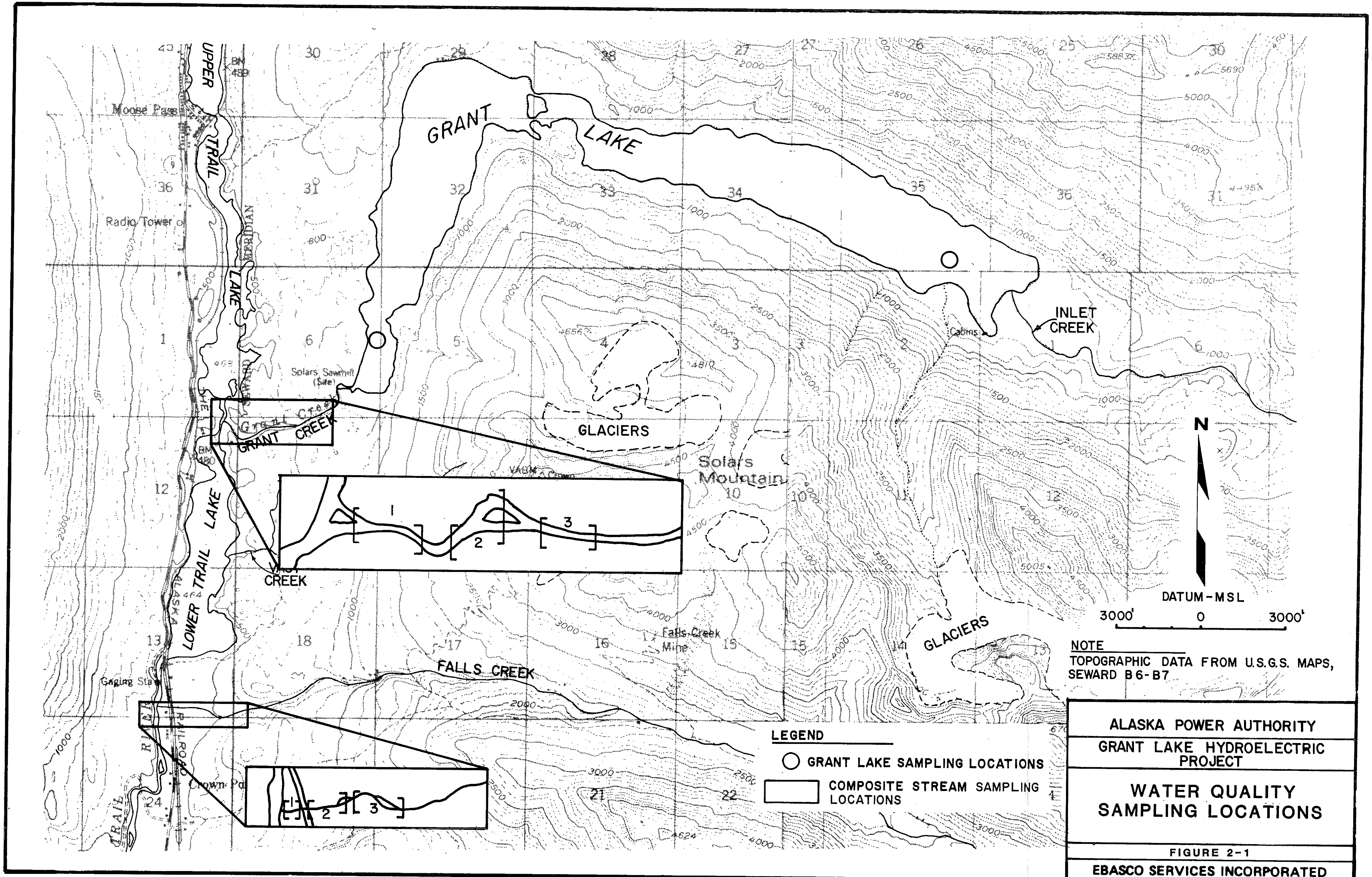
2.2.1 Water Quality Data Sources

2.2.1.1 Historical Data

A limited amount of water quality data was collected in the study area between 1959 and 1981. A limnological survey by the U.S. Fish and Wildlife Service (USFWS) in 1961 obtained temperature and dissolved oxygen data at Grant Lake, Grant Creek, and Falls Creek. ADF&G (1981) and the Forest Service (Quilliam 1982) conducted a limnological survey of Grant Lake in 1981, and also collected data on dissolved oxygen and temperature. The U.S. Geological Survey (USGS 1981) has collected a limited amount of water quality data on the Project waters since 1950, including pH, nutrients, dissolved solids, and temperature. The results of these studies are discussed in Section 2.3.

2.2.1.2 Monitoring Program

To establish baseline water quality conditions in the study area, a year-long water quality monitoring program was conducted at Grant Lake and Grant and Falls creeks (AEIDC 1982). Sampling dates were October 12-15, 1981 and March 1-3, June 8-10, and August 2-4, 1982. Supplemental temperature, turbidity, and sediment data were obtained during August 25-29, 1982. Samples were collected from Grant Lake, Grant Creek, and Falls Creek at the locations shown in Figure 2-1. In Grant and Falls creeks samples were obtained from near the stream surface, approximately one to two ft from shore. Additional Grant Lake temperature profiles are planned to be collected during the winter of 1982-83.


GRANT LAKE
UPPER TRAIL LAKE
LOWER TRAIL LAKE
Moose Pass
Radio Tower
GRANT CREEK
CREEK
INLET CREEK
Cabins
GLACIERS
Solars Mountain
Falls Creek Mine
FALLS CREEK
Gaging Sta
ALASKA RAILROAD
TRAIL
N
DATUM-MSL
3000' 0 3000'
NOTE
TOPOGRAPHIC DATA FROM U.S.G.S. MAPS, SEWARD B6-B7
LEGEND
GRANT LAKE SAMPLING LOCATIONS
COMPOSITE STREAM SAMPLING LOCATIONS
ALASKA POWER AUTHORITY
GRANT LAKE HYDROELECTRIC PROJECT
WATER QUALITY SAMPLING LOCATIONS
FIGURE 2-1
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Water quality parameters measured and analytical techniques used on the samples are listed in Table 2-1. For Grant and Falls creeks one sample was obtained from each stream reach shown in Figure 2-1 and composited in the field so that one analysis was made for each parameter per stream. Grant Lake measurements of temperature and dissolved oxygen were taken at 3.28 ft (1 m) intervals from the surface to 164 ft (50 m) in depth. All other parameters were measured at the surface of the two basins. The upper and lower basin samples were composited for the October 1981 and March 1982 sampling dates, but were analyzed separately for June and August 1982 for all parameters except trace metals. In addition to surface samples, measurements of suspended solids and turbidity in the upper and lower basins of Grant Lake were obtained at a 164 ft (50 m) depth during June and August 1982.

In situ water quality measurements were obtained with a YSI Model 33 salinity/conductivity/temperature meter, a pocket thermometer (-35° to 50°C), a YSI Model 51B dissolved oxygen meter, a Horizon analog pH meter, and a Secchi disc. A 1.2 liter Kemmerer sampling bottle was used for collecting water samples. Composite samples were placed in a polyethylene carboy and one liter samples were drawn in polyethylene containers, stored in an ice cooler, and returned within 24 hours to Anchorage for analysis. Samples for trace metals were placed in metal-free containers and fixed with nitric acid. All in situ data was collected by Arctic Environmental Information and Data Center (AEIDC). Trace metals were analyzed by Am Test, Inc. of Seattle, Washington with the exception of the October, 1981 samples, which were analyzed by Chemical and Geological Laboratories of Alaska, Inc. of Anchorage, Alaska. All other parameters were analyzed by Chemical and Geological Laboratories of Alaska, Inc.

2.2.2 Water Quality Standards

None of the water bodies in the study area have been classified into water use categories by the state. The Alaska water quality standards

TABLE 2-1
ANALYTICAL METHODS USED IN WATER QUALITY MONITORING PROGRAM

Parameter	Method	Detection Limit[a]
Nitrate	Brucine	0.1
Phosphate (ortho, as P)	Colorimetric, Ascorbic Acid, Single reagent	0.01
Alkalinity (as $CaCO_3$)	Titration	2.0
Hardness (as $CaCO_3$)	Calculation	1.0
Turbidity (NTU)	Nephelometer	0.05 NTU
Conductivity	Wheatstone Bridge	1.0 mho/cm
pH	Electrometric	0.05 pH units
Dissolved oxygen	Membrane Electrode	0.1
Total dissolved solids	Gravimetric	1.0
Suspended solids	Gravimetric	1.0
Coliform bacteria	Membrane filter	0/100 ml
Silver	ICAP,[b] Graphite Furnace AA[c]	0.05, 0.0003
Aluminum	ICAP, Flame AA	0.05, 0.1
Calcium	ICAP, Flame AA	0.05, 0.02
Cadmium	ICAP, Graphite Furnace AA	0.01, 0.0001
Chromium	ICAP, Graphite Furnace AA	0.05, 0.0005
Copper	ICAP, Graphite Furnace AA	0.05, 0.001
Iron	ICAP, Graphite Furnace AA	0.02, 0.05
Mercury	ICAP, Cold Vapor Technique	0.05, 0.0002
Potassium	ICAP, Flame AA	0.05, 0.01
Magnesium	ICAP, Flame AA	0.05, 0.01
Sodium	ICAP, Flame AA	0.05, 0.002
Lead	ICAP, Graphite Furnace AA	0.05, 0.001
Zinc	ICAP, Flame AA	0.05, 0.005
Chloride	Mercuric Nitrate	0.2
Sulfate	Turbidimetric	1.0

a/ mg/l unless otherwise indicated.
b/ ICAP - Inductively coupled Argon Plasma Scan. This method was used was used only for selected parameters in the October, 1981 samples.
c/ AA - Atomic Absorption

TABLE 2-1 (continued)

Sheet 2 of 2

Parameter	Method	Detection Limit[a/]
Arsenic	ICAP	0.05
Gold	ICAP	0.05
Boron	ICAP	0.05
Barium	ICAP	0.05
Bismuth	ICAP	0.05
Cobalt	ICAP	0.05
Manganese	ICAP	0.05
Molybdenum	ICAP	0.05
Nickel	ICAP	0.05
Phosphorous	ICAP	0.05
Platinum	ICAP	0.05
Antimony	ICAP	0.05
Selenium	ICAP	0.05
Silicon	ICAP	1.0
Tin	ICAP	0.1
Strontium	ICAP	0.02
Titanium	ICAP	0.05
Tungsten	ICAP	1.0
Vanadium	ICAP	0.05
Zirconium	ICAP	0.05

(Tables 2-2 and 2-3) state that all unclassified fresh waters shall meet the standards for: 1) Water Supply, including drinking water, 2) Water Recreation, including swimming, and 3) Growth and Propagation of Fish, Shellfish, and other Aquatic Life, and Wildlife (18 AAC 70.050). When the water quality standards vary for the three categories, the most stringent applies (Hayden 1982). The U.S. Environmental Protection Agency (EPA) criteria for freshwater aquatic life and the National Drinking Water Regulations are also presented in Tables 2-2 and 2-3.

2.2.3 Summary and Discussion of Study Area Water Quality

Existing water quality data indicate that study area waters are generally of good quality and meet all applicable water quality standards. Certain trace metal concentrations, however, occasionally exceeded the 24-hour average EPA criteria for freshwater aquatic life as discussed below. Study area water characteristics are similar to other water bodies in the Kenai River Drainage. Grant Lake is oligotrophic (low in nutrients) as are most deep wilderness lakes of southcentral Alaska. Study area waters are slightly acidic to neutral in pH, soft, and low in suspended and dissolved solids. A detailed discussion of the chemical, physical, and bacteriological data collected to date is given below. Data collected during the monitoring program is presented in Tables 2-3, 2-4, and 2-5, and also shown graphically in Figures 2-2 to 2-5. All values given for Grant Lake represent a composite sample of upper and lower basin surface water, unless otherwise noted.

2.2.3.1 Water Clarity and Suspended Solids

Several small glaciers drain into Grant Lake resulting in blue-green colored water typical of glacial drainages. Turbidity and suspended solids levels, however, have been consistently low throughout the monitoring period. Water clarity data (Secchi disc readings, turbidity, and suspended solids levels) are listed in Table 2-5 for Grant Lake and shown graphically for Grant Lake, Grant Creek, and Falls Creek in Figure 2-2.

TABLE 2-2

WATER QUALITY CRITERIA AND APPLICABLE STANDARDS

Parameter	Alaska Standard[a/]	EPA Criteria[b/]	EPA Drinking Water Regulations[c/]
Nitrate (mg/l)	No standard	No recommendation	Less than 10 mg/l
Phosphate (Ortho)	No standard	No recommendation	No regulation
Total Hardness (as $CaCO_3$ in mg/l)	No standard	No recommendation	No regulation
Alkalinity (as $CaCO_3$ in mg/l)	No standard	20 mg/l or more except where natural conditions are less	No regulation
Total Dissolved Solids (mg/l)	Not to exceed 500 mg/l. Neither chlorides nor sulfates shall exceed 200 mg/l.	No recommendation	Less than 500 mg/l
Suspended Solids (mg/l)	No measurable increase in concentrations of sediment above natural conditions.	Should not reduce the depth of the compensation point for photosynthetic activity by more than 10 percent from the seasonally established norm	No regulation
pH (standard units)	6.5 - 9.0; not to vary more than 0.5 pH units from natural conditions	6.5 - 9.0	Less than 6.5-8.5
Water Clarity (m)	No standard	No recommendation	No regulation
Turbidity (NTU)	Not to exceed 5 NTU above natural conditions	Depth of light penetration should not be reduced by more than 10 percent	Less than one NTU
Conductivity (umhos/cm)	No standard	No recommendation	No regulation
Coliform (number/100 ml)	Less than 2 FC/100 ml	No recommendation	Less than 1 FC/100 ml
Dissolved oxygen (mg/l)	Shall be greater than 7 mg/l in surface waters	Greater than 5.0 mg/l	No regulation
Temperature	Shall not exceed 15°C	Shall meet site-specific requirements for reproduction functions of important species	No regulation
Aluminum	No standard[d/]	No recommendation	No regulation
Calcium	No standard[d/]	No recommendation	No regulation
Chloride	Shall not exceed 200 mg/l	No recommendation	250 mg/l
Iron	1.0 mg/l[d/]	1.0 mg/l	0.3 mg/l
Magnesium	No standard[d/]	No recommendation	No regulation
Potassium	No standard[d/]	No recommendation	No regulation
Sodium	No standard[d/]	No recommendation	No regulation
Sulfate	Shall not exceed 200 mg/l	No recommendation	250 mg/l

a/ Water quality parameters as given in Water Quality Standards, Alaska Department of Environmental Conservation, 1979.

b/ Freshwater aquatic life criteria as given by U.S. Environmental Protection Agency in Quality Criteria for Water, 1976 andrevised criteria presented in the Federal Register, Vol. 45, No. 231, November 28, 1980.

c/ EPA National Interim Primary Drinking Water Regulations, 40 CFR 141, and EPA National Secondary Drinking Water Regulations, 40 CFR 143.

d/ Based on the Alaska Water Quality Standard requiring the concentration to not exceed the EPA criteria in EPA (1976).

TABLE 2-2 (continued)

WATER QUALITY CRITERIA AND APPLICABLE STANDARDS

Sheet 2 of 2

Parameter	Alaska Standard[a]	EPA Criteria[b]	EPA Drinking Water Regulations[c]
Arsenic	440 mg/l[d]	440 mg/l	No regulation
Gold	No Standard[d]	No recommendation	No regulation
Boron	No Standard[d]	No recommendation	No regulation
Barium	No Standard[d]	No recommendation	No regulation
Bismuth	No Standard[d]	No recommendation	No regulation
Cobalt	No Standard[d]	No recommendation	No regulation
Manganese	No Standard[d]	No recommendation	0.05 mg/l
Molybdenum	No Standard[d]	No recommendation	No regulation
Nickel	643 mg/l[d]	643 mg/l	No regulation
Phosphorous	No Standard[d]	No recommendation	No regulation
Platinum	No Standard[d]	No recommendation	No regulation
Antimony	No Standard[d]	No recommendation	No regulation
Selenium	260 mg/l[d]	260 mg/l	No regulation
Silicon	No Standard[d]	No recommendation	No regulation
Tin	No Standard[d]	No recommendation	No regulation
Strontium	No Standard[d]	No recommendation	No regulation
Titanium	No Standard[d]	No recommendation	No regulation
Tungsten	No Standard[d]	No recommendation	No regulation
Vanadium	No Standard[d]	No recommendation	No regulation
Zirconium	No Standard[d]	No recommendation	No regulation

TABLE 2-3

TRACE METALS: MONITORING PROGRAM RESULTS AND APPLICABLE STANDARDS

Metal	APPLICABLE STANDARD OR CRITERIA (μg/l)				DATA (μg/l) 1982[a]							
	EPA Criteria[b]		EPA Drinking Water Standards[c]	Alaska Water Quality Standards[d]	Grant Lake			Grant Creek			Falls Creek	
	Max[e]	24-hr Avg [e]			March	June	August	March	June	August	June	August
Cadmium	0.7	0.006	10	0.4	0.3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium (trivalent)	1050	no std.	50	100	0.6	0.8	1.4	0.5	<0.5	0.6	3.7	<0.5
Copper	6.0	5.6	1000	0.1 x LC50[f]	3	2	18	2	<1	2	4	1
Lead	32	0.15	50	0.1 x LC50	9	2	5	4	<1	<1	2	<1
Mercury	4.1	0.2	2	0.05	<0.2	NM[g]	NM	<0.2	NM	NM	NM	NM
Silver	0.37	no std.	50	0.1 x LC50	<0.3	0.3	<0.3	<0.3	<0.3	<0.3	<0.3	0.3
Zinc	73	47	5000	0.1 x LC50	<5	6	15	125	6	<5	8	8

a/ Additional parameters were measured in October, 1981 only. These included barium, cobalt, manganese, and phosphorous in all three water bodies. All were below detection limits. In addition, arsenic, gold, boron, bismuth, molybdenum, nickel, platinum, antimony, selenium, tin, strontium, titanium, tungsten, vanadium and zirconium were measured in the creeks. All were below detection limits except strontium, which measured 0.06 mg/l in Grant Creek and 0.07 mg/l in Falls Creek.

b/ Freshwater aquatic life criteria as given by U.S. Environmental Protection Agency in Quality Criteria for Water, 1976 and revised criteria presented in the Federal Register, Vol. 45, No. 231, November 28, 1980.

c/ EPA National Interim Primary Drinking Water Regulations, 40 CFR 141, and EPA National Secondary Drinking Water Regulations, 40 CFR 143.

d/ Based on the Alaska Water Quality Standard requiring the concentration to not exceed the EPA criteria in EPA (1976).

e/ Based on the minimum hardness value obtained during the monitoring program, 25 mg/l.

f/ LC50 - a 96-hour LC50 as determined through bioassay using a sensitive resident species.

g/ NM = Not measured.

2200B

TABLE 2-4

MONITORING PROGRAM RESULTS

Parameter	Grant Lake - Surface Water						Grant Creek				Falls Creek		
	October 1981	March 1982	June 1982 Lower Basin	June 1982 Upper Basin	August 1982 Lower Basin	August 1982 Upper Basin	October 1981	March 1982	June 1982	August 1982	October 1981	June 1982	August 1982
Nitrate (mg/l)	0.21	0.34	0.31	0.38	0.11	<0.1	0.18	0.36	0.25	<0.1	0.11	0.12	<0.1
Orthophosphate (mg/l)	<0.01	0.13	<0.01	<0.01	<0.01	<0.01	<0.01	0.04	<0.01	<0.01	<0.01	<0.01	<0.01
Total hardness (mg/l as $CaCO_3$)	32	30	27	31	33	27	31	30	28	28	39	27	25
Alkalinity (mg/l as $CaCO_3$)	20	28	20	10	24	24	18	26	19	24	24	17	20
Total dissolved solids (mg/l)	51	87	33	28	41	47	34	84	31	48	60	24	33
Suspended solids (mg/l)	8.6	4	1.3	2	1.3	1.3	0.6	1	1	4.3	<1.0	86	2.3
pH (standard units)	6.2	7.3	NM[b]	NM	7.6	7.3	6.2	7.2	NM	7.2	6.3	NM	7.3
Water clarity (m)	2	NM	5	2.5	2	0.5	NM	NM	NM	NM	NM	NM	NM
Turbidity (NTU)	3.8	0.5	0.2	0.4	0.7	1.9	0.8	0.4	0.4	1.1	0.4	6.0	0.5
Conductivity (umhos/cm)	61	8	59	48	61	48	51	14	60	NM	60	150	45
Coliforms (No./100 ml)	0	0	0	0	0	0	0	0	0	0	0	0	0
Sulfate (mg/l)	NM	6.3	5.9	6.5	4.5	4.8	NM	6.2	4.0	4.9	NM	5.4	4.8
Chloride (mg/l)	<1.0	<1.0	2	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Aluminum (mg/l)	0.34	<0.1	<0.1[a]		0.2[a]		0.06	0.2	<0.1	0.1	<0.05	1.2	0.1
Iron (mg/l)	0.41	0.08	0.05[a]		0.40[a]		0.18	0.06	0.05	0.17	0.07	0.93	<0.05
Calcium (mg/l)	11	12.5	13.0[a]		9.9[a]		11	11.7	10.0	10.0	14	8.5	7.7
Potassium (mg/l)	0.7	0.59	0.44[a]		0.51[a]		0.5	0.48	0.44	0.46	0.60	0.62	0.42
Magnesium (mg/l)	0.98	0.89	0.79[a]		0.95		0.81	0.75	0.77	0.83	10	1.3	0.79
Sodium (mg/l)	0.99	0.92	0.75[a]		0.84[a]		0.8	0.98	0.76	0.79	1.1	0.69	0.61
Silicon (mg/l)	1.7	NM	NM		NM		1.5	NM	NM	NM	1.7	NM	NM
Temperature (°C)	(See Figures 2-6 and 2-7, and Table 2-6)						6.0	1.0	6.5	12.5	3.5	4.0	5.5

a/ Composite sample of Upper and Lower Grant Lake

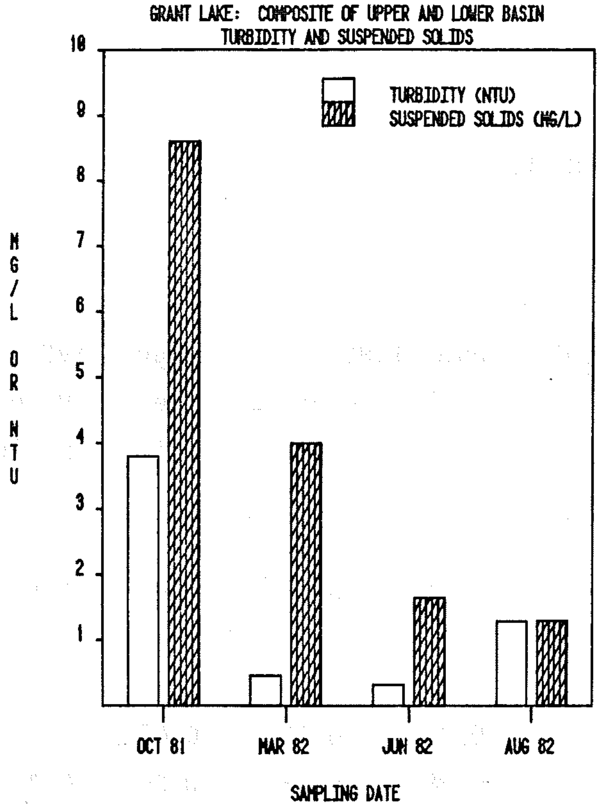
b/ NM - Not measured

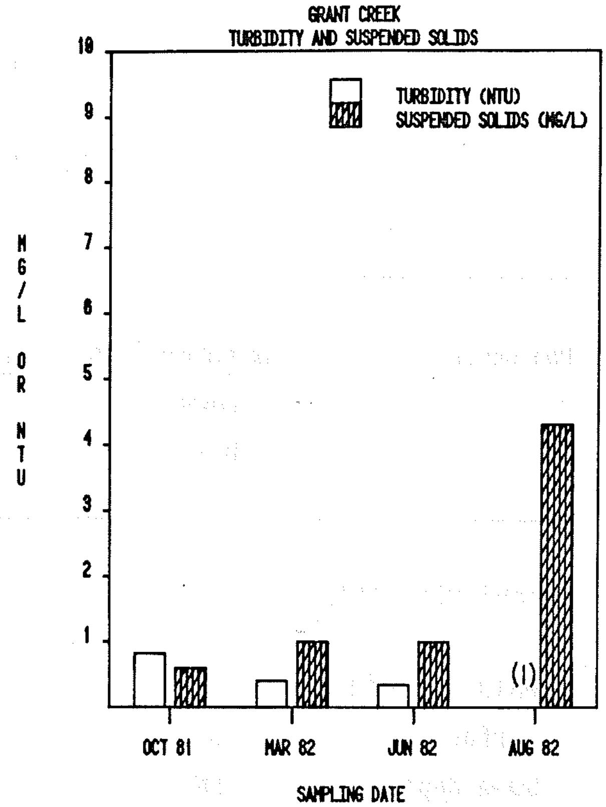
TABLE 2-5

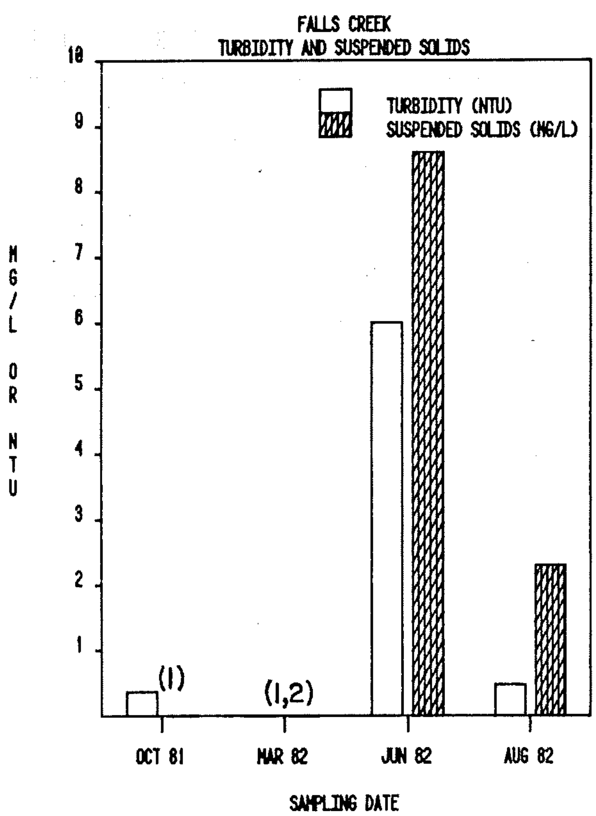
GRANT LAKE WATER CLARITY

Parameter	October 1981 Lower Basin	March 1982 Lower Basin	June 1982 Lower Basin	June 1982 Upper Basin	August 1982 Lower Basin	August 1982 Upper Basin
Secchi Disc (ft)	6.6	NM[a/]	16.4	8.2	6.6	1.6
Turbidity (NTU)						
surface	3.8	0.46	0.24	0.40	0.67	1.9
50-m depth	NM	NM	0.28	0.43	0.24	0.46
Suspended Solids (mg/l)						
surface	8.6	4.0	1.3	2.0	1.3	1.3
50-m depth	NM	NM	1.1	1.9	0.3	1.0

a/ NM = Not measured







(1) NOT MEASURED
(2) FALLS CREEK FROZEN MARCH 1982

Source: AEIDC 1982

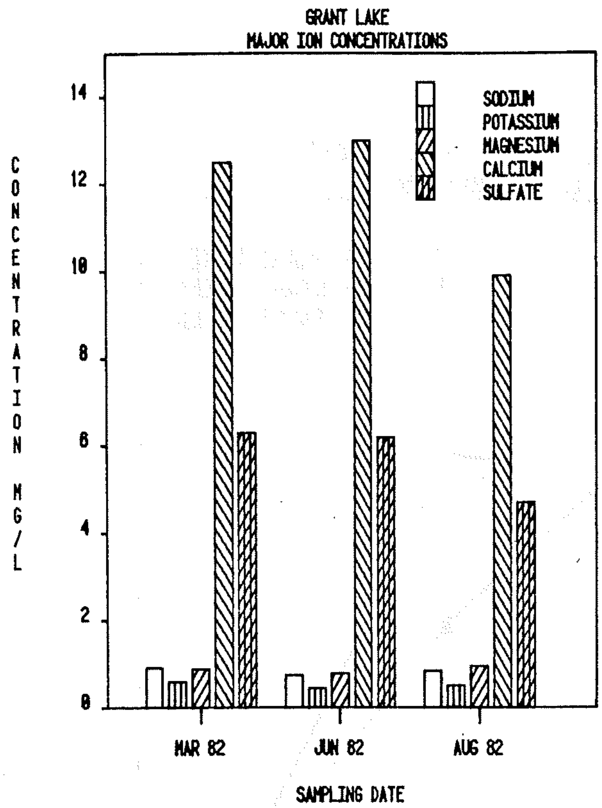
ALASKA POWER AUTHORITY

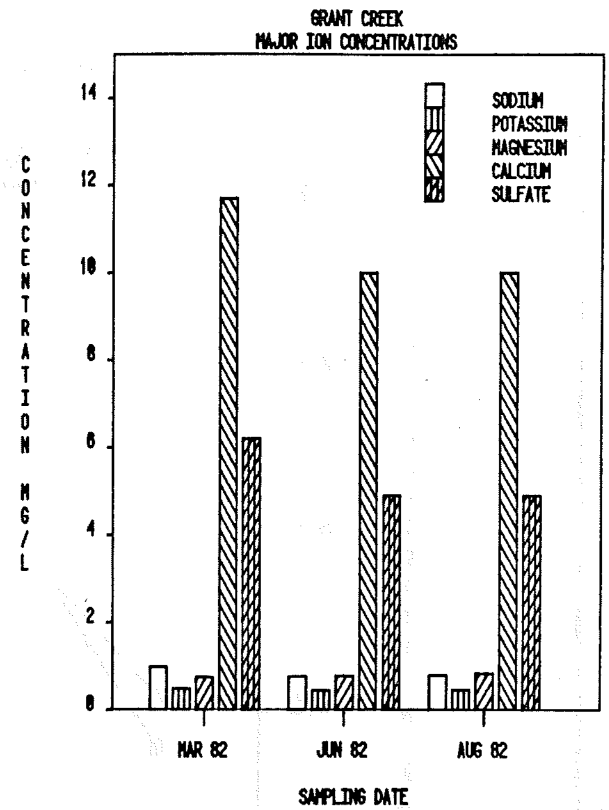
GRANT LAKE HYDROELECTRIC PROJECT

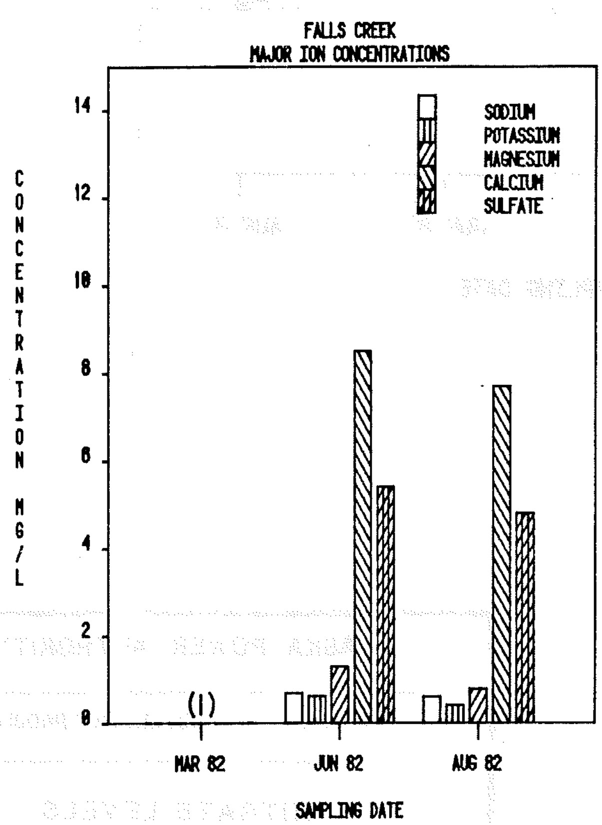
TURBIDITY AND SUSPENDED SOLIDS

FIGURE 2-2

EBASCO SERVICES INCORPORATED







(I) FALLS CREEK FROZEN MARCH 1982

Source: Am Test, Inc.

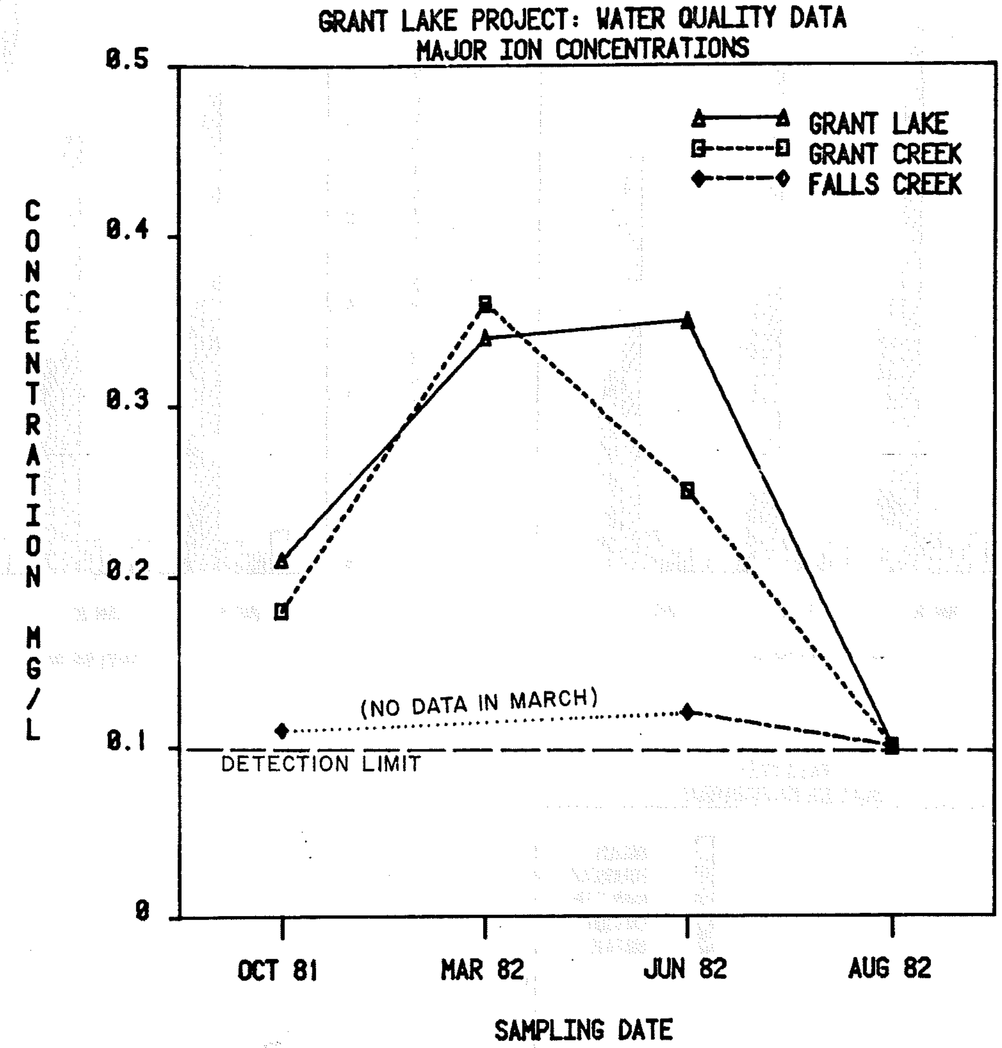
ALASKA POWER AUTHORITY

GRANT LAKE HYDROELECTRIC PROJECT

MAJOR ION CONCENTRATIONS

FIGURE 2-3

EBASCO SERVICES INCORPORATED



Source: AEIDC 1982

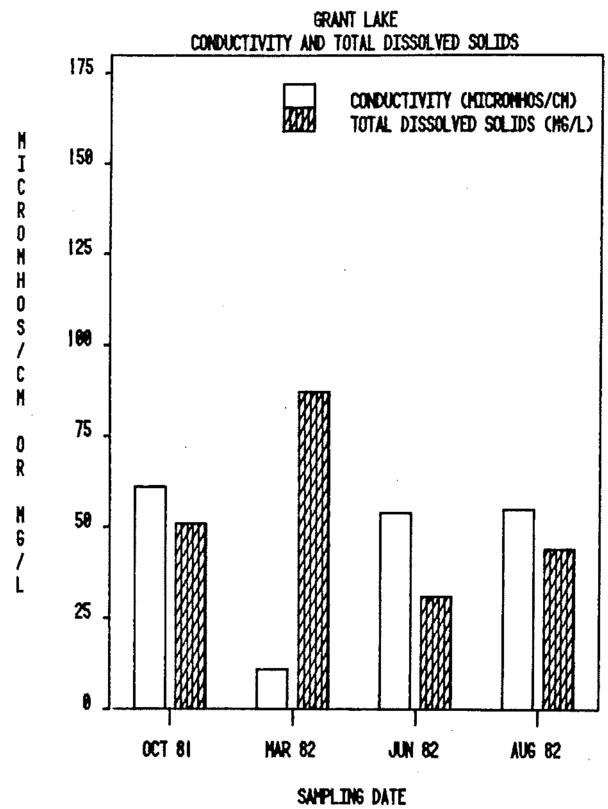
ALASKA POWER AUTHORITY

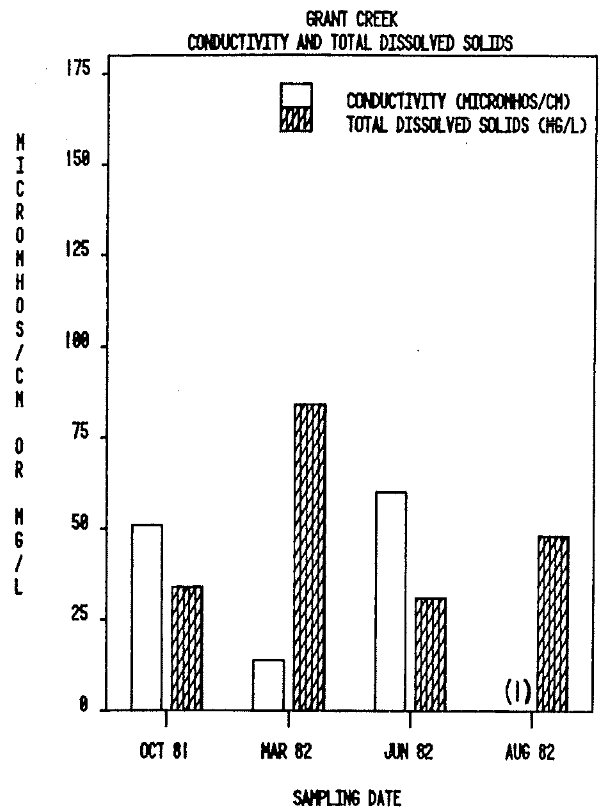
GRANT LAKE HYDROELECTRIC PROJECT

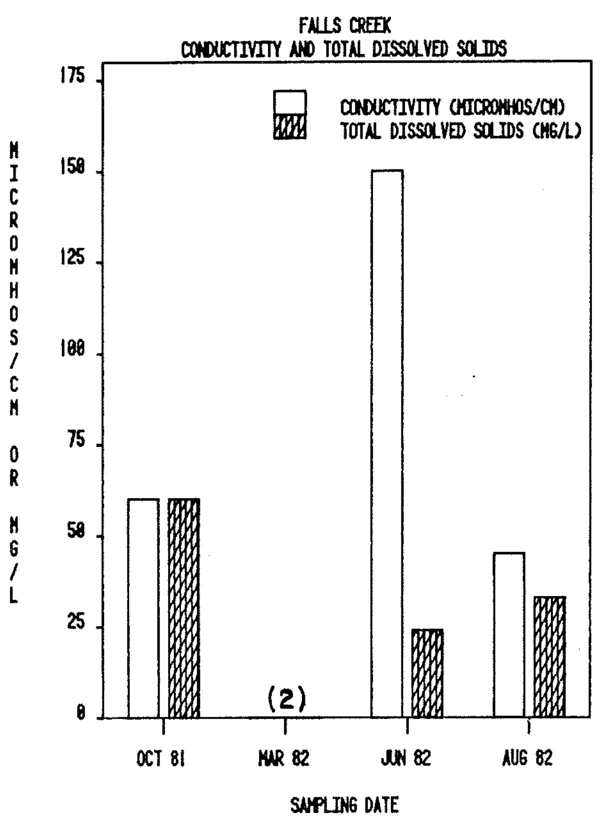
NITRATE LEVELS

FIGURE 2-4

EBASCO SERVICES INCORPORATED







(1) NOT MEASURED
(2) FALLS CREEK FROZEN MARCH 1982

Source: AEIDC 1982

ALASKA POWER AUTHORITY

GRANT LAKE HYDROELECTRIC PROJECT

CONDUCTIVITY AND TOTAL DISSOLVED SOLIDS

FIGURE 2-5

EBASCO SERVICES INCORPORATED

Grant Lake turbidity values ranged from 0.24 to 3.8 NTUs, with the highest value occurring in October 1981. It should be noted that the presence of "true color" (water color due to dissolved substances that absorb light) can cause measured turbidities to be low (APHA 1981). However, suspended solids levels in Grant Lake were also low, ranging from 0.3 to 8.6 mg/l. Although the suspended solids data appear to show a seasonal trend, the low precision of suspended solids measurements (a standard deviation of approximately 5 mg/l at a concentration of 15 mg/l suspended solids [APHA 1981]) precludes drawing conclusions on seasonal variations. Secchi disc readings ranged from 1.6 to 16.4 ft. The lower basin is consistently slightly clearer, less turbid, and generally lower in suspended solids than the upper basin, suggesting some settling in the upper basin.

Grant Creek turbidity values ranged from 0.40 to 0.80 NTUs and suspended solids ranged from 0.6 to 4.3 mg/l. Because Grant Creek is a surface outflow from Grant Lake, Grant Creek water quality values correspond closely to those of Grant Lake's lower basin.

Falls Creek turbidity values ranged from 0.35 to 6.0 NTUs and suspended solids levels varied from less than 1 to 8.6 mg/l. Suspended solids levels were presented during June, the high flow period of the year.

2.2.3.2 Dissolved Solids

The predominant ions present in the Grant Lake system are calcium, sulfate, magnesium, aluminum, potassium, sodium, chloride, iron, and bicarbonate. Observed concentrations for five ions are presented in Figure 2-3.

The major ionic concentrations for Grant Lake were consistently low and remained essentially constant throughout the monitoring period. Calcium ranged from 9.9 to 12.5 mg/l and sulfate from 4.5 to 6.5 mg/l. All other ionic concentrations were less than 2 mg/l.

Grant Creek ionic concentrations were similar to those of Grant Lake and showed very little seasonal variation. Falls Creek data showed similar ionic concentrations, although calcium levels were somewhat lower, ranging from 7.7 to 8.5 mg/l.

Alkalinity levels were low in all study area waters, indicating a low buffering capacity. Alkalinities ranged from 15 to 28 mg/l as $CaCO_3$, with the highest values occurring in March. The pH values ranged from 6.2 to 7.5, with the lowest values occurring in August. Study area waters are slightly acidic to neutral in pH, characteristic of water with a low buffering capacity.

Nutrients measured during the monitoring program were nitrate (Figure 2-4) and orthophosphate. Grant Lake nitrate concentrations ranged from less than 0.1 to 0.38 mg/l. Nitrate concentrations rose during the summer, reflecting low nitrate demand, and declined during the winter, reflecting nitrate consumption. Orthophosphate levels were below the detection limit of 0.01 mg/l for all samples except in March, 1982, when a value of 0.13 mg/l was measured.

Nutrient values in Grant Creek closely followed those of Grant Lake, as shown in Figure 2-4. Orthophosphate levels in Grant Creek were below 0.01 mg/l except during March, when the concentratiion was 0.04 mg/l. Nutrient levels in Falls Creek were consistently near the detection limits of 0.1 mg/l for nitrates and 0.01 mg/l for orthophosphates.

Total dissolved solids concentrations (Figure 2-5) should closely approximate the sum of all the major ionic components of the sampled water. For most of the samples, however, the sum of the ionic components was significantly less than total dissolved solids concentrations. The percentage of total dissolved solids represented by the ions ranged from 44 to 123 percent, with only two samples between 85 and 115 percent. Because the major ion concentrations were consistent, it is assumed that the total dissolved solids data are somewhat in error. This is supported by the October, 1981 sampling in which a number of additional ions were examined. Most were below detection limits; the rest occurred at very low concentration levels. Hence, there is no significant contribution to the dissolved solids from these constituents. Despite this uncertainty, however, dissolved solids levels were generally low. A dissolved solids range of 30-50 mg/l appears to be representative, indicating a soft, slightly mineralized water.

Conductivity values should be closely related to total dissolved solids. As shown in Figure 2-5, this is true for most of the samples. Conductivity values in March, however, appeared to be unreasonably low, and the June reading for Falls Creek appeared unreasonably high. In general, conductivity levels were low, consistent with other data showing low ionic concentrations.

2.2.3.3 Trace Metals

Trace metal concentrations obtained during the monitoring program are shown in Table 2-3 with the relevant water quality criteria and standards. The most stringent criteria are generally the 24-hour average concentrations for freshwater aquatic life issued by EPA. These criteria are dependent on hardness concentrations; low toxicity levels are associated with low hardness values. Because hardness levels in the study area waters were as low as 25 mg/l, the resulting criteria were often below analytical detection limits, as was the case for cadmium and lead. Concentrations of cadmium, copper, and zinc were above the 24-hour average criteria for freshwater aquatic life for one sample each (Table 2-3). Concentrations of lead were consistently above the 24-hour average criterion level of 0.15 micrograms per liter (ug/l) for freshwater aquatic life, but did not exceed the maximum concentration criteria of 32 ug/l.

Two trace metal concentrations appear to be a result of sample contamination because of their inconsistency with other values; the August Grant Lake reading of 18 ug/l copper, and the March 1982 Grant

Creek reading of 125 ug/l zinc. Other than these two measurements, all trace metal concentrations were below the maximum freshwater aquatic and human health criteria, and below the Alaska water quality standards.

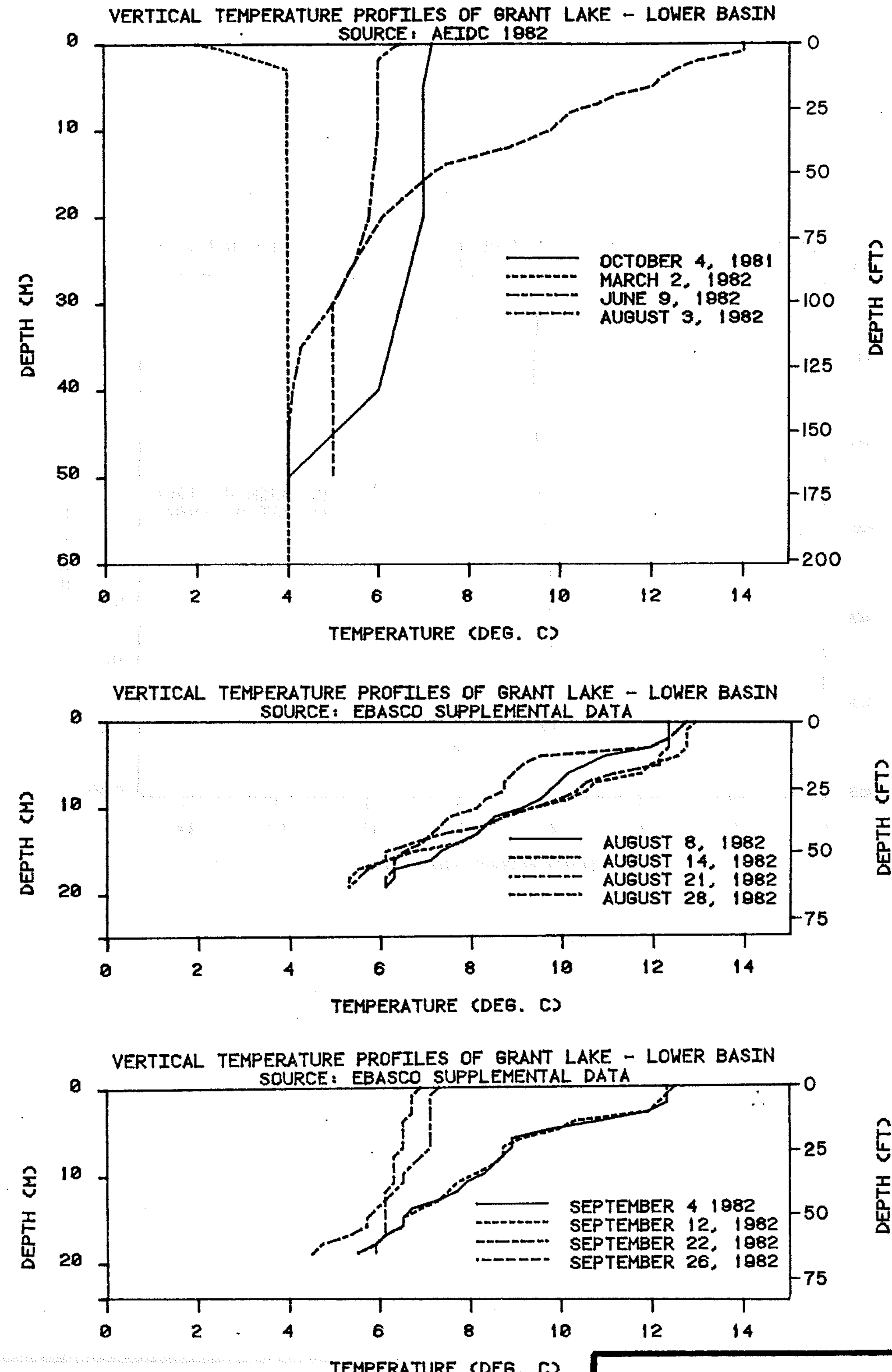
2.2.3.4 Temperature

Seasonal temperature measurements were taken at Grant Lake, Grant Creek, and Falls Creek during the 1981-82 monitoring program. In addition, weekly temperature profiles were obtained during August and September 1982 in Grant Lake's lower basin. A limited amount of historical temperature data for study area waters is also available.

Seasonal temperature profiles for the upper and lower basins of Grant Lake are shown in Figures 2-6 and 2-7 and are tabulated in Tables 2-6 and 2-7. Grant Lake showed thermal stratification during August and September, although a classic, sharply defined thermocline did not develop. Summer temperatures ranged from 14°C at the surface to 5°C at 98 ft depth. Fall overturn began in mid-September 1982 and October 1981, as evidenced by the limited temperature variation with depth. Winter data from early March 1982 shows an inverted thermocline, ranging from 2°C near the ice/water interface to 4°C at 9.8 ft depth. Spring overturn resulted in an isothermal condition in early June, as shown by the June 1982 profile. The upper basin (Figure 2-7) displays the same thermal regime as the lower basin, with a smaller range in temperatures.

Historical Grant Creek temperatures (Table 2-8) ranged from 13 to 0°C. Grant Creek temperatures were closely related to Grant Lake surface temperatures; the maximum difference was less than 1.7°C.

Falls Creek is generally colder than Grant Creek, ranging from 7°C colder in July, 1959 to 2.5°C colder in October 1981. Table 2-7 compares the historical temperatures of Falls Creek to other study area waters.



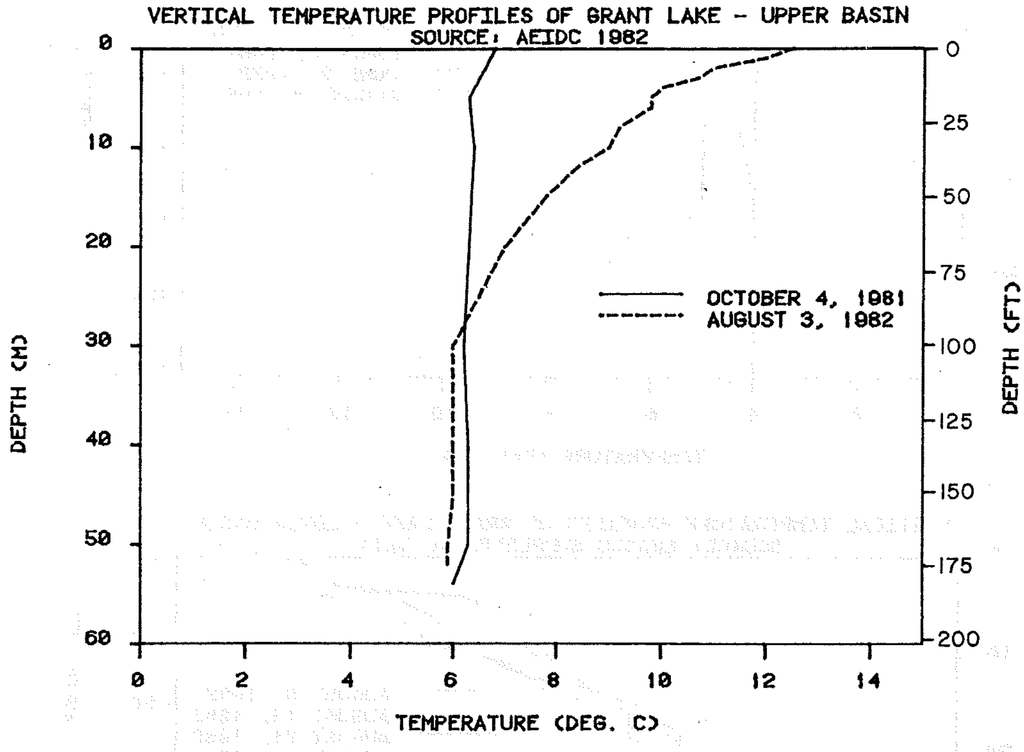
ALASKA POWER AUTHORITY

GRANT LAKE HYDROELECTRIC PROJECT

TEMPERATURE PROFILES
GRANT LAKE LOWER BASIN

FIGURE 2-6

EBASCO SERVICES INCORPORATED



ALASKA POWER AUTHORITY

GRANT LAKE HYDROELECTRIC PROJECT

TEMPERATURE PROFILES
GRANT LAKE UPPER BASIN

FIGURE 2-7

EBASCO SERVICES INCORPORATED

TABLE 2-6

GRANT LAKE TEMPERATURES (°C)
COLLECTED DURING THE 1981-82 MONITORING PROGRAM

Depth (m)	Depth (ft)	Lower Basin Date Oct 81	Lower Basin Date Mar 82	Lower Basin Date June 82	Lower Basin Date Aug 82	Upper Basin Date Oct 81	Upper Basin Date Aug 82
	Surface	7.2	2.0	6.5	14.0	6.8	12.5
1	3.3		2.8	6.2	14.0		12.0
2	6.6		3.4	6.0	13.0		11.0
3	9.9		4.0	6.0	12.5		10.7
4	13.1		4.0	6.0	12.2		10.0
5	16.4	7.0	4.0	6.0	12.0	6.3	9.8
6	19.7		4.0	6.0	11.2		9.8
7	23.0		4.0	6.0	10.8		9.5
8	26.2		4.0	6.0	10.2		9.2
9	29.5		4.0	6.0	10.0		9.1
10	32.8	7.0	4.0	6.0	9.8	6.4	9.0
12	39.4				8.9		8.4
14	45.9				7.5		-
15	49.2			5.9	7.2		7.8
20	65.6	7.0	4.0	5.8	6.1	6.4	7.0
25	82.0		4.0	5.5	5.5		6.5
30	98.4	6.5	4.0	5.0	5.0	6.2	6.0
35	114.8		4.0	4.3	5.0		6.0
40	131.2	6.0	4.0	4.1	5.0	6.3	6.0
45	147.6		4.0	4.0	5.0		6.0
50	164.1		4.0	4.0	5.0	6.3	5.9
52	170.6	4.0		4.0			5.9
54	177.2					6.0	
55	180.5		4.0				
60	196.9		4.0				

Source: AEIDC (1982).

TABLE 2-7

GRANT LAKE TEMPERATURES (°C)
COLLECTED DURING THE 1982 SUPPLEMENTAL DATA COLLECTION PROGRAM

LOWER BASIN OF GRANT LAKE NEAR THE TUNNEL INTAKE SITE

Depth		Date							
(m)	(ft)	8/8/82	8/14/82	8/21/82	8/28/82	9/4/82	9/12/82	9/22/82	9/26/82
1	3.3	12.3	12.9	12.7	12.7	12.5	12.3	7.3	6.9
2	6.6	12.3	12.7	12.5	12.5	12.3	12.3	7.1	6.7
3	9.9	12.3	12.7	12.3	12.3	12.3	12.1	7.1	6.7
4	13.1	11.9	12.7	12.3	11.9	11.9	11.9	7.1	6.7
5	16.4	10.9	12.5	12.1	9.5	10.9	10.3	7.1	6.5
6	19.7	10.5	11.9	12.1	9.1	9.7	9.9	7.1	6.5
7	23.0	10.1	11.7	11.1	8.9	8.9	9.1	7.1	6.5
8	26.2	9.9	10.7	10.5	8.7	8.9	8.7	7.1	6.5
9	29.5	9.7	10.5	10.3	8.7	8.7	8.7	6.9	6.3
10	32.8	9.5	10.1	9.9	8.3	8.5	8.5	6.7	6.3
11	36.1	9.1	9.3	9.3	8.1	8.3	8.1	6.5	6.3
12	39.4	8.5	8.7	8.7	7.5	7.9	7.7	6.5	6.3
13	42.7	8.3	8.3	8.3	7.3	7.7	7.5	6.3	6.1
14	45.9	8.1	8.1	7.3	7.1	7.3	7.3	6.1	6.1
15	49.2	7.7	7.7	6.7	6.9	6.7	6.9	5.9	6.1
16	52.5	7.3	6.7	6.1	6.5	6.5	6.5	5.7	6.1
17	55.8	7.1	6.1	6.1	6.3	6.5	6.5	5.7	6.1
18	59.1	6.3	5.5	5.7	6.3	6.1	6.1	5.3	6.1
19	62.3	6.3	5.3	5.5	6.1	5.9	5.9	4.7	5.9
20	65.6	6.1	5.3	5.3	6.1	5.5	5.5	4.5	5.9

UPPER TRAIL LAKE TEMPERATURES (°C)
UPPER TRAIL LAKE NEAR THE TAILRACE SITE

Depth		Date							
(m)	(ft)	8/8/82	8/14/82	8/21/82	8/28/82	9/4/82	9/12/82	9/22/82	9/26/82
1	3.3	10.1	11.1	10.9	9.7	10.1	10.3	5.5	5.3

Source: Ebasco Supplemental Data.

TABLE 2-8

TEMPERATURE COMPARISONS FOR PROJECT WATERBODIES

Date	Source	Grant Lake Surface (°C)	Grant Creek (°C)	Falls Creek (°C)	Temperature Difference Between Grant Lake & Grant Cr. (°C)	Temperature Difference Between Grant Cr. & Falls Cr. (°C)
11/3/59	USFW (1961)		4.4	0.3		4.1
6/8/60	"		7.8	5.0		2.8
6/17/60	"	11.7	11.7		0	
7/20/60	"	12.8	11.1	5.0	1.7	6.1
8/8/60	"	11.1	11.1		0	
8/13/60	"		10.6	6.7		3.9
9/1/60	"		10.0	5.6		4.4
9/14/60	"		9.4	5.0		4.4
10/16/60	"	6.7	5.6	2.2	1.1	3.4
10/13/81	AEIDC (1982)	7.2	6.0	3.5	1.2	2.5
3/2/82	"	2.0	1.0		1.0	
6/9/82	"	6.6	6.5	4.0	0.1	2.5
8/3/82	"	14.0	12.5	5.5	1.5	7.0
Average Temperature Difference, °C		...	...	...	0.8	4.1

2.2.3.5 Dissolved Oxygen

Dissolved oxygen levels in Grant Lake are shown in Table 2-9. Dissolved oxygen levels remained near saturation over the entire range measured (0-164 ft) for all sampling dates.

2.2.3.6 Coliform Bacteria

Coliform bacterial counts were zero per 100 ml for all samples measured.

2.3 HYDROGRAPHY OF LAKES AND STREAMS AFFECTED BY THE PROJECT

2.3.1 Grant Lake

Grant Lake is composed of two basins joined at right angles by a relatively narrow and shallow channel. Both basins are quite deep; the upper basin reaches 283 ft in depth and the lower basin 262 ft. The upper basin has a surface area of 997 acres and the lower basin 688 acres. Total volume of the lake is approximately 250,000 acre-feet and the mean depth is 91 ft. The current surface elevation of Grant Lake is 696 ft, although the lake level generally fluctuates several feet during the year.

Grant Lake is primarily fed by Inlet Creek at its headwaters, but several other smaller streams drain the steep mountain slopes adjacent to the lake. The sole outlet from Grant Lake is Grant Creek, located at the south end of the lower basin. Grant Creek has an average flow of 188 cfs, which suggests Grant Lake has a flushing rate of 672 days.

After Project completion, Grant Lake surface elevation will range from 660 to 691 ft. Post-Project lake volume will range from 192,800 to 239,700 acre-feet, representing a reduction of 23 to 4 percent from pre-Project conditions. Total outflow would continue to average 188 cfs, resulting in a minimum flushing rate of 518 days at a lake elevation of 660 ft. Pre- and post-Project characteristics for Grant Lake are summarized in Table 2-10.

TABLE 2-9

DISSOLVED OXYGEN MEASUREMENTS FOR GRANT LAKE

Depth		Dissolved Oxygen (mg/l)					
		June 1981[a]		October 1981[b]		June 1982[b]	
(m)	(ft)	Lower Basin	Upper Basin	Lower Basin	Upper Basin	Lower Basin	Upper Basin
Surface		11.3	11.6	10.75	10.5	14	14.5
1	3.3	11.5	11.8			13.5	
2	6.6	11.7	11.9			13.5	
3	9.9	11.8	12.0			13.5	
4	13.1	11.8	12.0			13.5	
5	16.4	11.9	12.1			13.5	
6	19.7	11.9	12.0			13.5	
7	23.0	12.0	11.8			13.5	
8	26.2	12.1	11.9			13.5	
9	29.5	12.1	12.0			13.5	
10	32.8	12.1	11.9			13.5	
15	49.2	12.2	12.4			12.9	
20	65.6	12.1	12.3			12.5	
25	82.0	12.2				12.5	
30	98.4	12.0	12.6			12.4	
35	114.8					12.4	
40	131.2	12.0	12.6			12.0	
45	147.6					11.8	
50	164.0	11.9	12.6			11.0	
52	170.6			9.75		10.8	
54	177.2				10.25		
60	196.9		12.6				

a/ Source: ADF&G 1981

b/ Source: AEIDC 1982

TABLE 2-10

LAKE AND STREAM CHARACTERISTICS FOR PRE- AND POST-PROJECT CONDITIONS

GRANT LAKE

	Surface Elevation (feet)	Surface Area (acres)	Lake Volume (acre-feet)	Shoreline Length (feet)
Pre-Project	696	1685	250,000	100,487
Post-Project	660-691	1484[a]	192,800[a]	92,639[a]

STREAMS

Stream	Mean Flow (cfs)	Length (ft)	Average Width (ft)	Stream Gradient (ft/mi)	Substrate
Grant Creek					
Pre-Project	188	5,810	25	207	Cobble and boulder with several gravel bars
Post-Project	0[c]	...	...	...	
Falls Creek[b]	38	42,240	15	418	Cobble and boulder with some gravel, uniformly covered with fine silt

a/ Minimum value corresponding to a lake elevation of 660 feet.

b/ Not directly affected by the Project.

c/ The only flow would be from local inflow and groundwater, or from occasional overspills.

2.3.2 Grant and Falls Creeks

Average annual flow for Grant Creek is currently 188 cfs. Total stream length is 5,810 ft, with an average gradient of 207 ft/mile. The Creek's substrate consists of cobble and boulder alluvial deposits with numerous gravel bars. Average stream width is approximately 25 ft. Grant Creek flows into the channel between Upper and Lower Trail Lakes (Figure 2-1).

The Grant Creek streambed would be essentially dewatered after Project completion. The only contribution to streamflow would be from local inflow and groundwater. Local inflow would be very low due to the small drainage area (less than one square mile). Groundwater contributions are expected to also be very low due to the lack of continuous surficial deposits and the low permeability of the bedrock material. Project discharge will flow into Upper Trail Lake approximately one-half mile north of the mouth of Grant Creek (Figure 1-3).

Average annual flow for Falls Creek is approximately 38 cfs, although the stream freezes solid in winter. The current stream length is 42,240 ft, with an average stream gradient of 418 ft/mile. Stream width varies considerably from headwaters to mouth, but averages approximately 15 ft. Falls Creek substrate consists of cobble and boulder deposits with few gravel bars and a thin blanket of fine silt near the mouth. The Falls Creek streambed has been extensively channelized and modified by placer mining within the lower one mile. Falls Creek flows into Trail River approximately 1.8 miles downstream from the mouth of Grant Creek (Figure 2-1).

Pre- and post-Project streamflow characteristics for Grant Creek are summarized in Table 2-10. Falls Creek is not affected by the Project.

2.4 GROUNDWATER

The Grant Lake and Upper Trail Lake region is characterized by glacially scoured bedrock with little or no soil cover. Isolated areas of alluvial material occur at the head of Grant Lake, in part of the Trail Lake valley, and as small pockets forming wetlands in bedrock depressions. There are no extensive, continuous aquifers in the region.

Bedrock permeability is fracture permeability only. Open fractures exist, but they do not form extensive, interconnected pathways. The fact that Grant Lake and the Trail lakes differ in elevation by more than 200 ft and are less than a mile apart attests to the low permeability of the bedrock ridge that separates them.

Little is known about the regional groundwater conditions since few wells exist. No major springs were identified during this study. Only a few minor seeps were noted along bedrock cliffs.

Many small surface streams are active during the summer, with some originating within the small wetlands found along the ridge separating Grant Lake and Upper Trail Lake. The presence of streams draining the small bogs indicates that the bogs are areas of discharge, at least during the summer months. These observations coupled with data obtained during the exploratory boring program indicate that the groundwater table is very near or at the surface over much of the area between Grant and Trail Lakes. During the summer, both Grant and Trail lakes are also areas of groundwater discharge, with Grant Creek draining Grant Lake, and Trail Lakes draining southward into the Trail River and into Kenai Lake.

Summer rains coupled with snow melt form the major source for recharging the groundwater system. The low bedrock permeability and the lack of major alluvial valleys, however, suggest that much of the available recharge water is discharged as surface runoff into Grant and Trail Lakes. This suggestion is supported by the observation that water levels in Grant and Trail lakes rise rapidly during very warm or wet summer weather. Variations of over one foot in Grant Lake and several feet in Upper Trail Lake were noted during the 1981-1982 field season, many times occurring in the space of a few hours.

Little recharge occurs during the winter due to the combined effects of geologic, geomorphic, and climatic factors, including the relatively impermeable bedrock and sub-freezing temperatures. Little is known about regional groundwater conditions in the winter, although the few small water supply wells in the Trail Lakes valley continue to operate year-round. The level of Grant Lake drops several feet during the winter until the outlet elevation is reached.

2.5 POTENTIAL IMPACTS

This section describes the expected short-term and long-term effects of the Project on water quantity, water use, and water quality.

2.5.1 Construction Phase

Vegetation removal for tunnel installation and powerhouse and access road construction will increase erosion rates somewhat in the affected areas. Where vegetation removal occurs near water bodies, such as the tunnel intake structure, increased sedimentation will result. To minimize this process, erosion control measures will be implemented, as discussed in Section 2.6, Mitigation of Impacts.

No contaminants other than sediment will be discharged into study area waters. All sanitary wastes will be transported out of the study area for proper disposal.

Construction impacts will be short-term, usually lasting only a few months. The Alaska Department of Environmental Conservation will review all construction plans and issue appropriate permits.

2.5.2 Operation Phase

2.5.2.1 Water Quantity

After Project completion, Grant Lake surface elevation will range from 660 to 691 ft, in contrast to its current mean elevation of 696 ft. The primary changes in the flow regime for the Grant Lake system will be in discharge timing, and location. The timing of the regulated monthly discharge will vary somewhat from pre-Project flows. Peak flows will be reduced and delayed from an average of 451 cfs (June) to 360 cfs (August), and low flows will be increased from 36.1 cfs (March) to 40.0 cfs (April). The location of the discharge will be moved one-half mile north of the mouth of Grant Creek.

Project discharge will represent approximately 32 percent of the average annual flow through the Trail lakes system at the point of inflow. Because peak flows will be reduced and low flows increased over existing Grant Creek flows, no adverse impacts on the Trail lakes flow regime are anticipated. The Project will have no affect on the Trail Lakes hatchery or tributaries upstream.

After Project completion, Grant Creek will be dewatered over its entire length. In the affected stream reaches, erosion and sediment deposition due to streamflow will cease. The only change to channel configuration will be a reduced width due to gradual revegetation of the channel sides. The impacts of stream dewatering on fish and wildlife are discussed in Chapter 3.

The Project is expected to cause little or no impact on the groundwater regime because of the limited groundwater resources in the area.

2.5.2.2 Water Use

The Project will not affect the water supply to the two mining operations possessing the water rights described in Section 2.1.2. The mine on Grant Lake's lower basin will continue to use Grant Lake water, although the lake elevation will be lower.

Recreational use of Grant Lake water will not be affected by the Project. Because Grant Creek will be dewatered, recreational use of Grant Creek will be affected by the Project; these impacts are discussed in Chapter 7.

Because no groundwater use is known to occur in the Project vicinity, no impacts on groundwater use are expected.

2.5.2.3 Water Quality

Because the Project is not expected to affect the main characteristics of Grant Lake, water quality impacts are expected to be minor. The most prominent Project impact on water quality will be the temperature of the discharge water. Additional minor effects on suspended solids levels and turbidity may also constitute a short-term impact. No impact on groundwater quality will occur because the Project should not affect groundwater resources.

General Water Quality Parameters

Because the essential characteristics of Grant Lake should not be significantly affected, post-Project levels of nutrients and major ions are not expected to change. No change in the levels of dissolved gases discharged to the Trail Lakes system is expected, because no spillway is involved.

Temperature

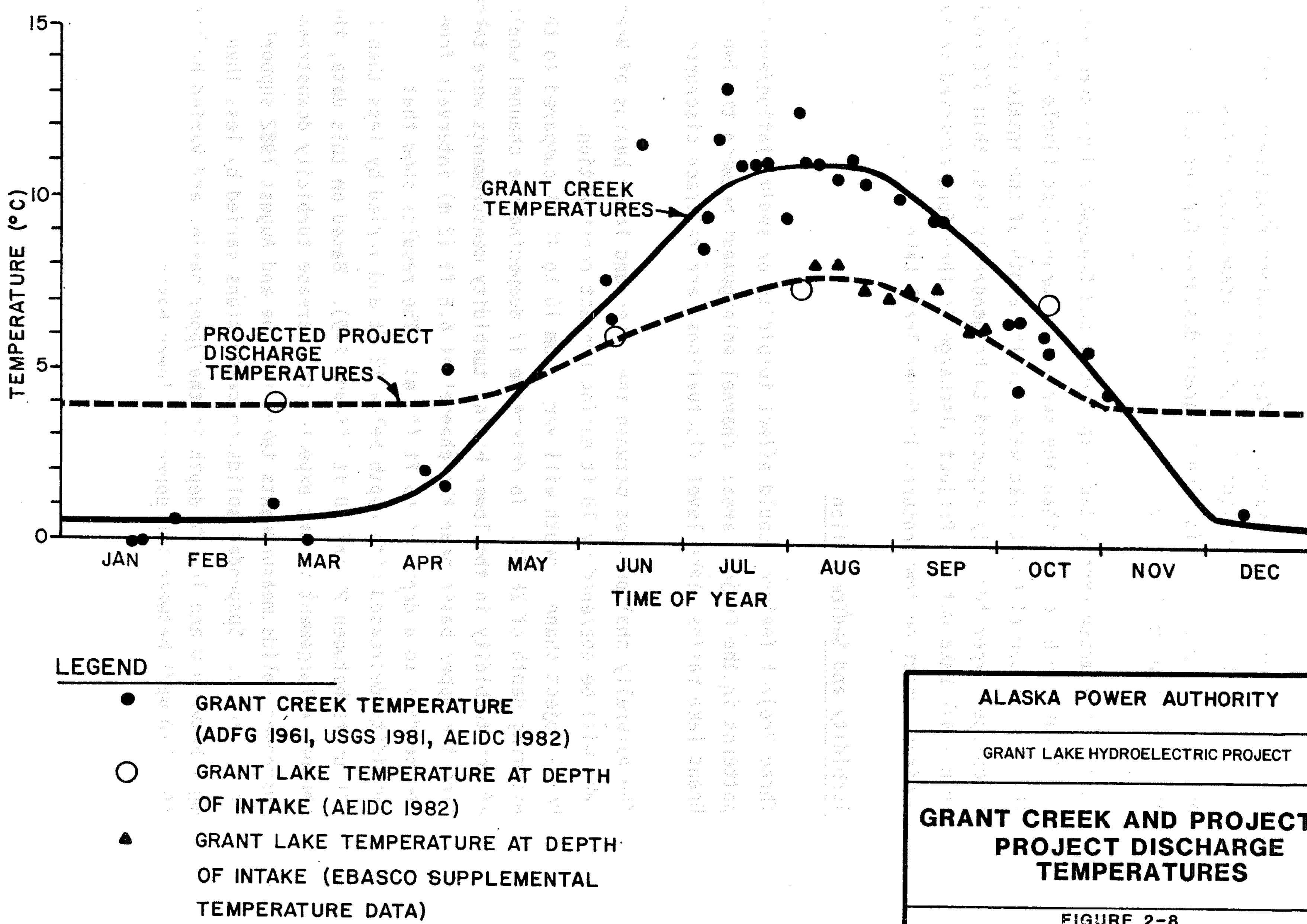
During late summer, Grant Lake is presently thermally stratified as evidenced by the temperature profiles shown in Figures 2-6 and 2-7. Because the dominant factors affecting thermal stratification will be unaffected by the Project (i.e., solar radiation, wind action, and geographic location), the lake will probably continue to stratify during late summer after the Project is in operation.

During the winter Grant Lake is cooler at the surface than at depth, as shown in Figure 2-6. This pattern will not be affected by the Project.

During the fall and spring, Grant Lake is essentially isothermal as shown by temperature profiles taken in June and October, 1982 (Figure 2-6). This thermal regime should be unaffected by the Project.

Project discharge, released from the submarine inlet at elevation 643 ft, will have a different thermal regime than Grant Creek. Historical temperatures recorded in Grant Creek have varied from 0 to 13°C, as shown in Figure 2-8. Assuming that Grant Lake will continue to stratify as observed in 1982, the temperature of the discharge water would correspond to the temperature of Grant Lake at the depth of the intake structure. In April, the intake will be 17 ft below the lake surface and in September 47 ft below the surface. The projected temperature at the appropriate depth is plotted on Figure 2-8 so that Grant Creek and Project discharge temperatures can be directly compared.

As seen in Figure 2-8 Project discharge temperatures are expected to vary only a few degrees throughout the year, from 4°C in the winter to approximately 8°C in the summer. Project discharge should be warmer



ALASKA POWER AUTHORITY

GRANT LAKE HYDROELECTRIC PROJECT

GRANT CREEK AND PROJECTED PROJECT DISCHARGE TEMPERATURES

FIGURE 2-8

EBASCO SERVICES INCORPORATED

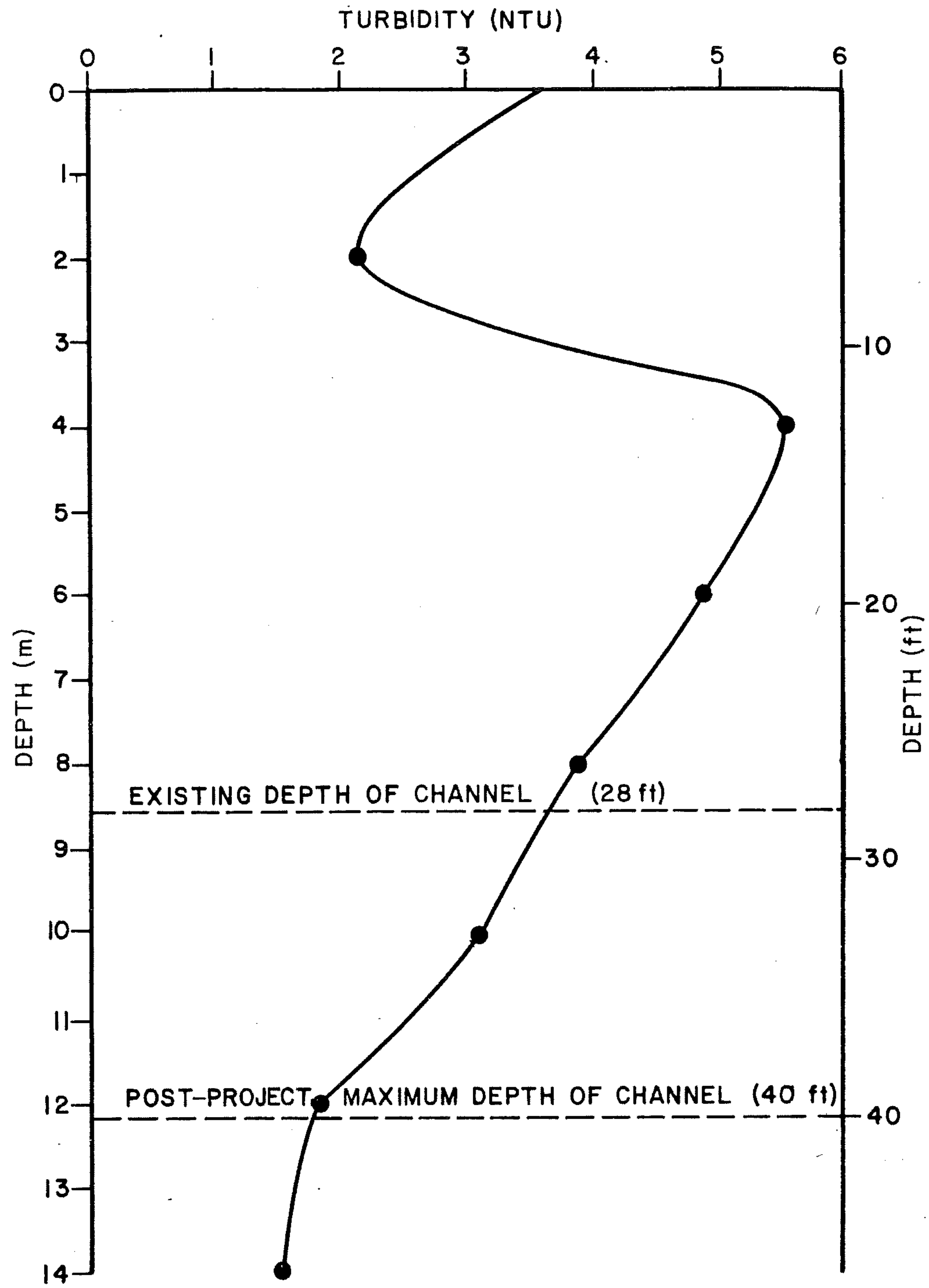
than Grant Creek from November to May and colder than Grant Creek from June to October. The implications of this temperature regime on potential fisheries mitigation programs designed for the tailrace area are described in Chapter 3.

Temperature measurements taken in August and September 1982 show Upper Trail Lake to be colder than the surface of Grant Lake (Table 2-7). The temperature of Grant Lake water at the depth of the intake (Project discharge temperature) is expected to be generally less than 3°C cooler than Trail Lake water. Project discharge is therefore expected to have a minor impact on temperatures in Upper Trail Lake.

Turbidity and Sedimentation

Three Project features could affect turbidity or sedimentation/erosion patterns in the Project area: channel enlargement between the two Grant lake basins, lake level fluctuations, and tailrace discharge.

The naturally shallow area between the upper and lower basins of Grant Lake will be deepened by 18 ft during Project construction. Post-Project channel depth will vary from 10 to 40 ft compared to the existing depth of 28 ft. To determine if deepening the channel would affect turbidity in the lower basin, turbidity measurements were taken from the upper basin near the channel at 6.6 ft (2 m) intervals from the surface to a depth of 46 ft (14 m). The results show that turbidity decreased with depth below 13 ft and varied by less than 2 NTU units between 28 and 40 ft (Figure 2-9). Based on this data, the channel enlargement is not expected to increase turbidity downstream. Suspended solids measurements taken in June and August 1982 support this premise. Suspended solids concentrations varied by less than 1.5 mg/l between 0 and 164 ft depth in the upper basin, and varied by less than 1.0 mg/l between the upper and lower basin.



SOURCE: EBASCO SUPPLEMENTAL DATA

ALASKA POWER AUTHORITY

GRANT LAKE HYDROELECTRIC PROJECT

GRANT LAKE UPPER BASIN

TURBIDITY vs DEPTH

FIGURE 2-9

EBASCO SERVICES INCORPORATED

Grant Lake's surface elevation will range from 660 to 691 ft after Project completion, resulting in a ring of shoreline that will be inundated part of the year and above the water level the remainder of the year. During Project operation, these lake-bottom sediments will occasionally be above or in shallow water, making them susceptible to erosion by wave action, surface runoff, or wind action.

Bathymetry of Grant Lake shows steep slopes resulting in a relatively small surface area between 660 and 691 ft. Significant deposits of lake bottom sediments are restricted to the few shallow bays along the western shore, areas near the channel between the two basins, and the Inlet Creek delta. Lake bottom sediments in the lower basin sampled at 10, 20, 30, and 40-ft depths showed the sediment to be fine-grained, with 54 percent of the particles having the dimension of clay or smaller (0.005 mm diameter). Following rain storms or strong winds when the lake level is low, localized turbidity clouds may form in the bays and shallow areas. This effect will gradually decrease with time as the sediments above elevation 660 ft are slowly washed into Grant Lake and redeposited on the lake bottom.

The tailrace, which would discharge Project water into Upper Trail Lake, has been specially designed to produce a very low exit velocity of less than one foot per second (fps). This one fps approximates the scour velocity for fine to medium grained non-cohesive sand (Chow 1959). Particles smaller than 0.2 mm (0.008 in) will be susceptible to erosion and subsequent deposition further downstream.

2.6 MITIGATION OF IMPACTS

Erosion and sedimentation will be controlled by several mitigation measures. A minimum amount of land area will be disturbed, exposing as little bare soil as possible to erosion effects. Access roads will avoid steep slopes wherever possible, and will incorporate adequate drainage systems such as water bars, culverts and ditches. Disturbed areas will be revegetated and stabilized, so that soil erosion will be primarily short-term. The bridge over Grant Creek will be constructed during low flow.

Several aspects of the Project have been designed to further minimize water quality and use impacts. Access roads have been located to reduce overall length and to place them away from water bodies, thereby decreasing sedimentation impacts. The tailrace has been specifically designed to minimize scour in the receiving channel by lowering the discharge velocity and reinforcing the channel bottom. Extensive fish mitigation facilities, described in Chapter 3, will be implemented to mitigate the dewatering of Grant Creek. Project recreation facilities, described in Chapter 7, will mitigate the loss of recreational use of Grant Creek. Mitigation measures to reduce erosion and sedimentation will be defined in greater detail during the final design phase of the Project.

2.7 SUMMARY OF AGENCY CONTACTS

The following is a summary of pertinent Agency contacts made in support of this report. Correspondence between the Alaska Power Authority and various agencies is included in Part VIII, Technical Appendix, Volume 3.

Alaska Department of Environmental Conservation

1)	Date:	September 1, 1982
	Agency Representative:	Dan Wilkerson and Bob Martin
	Location:	ADEC Anchorage office
	Subject:	Water quality studies performed by Ebasco's water resources personnel in the Grant Lake area during the summer of 1982, including temperature and turbidity measurements and collection of lake bottom sediments
2)	Date:	November 12, 1982
	Agency Representative:	Gary Hayden (Anchorage)
	Location:	(Telephone conversation)
	Subject:	Water quality standards that apply to the Project

Alaska Department of Fish and Game

1) Date: January 25, 1982

Agency Representative: Ted McHenry (Seward)

Location: (Telephone conversation)

Subject: Cyanide use in hard rock mining in the Project vicinity and the potential for contamination of Falls Creek

2) Date: September 1, 1982

Agency Representative: Tom Arminski

Location: ADF&G Anchorage office

Subject: Water quality studies performed by Ebasco's water resources personnel in the Grant Lake area during the summer of 1982, including temperature and turbidity measurements and collection of lake bottom sediments

Alaska Department of Natural Resources

1) Date: January 19, 1982

Agency Representative: John Mohorvich (Soldotna office)

Location: (Telephone conversation)

Subject: Existing water rights on Falls Creek

2) Date: August 31, 1982

Agency Representative: John Mohorvich

Location: DNR Soldotna office

Subject: Status of water rights in the Project area

3) **Date:** October 21, 1982

Agency Representative: Gary Prokosch (Anchorage)

Location: (Telephone conversation)

Subject: The major issues regarding water rights for Falls Creek, including the Federal Land Reserve, existing water rights and existing water use

U.S. Department of Agriculture, Forest Service

1) **Date:** August 30, 1982

Agency Representative: Curt Nelson and Ralph Browning

Location: USFS Seward office

Subject: Water quality studies performed by Ebasco's water resources personnel in the Grant Lake area during the summer of 1982, including temperature and turbidity measurements and collection of lake bottom sediments

2) **Date:** November 16, 1982

Agency Representative: Ron Quilliam (Seward)

Location: (Telephone conversation)

Subject: Status of cabins near Falls Creek located on Forest Service property

U.S. Fish and Wildlife Service

1) **Date:** September 1, 1982

Agency Representative: Mary Lynn Nation

Location: USF&W office in Anchorage

Subject: Water quality studies performed by Ebasco's water resources personnel in the Grant Lake area during the summer of 1982, including temperature and turbidity measurements and collection of lake bottom sediments

3.0 REPORT ON AQUATIC, BOTANICAL, AND WILDLIFE RESOURCES

3.1 AQUATIC RESOURCES

The proposed Project will directly affect Grant Lake and Grant Creek. Nearby Falls Creek will not be affected by the Project (Figure 1-3). These water bodies were defined as the principal aquatic resource study area and are described in the following sections.

3.1.1 Existing Conditions

To determine the existing aquatic resources of the study area, a program was conducted that involved the following: literature reviews, field surveys, and consultation with federal and state planning, resource management, and regulatory agencies, local residents, and recreationists. The program was organized to provide information on the occurrence and ecological character of aquatic macrophytes, phytoplankton and periphyton, zooplankton, benthic macroinvertebrates, and fish. The following sections describe the water bodies of the study area and their plant and animal communities. Findings are based upon field studies initiated in October 1981 and completed in September 1982. The sampling locations, sampling frequency, and methodology of these studies are summarized in the Technical Appendix, Part IX.

3.1.1.1 Grant Lake

The two basins of Grant Lake are surrounded by precipitous mountains. The shoreline in most areas is chararacterized by precipitous bedrock slopes with occasional small gravel deposits formed by runoff from the mountains. The steep shoreline areas have a light sediment covering (less than 0.1 in). The shoreline vegetation consists of lowbush cranberry, ferns, alders, spruce, hemlock, and a few cottonwoods near inlet stream deltas. The shoreline is littered with floating and sunken organic debris and patches of thick macrophyte growth (e.g., Ranuculus spp.) in the limited littoral areas. The lake is divided into two basins by a narrow constriction about midlake. An island at the constriction creates a shallow sill about 25 ft deep which hinders mixing between the two lake basins. The influence of sediment-laden Inlet Creek is slightly more pronounced in the upper basin. Water clarity, as measured by Secchi disc transparency, is significantly higher in the lower basin, but turbidity and suspended solids differ by less than 1.5 NTU and 1 mg/l, respectively, between basins (see Table 2-5). The water surface of the lake fluctuates moderately, rising to its highest level during summer runoff and falling to a low point in winter. The distance from the lake surface to the high water mark was approximately six ft in October 1981, but was above this mark in August 1982. Numerous short streams, including three glacial streams, originate in the nearly vertical mountains surrounding much of the lake. Based on the 1981-82 field sampling, none of the tributaries support fish populations and only sculpin and threespine stickleback inhabit the lake. The abundance of zooplankton suggests that it may provide adequate habitat and food for juvenile salmonids.

3.1.1.2 Grant Creek

Grant Creek flows from its origin in Grant Lake approximately 1 mile in a westerly direction and discharges at the narrows between Upper and Lower Trail lakes. In the upper section the creek courses over three substantial waterfalls, through a rocky gorge, and over large rubble and boulders. The lower section is somewhat less turbulent with fewer boulders and more frequent gravel shoals, although the gradient of the lower 0.5-mile segment is still fairly steep. The average width of the stream is approximately 25 ft. Cover for juvenile fish is limited to stream margins, backwaters, deep pools, and to a few small side channels offering reduced velocities during low flow.

3.1.1.3 Aquatic Macrophytes

Macrophytes supply habitat for aquatic organisms (e.g., larval insects) and a substrate for periphyton. They may also protect fish eggs and juvenile fish (Welch 1980) as well as contribute to primary production in lakes. In some cases the protection afforded juvenile fish may cause overabundance and crowding of fish species.

White water crowfoot (Ranuculus trichophyllus) grows along the shore of Grant Lake but is abundant only at the lake's outlet. A small stand of a sedge (Carex rhynchophysa) was found in a protected cove at the narrows between the upper and lower Grant lake basins. Both species have low abundance in Grant Lake because the two factors that most promote macrophyte growth, low turbidity and shallow depth (Blazka et al. 1980), are limited in Grant Lake. Because of their low abundance the importance of the macrophytes in the Grant Lake food chain is limited.

3.1.1.4 Phytoplankton and Periphyton

Phytoplankton and periphyton (i.e., attached algae) constitute an important part of the aquatic food chain by providing a food forage base for macroinvertebrates and fish. No background information on periphyton or phytoplankton in the study area streams is available other than that collected during field programs conducted in 1982 (AEIDC 1982).

The results of the 1982 phytoplankton collections in Grant Lake are shown in Table 3-1. The dominant algal genera during all seasons were diatoms, mostly Cyclotella and Synedra. Similar algae have been found in other Alaskan lakes (Poe 1980) and those in British Columbia (Stockner and Shortreed 1978) possessing sockeye salmon runs. The density of algae was low compared to northern oligotrophic lakes and slightly lower than densities found in northwestern British Columbia and Yukon area lakes with glacial silt (Stockner and Shortreed 1978). Peak cell counts, mostly diatoms, occurred in August. Duthie (1979) observed similar late summer blooms of phytoplankton, consisting mostly of diatoms, in larger subarctic Canadian lakes. Chlorophytes and diatoms are considered preferred food organisms for zooplankton that serve as prey for sockeye salmon (Stockner 1977). Rankin and Ashton

TABLE 3-1

COMPOSITION AND DENSITY OF PHYTOPLANKTON FROM GRANT LAKE, 1982[a/]

	Cells/Liter		
	March	June	August
Chlorophyta (Green Algae)			
Ankistrodesmus		69	
Chodatella	811	1,069	103
Monoraphidium	150		
Cryptophyta (Cryptomonads)			
Crypotomonas	345		
Pyrrophyta (Dinoflagellates)			
Peridinium (C.F.)[b/]	2,691	1,052	931
Chrysophyta (Golden Algae)			
Dinobryon	52	1,527	6,313
Diatoms			
Achnanthes	1,757		152
Amphora	123	88	
Asterionella		394	
Cocconeis	204		152
Cyclotella	1,675	9,377	18,590
Cymbella	776	219	
Diatoma	327		
Fragilaria	204		
Gomphonema	531		
Hannea	409		
Navicula	123		
Nitzschia	41		
Stephanodiscus	4,330	2,980	
Synedra (C.F.)[a/]	2,941	4,338	33,218
Unidentified diatoms	163		152
Unidentified Algae	1,926	603	
Total Cells	19,579	21,716	59,611

a/ AEIDC 1982.
b/ Apparent genus identification.

(1980) found that zooplankton biomass was highly correlated with pelagic primary production in 13 British Columbia oligotrophic lakes, some of which had glacial turbidity. The International Biological Program (Brylinsky 1980) also found significant positive relationships between primary production and secondary pelagic production in lakes from around the world, but a less distinct relationship between primary production and benthic production. Therefore, although phytoplankton density in Grant Lake is low, the characteristics of the algal population appear sufficient to support a desirable zooplankton community and hence a fish population.

The importance of organic input to the food chain from phytoplankton production in Grant Lake may be significant but cannot be readily determined. As a general rule the relative importance of allochthonous organic matter (i.e., organic matter originating outside the water body, e.g., leaves) increases inversely to the ratio of surface area of the lake to length of shoreline (Saunders 1980). For Grant Lake, this would suggest that allochthonous input may be less important than primary production. However, this may be somewhat offset by the limiting effect of glacial flour on water transparency and hence primary production.

The periphyton community in Grant Creek, summarized in Table 3-2, was dominated by diatom species that are typical of a flowing water environment (Ruttner 1974), namely, Achnanthes and Synedra. The highest diatom abundance occurred in spring, which corresponds with the normal peak diatom bloom period in other water bodies (Welch 1980). All three filamentous green algae found in Grant Lake are also characteristic of flowing water, but Bulbochaete, the dominant genus found in February, is more characteristic of slower flowing water than the other two (Whitton 1975). The reason that Bulbochaete was most abundant in February is that Grant Creek had a low discharge and most probably lower velocities than in other months sampled. Both Ulothrix and diatoms are highly tolerant of low light (Whitton 1975). Low light conditions may occur in Grant Creek from glacial silt runoff, which

TABLE 3-2

COMPOSITION AND RELATIVE ABUNDANCE OF PERIPHYTON
FROM GRANT CREEK, 1982[a]

	Relative Abundance (Percent)		
	February	May	August
Chlorophyta (Filamentous Green Algae)			
Bulbochaete	.386	T[b]	
Ulothrix		.076	
Zygnema			.190
Chrysophyta (Golden Algae)			
Diatoms			
Achnanthes	.284	.472	.445
Cocconeis	.007	.004	.003
Cyclotella	.002		
Cymbella	.032	.024	.027
Diatoma	.033	.159	.035
Gomphonema	.020	.026	.042
Hannea		.004	
Navicula	.003	.004	
Nitzschia	.002	.002	.015
Synedra	.231	.228	.245
Total	1.000	.999	1.002

a/ AEIDC 1982.
b/ Trace.

reduces light penetration to the creek bottom. Zygnema is known to tolerate low pH (Whitton 1975). It may be the most abundant species during mid-summer because the pH in Grant Creek often goes below 7.0 during the high runoff of this period. Although the dominant genera changed each season, they had similar characteristics, controlled mostly by the physical environment of flowing water. Periphyton constitutes a food source to some benthic insects, particularly grazers and scrappers (Cummins 1975), but as is typical of most North American streams, the major source of food for benthos is allochthonous input such as falling leaves and, in this case, algae and zooplankton from Grant Lake. Typically the smaller and more shaded the stream the greater the importance of allochthonous matter.

3.1.1.5 Zooplankton

Zooplankton are often the main source of food for fish in lakes. If a lake such as Grant Lake is highly influenced by glacial runoff the abundance of zooplankton is often low (Stockner and Shortreed 1978). In such systems zooplankton populations are generally comprised of copepods and rotifers with a marked absence of cladocerans (Koenigs 1982). Cladocerans are usually more common in clear water systems and are often the preferred zooplankton prey of fish. Several studies of juvenile sockeye salmon food habits documented they will usually select cladocerans, particularly larger individuals or species, over copepods (Eggers 1978; Rodgers 1968; Vinyard 1981). Also none of these studies reported feeding on rotifers even though they were available. The small size of rotifers compared to copepods or cladocerans is the main reason they are not eaten. The main reason for the selection of cladocerans appears to be better evasion by copepods (Vinyard 1981) and the usually larger size and easier visibility of cladocerans for the visual feeding sockeye salmon (Eggers 1978). In the absence or low abundance of large cladocerans, copepods will be eaten by planktivorous fish (i.e., fish that feed mainly on organisms that are in the water column as opposed to those that feed on other fish or on bottom or surface organisms). However, if copepods are large they may be actively pursued by fish. A study of juvenile feeding coho in southeast Alaskan lakes found that large copepods were actually preferred over cladocerans (Crone 1981). Cyclopoid copepods also can be a significant food item; they exceeded 25 percent of stomach contents (by number) in the Wood River Lakes of Alaska in August for both sockeye salmon juveniles and threespine sticklebacks (Rodgers 1968).

Table 3-3 lists zooplankton taxa and their density for each basin in Grant Lake. Two genera of rotifers and a cyclopoid copepod genus (most probably a small Cyclops genus) dominate the zooplankton community. There are few cladocerans in Grant Lake. This agrees with the 1981 preliminary findings by the Alaska Department of Fish and Game (Koenigs 1982), also shown in Table 3-3. The near absence of cladocerans in this glacially-fed lake appears typical. Stockner and Shortreed (1978) studied ten lakes containing sockeye salmon in northwest British Columbia and Yukon Territory. In three lakes possessing a high glacial silt load, only cyclops and rotifers were abundant. These glacially-fed lakes generally had the lowest zooplankton abundance of the ten studied.

Highest abundance of non-rotifer zooplankton (i.e., cyclopoid copepods) occurred during August 1982, although the June 1981 count by ADF&G in the upper basin was higher. Peak zooplankton abundance would be expected sometime after peak abundance of their algal prey. Peak counts of algal cells occurred in August in Grant Lake. Duthie (1979) found that in subarctic lakes in Canada, important zooplankton abundance also peaked in August or September.

Predation by fish may have significant effects on zooplankton composition and abundance. The abundance of large zooplankton in Grant Lake was usually higher in the upper basin. It may be that threespine sticklebacks, which were ten times more abundant in the lower basin than in the upper one (AEIDC 1982), may affect significant predation of the large zooplankton. Rankin and Ashton (1980) found that in a lake

TABLE 3-3

COMPOSITION AND DENSITY OF ZOOPLANKTON FROM GRANT LAKE, 1981-1982

Taxa	Numbers/m³									
	June 1981 a/		October 1981 b/		March 1982 b/		June 1982 b/		August 1982 b/	
	Lower Basin	Upper Basin	Lower Basin	Upper Basin	Lower Basin	Upper Basin	Lower Basin	Upper Basin	Lower Basin	Upper Basin
Eucopedoda (copepods)										
Cyclopoida	1,558	13,654	1,831	1,197	1,165	761	1,214	2,738	4,225	7,859
Copepod nauplii	2384	740					143	327	169	86
Cladocera (water fleas)			14							
Rotatoria (rotifers)										
Kellicottia	2,273	4,269	183	2,606	109	211	1,738	1,518	845	3,211
Asplanchna	385	1,154	296	296			71	119	338	10,563

a/ Unpublished data Alaska Department of Fish and Game (Koenigs 1982).
b/ AEIDC 1982.

highly populated with threespine sticklebacks the zooplankton population was impacted. Crone (1981) found that the introduction of juvenile coho salmon into lakes in southeast Alaska virtually eliminated larger zooplankton species. It is possible that lower visibility in the upper basin inhibits feeding by visual feeding threespine stickleback, allowing zooplankton populations to increase. The turbidity in the upper basin was higher than the lower basin (0.24 NTU vs 0.4 NTU in June and 0.67 NTU vs 1.9 NTU for August for the lower and upper basin, respectively).

It would be expected that zooplankton production per unit area in Grant Lake would be similar to or higher than that of benthos in the littoral region. Morgan (1980) states that the ratio of benthic production to primary production in lakes is typically less than the ratio of zooplankton production to primary production except for the littoral region where they may be similar. He also states that the zooplankton production to primary production ratio is generally higher in oligotrophic lakes, such as Grant Lake. Because of the relatively small littoral area of Grant Lake, due to the steep sides, total zooplankton production in the lake is expected to be considerably greater than that of littoral benthos.

3.1.1.6 Benthic Macroinvertebrates

Benthic macroinvertebrates (benthos) are a major group of consumers in the aquatic ecosystem that live in or on the bottom of lakes and streams. In Alaska the group is composed primarily of immature larval insects. Benthos comprise an important link in the aquatic food chain and provide food for most fish and other aquatic vertebrates such as birds and small mammals. The food habits of the group are very diverse; some feed on periphyton or phytoplankton, while others consume detritus or prey upon other aquatic organisms. Changes or disruptions in the aquatic environment of temperature regimes, turbidity, or sedimentation of the lake or stream, can markedly influence the number and types of benthic organisms present. Such changes ultimately can alter the numbers and types of fish that the water body can sustain. Because benthic macroinvertebrates are sampled easily, are sedentary and are indicative of previous changes in water quality, they can serve as convenient indicators of water quality change (U.S. Army Corps of Engineers 1978).

Hynes (1970) stated that the benthos of streams is remarkably similar the world over and that alpine cold-water streams are occupied by limited populations of a few species adapted to specific conditions sharply defined by consistently low temperatures and glacial runoff. Benthos have been collected throughout Alaska by various groups (Craig and McCart 1974; Craig and Wells 1975; Elliott and Reed 1973; McCoy 1974; Nauman and Kernodle 1974), but little specific information is available for the Kenai River drainage. The most abundant benthos found in Alaska are the larvae of chironomidae (midges) of the insect order Diptera. Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) are generally abundant in streams while Oligochaeta (aquatic worms) and Pelecypoda (clams) are often common in lakes. In 1959-60 the Fish and Wildlife Service, U.S. Department of the Interior (1961), surveyed Grant Lake at the mouths of its various tributaries to determine the species composition of aquatic insects. Trichoptera (caddisflies), Plecoptera (stoneflies), Simuliidae (blackflies), and Gastropoda (snails) were recorded.

Benthic macroinvertebrates collected from Grant Lake in 1981 and 1982 are listed in Table 3-4. Samples collected during this survey contained relatively low densities of insects with the exception of chironomids (midges). Also there was a low diversity of bottom organisms, which is common for cold-water, glacial-fed systems with small littoral zones (Hynes 1970). The most common macroinvertebrates were midges, oligochaetes (aquatic worms), and clams. Differences in abundance between the three sample periods appeared minor, although generally there were more organisms in June and August than in October. The lower basin had more caddisflies, clams, and snails and fewer aquatic worms. Reasons for these differences between basins are

TABLE 3-4

COMPOSITION AND DENSITY OF BENTHOS
FROM GRANT LAKE, 1981-1982[a/]

	Organisms/m²					
	October 1981		June 1982		August 1982	
Taxa	Lower Basin	Upper Basin	Lower Basin	Upper Basin	Lower Basin	Upper Basin
Diptera Chironomidae (midges)	201	678	488	430	432	775
Plecoptera (stoneflies)	14					
Trichoptera (caddisflies)	7		100	14	65	
Oligochaeta (aquatic worms)	21	76	86	473	215	473
Nematoda (round worms)			14	14		
Hirudinea (leeches)			14			43
Bivalvia (clams)	36		402	43	129	
Gastropoda (snails)	7		158	14	65	43
Gammaridae (scuds)			14			

a/ AEIDC 1982.

unknown, but may be a function of higher quantities of sediment in the upper basin, which typically had higher suspended sediment concentrations (see Section 2.0), which would favor burrowing oligochaetes.

In Alaskan lakes, midges are often heavily utilized for food by juvenile sockeye salmon, threespine stickleback, and other fish species. Rodgers (1968) found that small juvenile sockeye and threespine sticklebacks in the littoral region of Lake Aleknagik, Alaska, consumed chironomids as the largest single item in their diets. Stoneflies, caddisflies, and gastropods each comprised less than 1 percent of their stomach contents. The importance of chironomids to these species was minimal in the limnetic zone of the lake. Also as the sockeye salmon increased in size they relied more on zooplankton. Other studies have found similar use of midges in lakes by sockeye salmon fry (Goodlad et al. 1974). Some fish, like sculpins, are almost entirely dependent on benthic organisms (Eggers et al. 1978) for food. The less available oligochaetes, which live buried in the sediment, contribute negligibly to the diet of sockeye and sticklebacks (Rodgers 1968). Adult mayflies, blackflies, caddisflies, and craneflies were observed near the lake and caddisfly larvae and Hemiptera (water boatmen) were captured in fish minnow traps. At present the benthic organisms probably play an important role in survival and production of sculpin in the lake but are of minor importance to threespine sticklebacks.

The results of benthic Surber sampling in Grant Creek during the four seasons 1981-1982 are shown in Table 3-5. To date no other published historical survey data on invertebrates in Grant Creek have been found. Diversity was low, which is typical for cold glacial streams. The most abundant organisms were midges, followed by moderate numbers of mayflies, stoneflies, and clams. Abundance varied between season, but without apparent temporal trends. The large numbers of midges and moderate numbers of mayflies and stonefies found in Grant Creek would be important food for salmonids in streams (Rodgers 1968).

TABLE 3-5

COMPOSITION AND DENSITY OF BENTHOS FROM GRANT CREEK, 1981-1982[a/]

Taxa	Organisms/m^2 October 1981	March 1982	May 1982	August 1982
Grant Creek				
Diptera				
Chironomidae (midges)	6,677	7,457	2,387	3,296
Empididae (dance flies)				27
Simuliidae (blackfiles)	11	11		11
Ephemeroptera (mayflies)	162	156	297	130
Plecoptera (stoneflies)	183	102	48	86
Trichoptera (caddis flies)	11	22	7	5
Coleoptera (beetles)			4	
Oligochaeta (aquatic worms)		6	11	
Hirudinea (leeches)			7	
Bivalvia (clams)	124	16	271	49
Hydracarina (water mites)	6	6	7	
Corixidae (water boatman)			7	

a/ AEIDC 1982.

3.1.1.7 Fish

The Kenai River is one of the most important upper Cook Inlet systems in terms of spawning habitat for commercial and game fish, which include five species of Pacific salmon, Dolly Varden, eulachon, and rainbow trout. Twenty-one species of fish have been reported in the Kenai River drainage (Table 3-6).

The species considered most important in the study area are chinook and sockeye salmon, Dolly Varden, and rainbow trout. Historical sport and commercial harvest data for chinook salmon compiled by AEIDC (1982) are summarized in Figure 3-1. For the period 1974-1981, the sport harvest of chinook salmon comprised approximately 48 percent of the total harvest; commercial and subsistence catches comprised approximately 52 percent. Figure 3-1 indicates considerable fluctuation in Kenai River chinook salmon harvest over the past eight years. Early run fish, typical of chinook returning to Grant Creek, show a general increase in harvest over the period. Sport harvest data for all salmonids are summarized in Figure 3-2. Chinook salmon comprise the greatest portion of the catch followed by coho salmon and Dolly Varden. Sport and commercial fishing for salmon is a dominant factor in the Kenai Peninsula's economy, although the fishery in Grant Lake and Falls Creeks is of relatively minor economic importance. Grant Creek is used by three species of salmon (chinook or king salmon, sockeye or red salmon, and coho or silver salmon), Dolly Varden, and rainbow trout that contribute to fisheries in the Kenai River and marine waters.

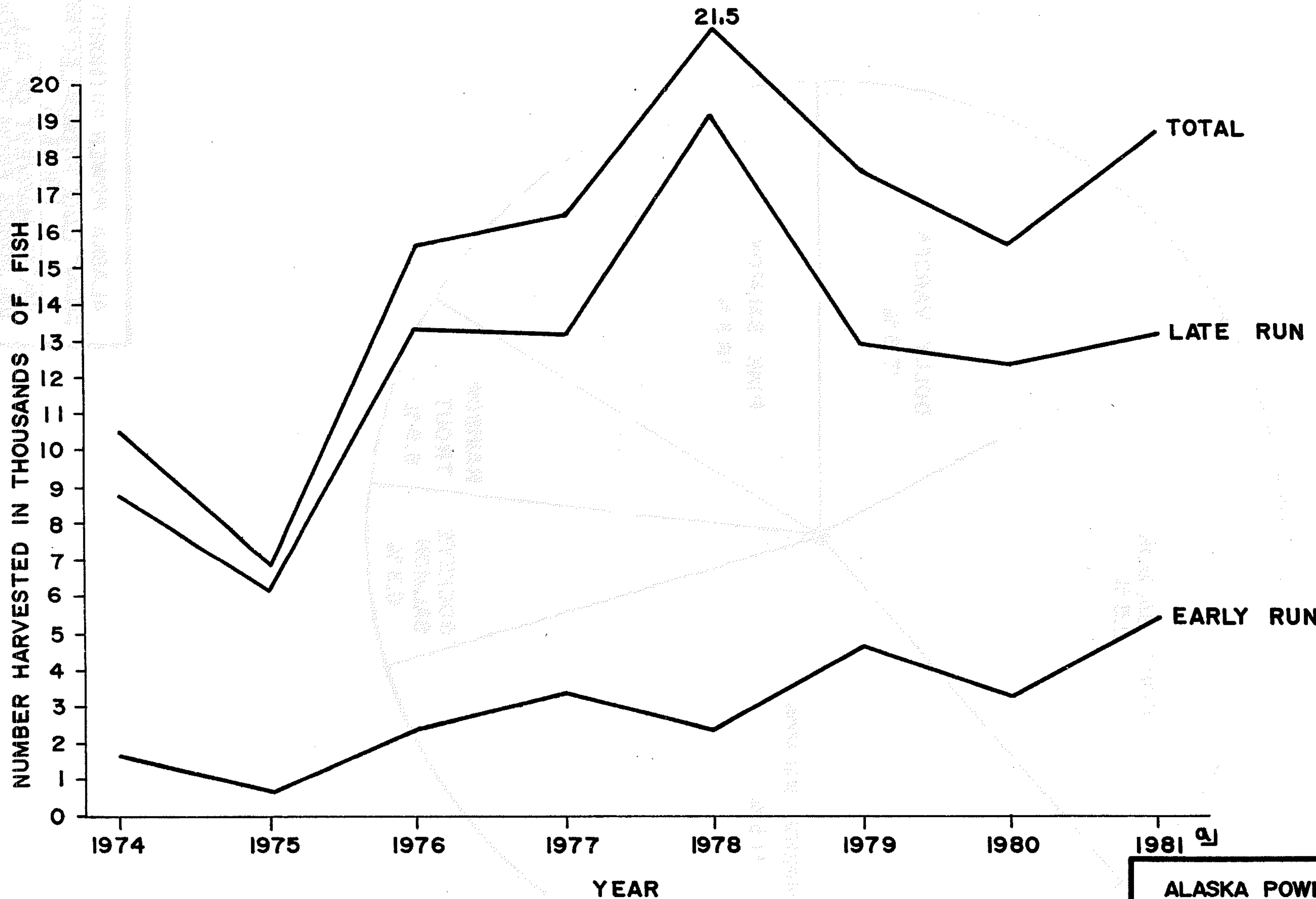
The following paragraphs summarize the life histories of the more important species in the Kenai River basin. Generalized life histories are also provided for Dolly Varden and rainbow trout, important sport fish in the study area. Table 3-7 presents life history information for Pacific salmon utilizing Grant Creek.

TABLE 3-6
FISH SPECIES REPORTED TO OCCUR IN THE KENAI RIVER SYSTEM[a/]

Species
Arctic lamprey (Lampetra japonica)
Chinook (king) salmon (Oncorhynchus tshawytscha)
Sockeye (red) salmon (Oncorhynchus nerka)
Coho (silver) salmon (Oncorhynchus kisutch)
Chum (dog) salmon (Oncorhynchus keta)
Pink (humpback) salmon (Oncorhynchus gorbuscha)
Rainbow trout (Salmo gairdneri)
Dolly Varden (Salvelinus malma)
Northern pike (Esox lucius)
Lake trout (Salvelinus namaycush)
Eulachon (Thaleichthys pacificus)
Longfin smelt (Spirinchus thaleichthys)
Sculpin (Cottus sp.)
Slimy sculpin (Cottus cognatus)
Coastrange sculpin (Cottus aleuticus)
Staghorn sculpin (Leptocottus armatus)
Round whitefish (Prosopium cylindracum)
Threespine stickleback (Gasterosteus aculeatus)
Ninespine stickleback (Pungitius pungitius)
Pacific herring (Clupea harengus pallasi)[b/]
Starry flounder (Platichthys stellatus)[b/]
Longnose sucker (Catostomus catostomus)
Arctic grayling (Thymallus arcticus)

a/ Adapted from Kenai River Review, 1978. U.S. Department of the Army, Alaska District Corps of Engineers.

b/ Found only in intertidal area.



a/ 1981 DATA ARE PRELIMINARY

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TOTAL SPORT & COMMERCIAL HARVEST OF CHINOOK SALMON BOUND FOR KENAI RIVER 1974-1981 (FROM AEIDC 1982)

FIGURE 3-1

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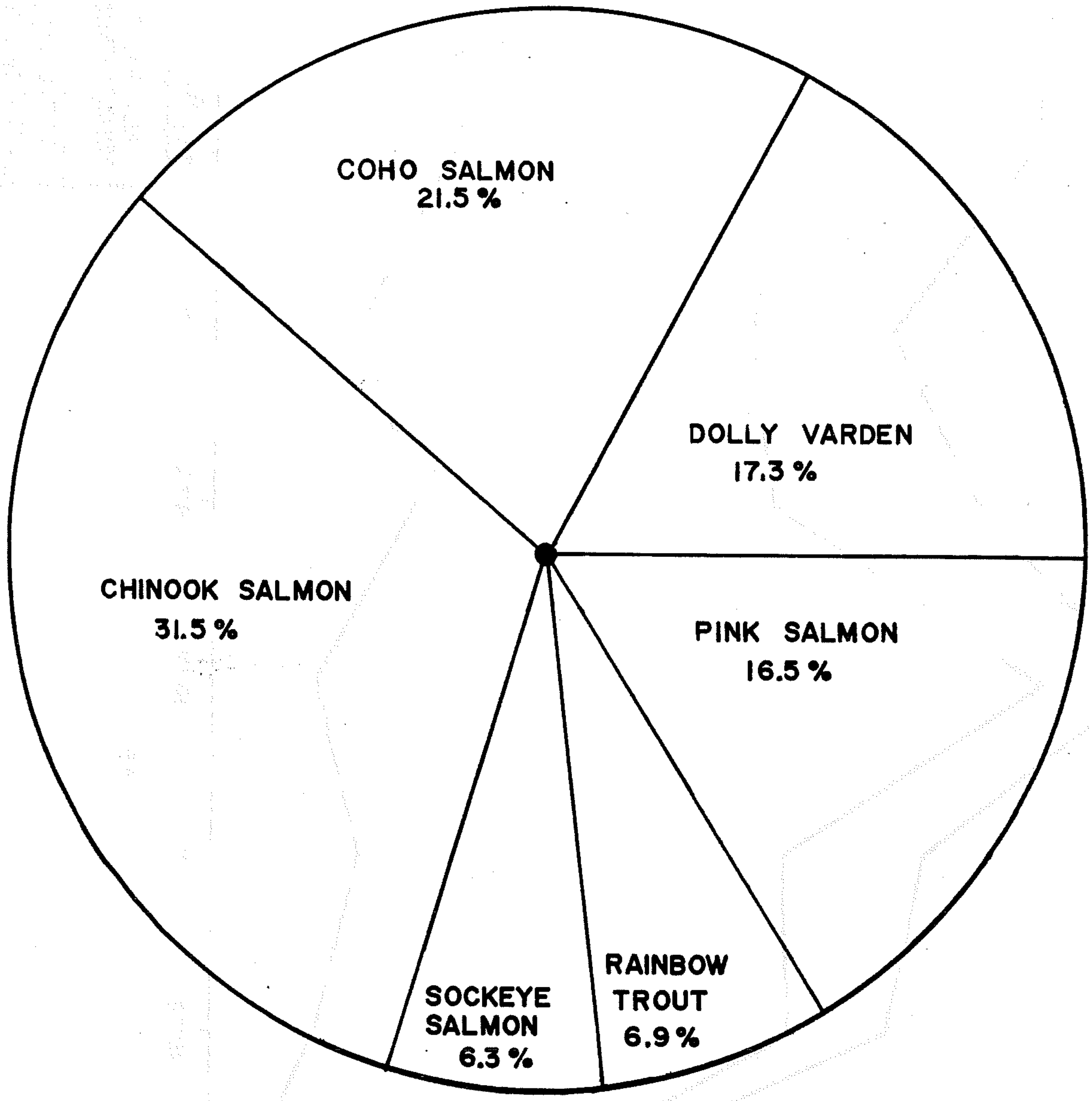

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SPORT HARVEST OF ALL SALMONIDS FROM THE KENAI RIVER BY SPECIES 1976-1981 (FROM AEIDC 1982)

FIGURE 3-2

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TABLE 3-7

LIFE HISTORIES OF PACIFIC SALMON KNOWN OR SUSPECTED TO SPAWN IN GRANT CREEK[a/]

Species of salmon[b/]	Time Spent in Fresh Water After Emergence from Gravel (Months)	Time Spent at Sea (Years)	Age at Spawning (Years)	Average Weight of Adults[c/] (Pounds)	Average Eggs Per Female (Number)
Chinook (king) salmon	3-12	1-6	3-7	30(E)-37(L)[d,e/]	9,000(E)-12,000(L)[e/]
Sockeye (red) salmon	12-36	1-4	3-6	6(L)-7(E)[d/]	3,500(L)-3,700(E)[e/]
Coho (silver) salmon[d/]	12-36	1	3-4	8 (E)-10(L)[e/]	3,700(E)-4,100(L)[e/]

a/ Merrell 1970, except where noted.

b/ Exceptions to these general characteristics occur frequently.

c/ Weight of whole or round fish (pounds).

d/ Limited spawning of this species is suspected, but unconfirmed.

e/ Specifically for the Kenai system (Cook Inlet Regional Planning Team 1981; and Heard 1982); E = Early run, L = Late run.

Chinook salmon enter the Kenai system in two distinct runs. The first run enters the river in late May, peaks in mid-June, and ends in early July. The second run begins in early July, peaks in late July, and ends by mid-August. Radio tagging experiments conducted by the U.S. Fish and Wildlife Service (USFWS) between 1979 and 1981 indicate that early run fish spawn exclusively in tributaries of the Kenai, including Grant Creek, while late run fish spawn exclusively in the main-stem Kenai (Burger 1981, 1982). Fertilized eggs hatch in 2 to 3 months, and the alevins (newly hatched fish) spend two to three weeks in the gravel before emerging as free-swimming fry (Morrow 1980). Juvenile chinook spend one year in fresh water before migrating to sea in late June. Adults return after two to six years at sea. An estimated 50,000 chinook salmon spawn in the Kenai River drainage (Burger 1981, 1982) although this estimate has not been substantiated by ADF&G. Chinook salmon prefer large gravel and cobble for spawning and a spawning territory of typically 20.1 square meters per spawning pair (Burner 1951).

Sockeye salmon also arrive in the Kenai in two discrete runs. The first run begins in mid to late May and continues through late June. The second run arrives in mid-July and continues through mid-August. Newly emerged fry migrate to lakes to rear and remain for one or two years before migrating seaward (U.S. Army, Corps of Engineers 1978). Sockeye salmon prefer smaller gravel than chinook, but similar in size to coho salmon. Although site specific spawning information was not obtained from Grant Creek, sockeye salmon in other areas have been shown to prefer a smaller spawning territory than that of chinook (Burner 1951).

Coho salmon also enter the Kenai in two runs: the first beginning in late July and continuing until mid-August; the second migrating from mid-August to December. Hatching occurs in roughly 150 days when water temperature reaches 35°F. Some fry migrate immediately to sea, but most remain in fresh water for one or two years (U.S. Army, Corps of Engineers 1978).

The limited water transparency and cold water of Grant Lake and its tributaries limit fish production, but its large population of sticklebacks shows that food supplies are adequate for at least some fish species. Although stickleback compete with species like sockeye salmon (Rodgers 1968; Rankin and Ashton 1980), they cannot out-compete sockeye and rainbow trout, and even constitute a significant food resource for fish-eating species like Dolly Varden and cutthroat (Nilsson and Northcote 1981, Rogers 1968). ADF&G has been studying Kenai drainage lakes since 1976 to locate suitable sockeye nursery areas for juveniles produced from the Trail Lakes Hatchery (scheduled for completion in late 1982) (Flagg 1982). In 1981 ADF&G sampled Grant Lake, and preliminary data suggest that it had the second highest plankton concentration of the lakes tested. Results suggest the lake may have potential for rearing salmonid fish. In addition, sockeye salmon in the Kenai system are known to be infected with the virus infectious hemotopoietic necrosis (IHN) (Dudiak 1980), and this virus could conceivably hamper some types of sockeye salmon enhancement efforts planned for Grant Lake.

An experimental introduction of 620,000 coho fry is scheduled for release into Grant Lake in June 1983. ADF&G plans a program to evaluate the development and outmigration of stocked fish in 1983 (Flagg 1982, 1983). If coho salmon survival is successful, future plants of chinook salmon fry will be conducted (Flagg 1983). No sockeye salmon fry will be planted in the lake in the future.

At present Grant Lake does not directly provide an economically important fishery, but it has potential in the future. In order to obtain a general estimate of potential production of that fishery, a model by Schlesinger and Regier (1982) was used to estimate annual fish production as maximum sustainable yield (MSY) (Table 3-8). The results indicate an annual fish production of approximately 3.5 kg/hectare/year (3.8 lbs/acre/year), or 2268 kg/year (4990 lbs/year) for the total lake. Assuming that total production would be one year old sockeye salmon smolts each weighing 6.6 grams (the average size of one year old smolts in four Alaska lakes [Eggers 1978]), the total annual yield from

Non-anadromous rainbow trout have been planted in numerous lakes and ponds in Alaska (Armstrong 1969). Rainbow spawn during late winter or early spring when water temperatures begin to increase. A redd is prepared in fine gravels by the female before she releases from 200 to 8,000 eggs, depending on her size. Redd size is about 0.2 square meters (Hunter 1973). Rainbow trout may spawn annually for up to five years. Stream dwelling fish generally stay in the natal stream while lake resident fish may migrate into and out of the lake to neighboring streams (Armstrong 1969).

Dolly Varden spawn in October and November. The female may deposit 300 to over 6,000 eggs, depending on size (Morrow 1980). The eggs develop slowly in cold water, hatching in March or April. In nonanadromous (non-migratory) populations in Alaska, the young may spend several months to three or four years in streams, then move to a lake. Juveniles of the anadromous race rear in streams three or four years before migrating seaward in late May. Sexual maturity is reached in three to six years in both races, with males often maturing a year earlier than females. Not all adults migrate into fresh water to spawn and may only enter streams to feed. Dolly Varden may spawn more than once, returning to their natal stream from mid-July to late September. Spawning mortality in Alaska fish varies; a small number live to spawn more than twice; but few appear to live longer than eight years (Armstrong 1969).

Grant Lake

Previous investigations (USFWS 1961) indicate that Grant Lake supports a small population of slimy sculpin and a dense population of threespine stickleback. A falls at the lake's outlet blocks immigration of other fish species. Results of fish sampling in October 1981 and March, June, and August 1982 indicate that density of threespine sticklebacks per minnow trap set were 10 times higher in the lower basin than the upper basin (AIEDC 1982). Sculpin were also captured during these surveys, but no other fish species were found in Grant Lake or its tributaries.

TABLE 3-8

REGRESSION EQUATION TO ESTIMATE FISH YIELD FROM GRANT LAKE[a/]

Formula: $\log_{10}$ Yield = 0.050 TEMP + 0.349 EFFORT + 0.146 $\log_{10}$ MEI_{25} - 0.367

Yield = kg/Hectare/year

Where variables: TEMP = mean annual air temperature (°C)

EFFORT = dummy variable (two for intensively-fished lakes, one for lakes with light to moderate or unknown fishing intensity

MEI_{25} = total dissolved solids/maximum mean depth of 25 m

Variables use: TEMP = 2.9°C (Moose Pass mean temperature)

EFFORT = 1

MEI_{25} = 53 mg/l/25m

Formula as calculated:

$\log_{10}$ Yield = (0.050 x 2.9) + (0.349 x 1) + (0.146 $\log_{10}$ 53/25)

Yield = 3.5 kg/Hectare/year

---

a/ Source of formula; Table 3, page 145 of Schlesinger and Regier 1982.

Grant Lake would be approximately 340,000 smolts. It should be noted that the model used does not compensate for high turbidity levels, which would reduce the estimated yield; therefore, this production estimate is probably high.

Grant Creek

The area used as habitat for fish is most likely concentrated in the lower half mile of the stream. The upstream half-mile is characterized by very fast water with a gorge with few pools and is bounded at the top by two large waterfalls.

Previous investigations of Grant Creek by ADF&G (1952-1981) focused on its use by salmon for spawning. All investigators have noted that the stream's glacial turbidity and turbulence severely hamper accurate surveying and spawner enumeration. Recorded spawner counts of chinook and sockeye salmon for the years 1952-1982 are presented in Table 3-9. Peak counts during this period averaged 19 and 61 for chinook and sockeye salmon, respectively. The numbers of adult salmon and trout returning to spawn in Grant Creek are probably higher than the data of Table 3-9 indicate due to the infrequency of spawning ground surveys, the poor visibility due to high turbidity, and high discharge rates, which restricted survey effectiveness. Highest stream discharge typically occurs from June through August and is still fairly high in September through November (US Geological Survey 1981). This high discharge further hampers accurate spawner counts. Grant Creek may also be used for spawning by coho salmon, Dolly Varden, rainbow trout, and sculpin and is definitely used as a nursery habitat. Radio tag studies in the Kenai system indicate that tributary spawners, both chinook and sockeye salmon, are early run fish that arrive in the Kenai River between mid-May and early July (Burger 1982). Previous investigators have concentrated their spawner surveys on Grant Creek in mid-August and early September, indicating that a delay of one to two months occurs between entry into the Kenai River and the arrival of spawners at Grant Creek.

TABLE 3-9
PEAK SALMON SPAWNING GROUND COUNTS FOR GRANT CREEK, 1952-1982[a/]

Year	Numbers of Spawners	
	Chinook Salmon	Sockeye Salmon
1952	0	250
1953	12	13
1954	6	45
1957	8	0
1959	28	0
1961	86 Total Salmon[b/]	
1962	2	234
1963	33	41
1976	29	0
1977	0	4
1978	5	0
1979	42	29
1980	5	0
1981	45	19
1982	46[c/]	135[c/]
Average	19	61

a/ Alaska Department of Fish and Game unpublished data 1952-1981.

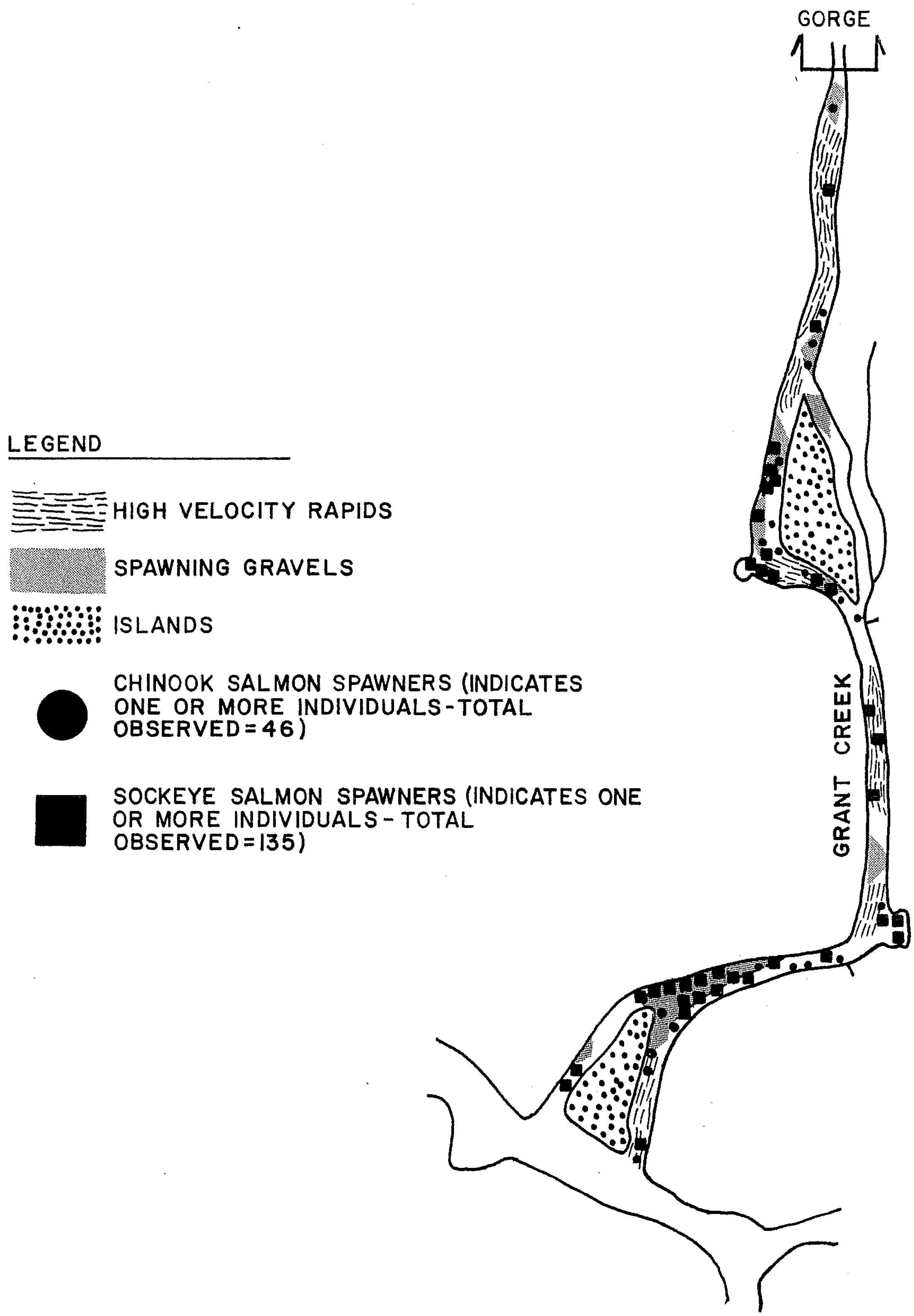
b/ Not included in averages.

c/ AEIDC 1982.

Initial field sampling in October 1981 by AEIDC (1982) found no live adult spawning fish although 10 chinook salmon carcasses were observed. Chinook counts in August 1981 by ADF&G recorded the highest numbers to that date, suggesting that most if not all spawning by chinook and sockeye is complete by October. The 1982 spawning counts by AEIDC (1982) found only 12 chinook in early August, but 46 spawners were observed in the third week of August when observation conditions were excellent. No other spawning fish were observed in early August, but 135 sockeye were observed later in August. No adult coho were observed during the present study (AEIDC 1982) or have been recorded historically in Grant Creek. It is possible that a late spawning run may occur in November or December; however, no counts have been made during those months.

Locations of adult salmon observed in Grant Creek in 1982 are shown in Figure 3-3. During March 1982 low flow, gravel composition was visually evaluated (AEIDC 1982). Substrate material was very coarse throughout the entire length of the creek due to the high velocity which tends to wash away suitable gravel. Areas that offer better than average potential for salmonid spawning are also shown in Figure 3-3.

Although spawning counts do not reflect the actual number of spawners, several authors have attempted to estimate escapement number from such counts (Gangmark and Fulton 1952; Craddock 1958). Neilson and Geen (1981) conducted intensive surveys of spawning chinook salmon in a north-central British Columbia stream and found that the peak count of salmon was 52 percent of the estimated escapement. Many variables are involved in making such an estimate, including time spent by salmon on the spawning ground, visibility of the stream, and timing of counts. Taking into account Neilson and Geens' work (1981), the excellent visibility in Grant Creek, and coincidence of peak counts in 1982 with recorded or peak accounts in Grant Creek, the actual number of spawners in Grant Creek was estimated to be 100 chinook and 500 sockeye, or approximately double the maximum number of fish observed during the



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LOCATIONS OF SPAWNING GRAVELS & OBSERVED ADULT SOCKEYE & CHINOOK SALMON IN GRANT CREEK 1981-1982

FIGURE 3-3

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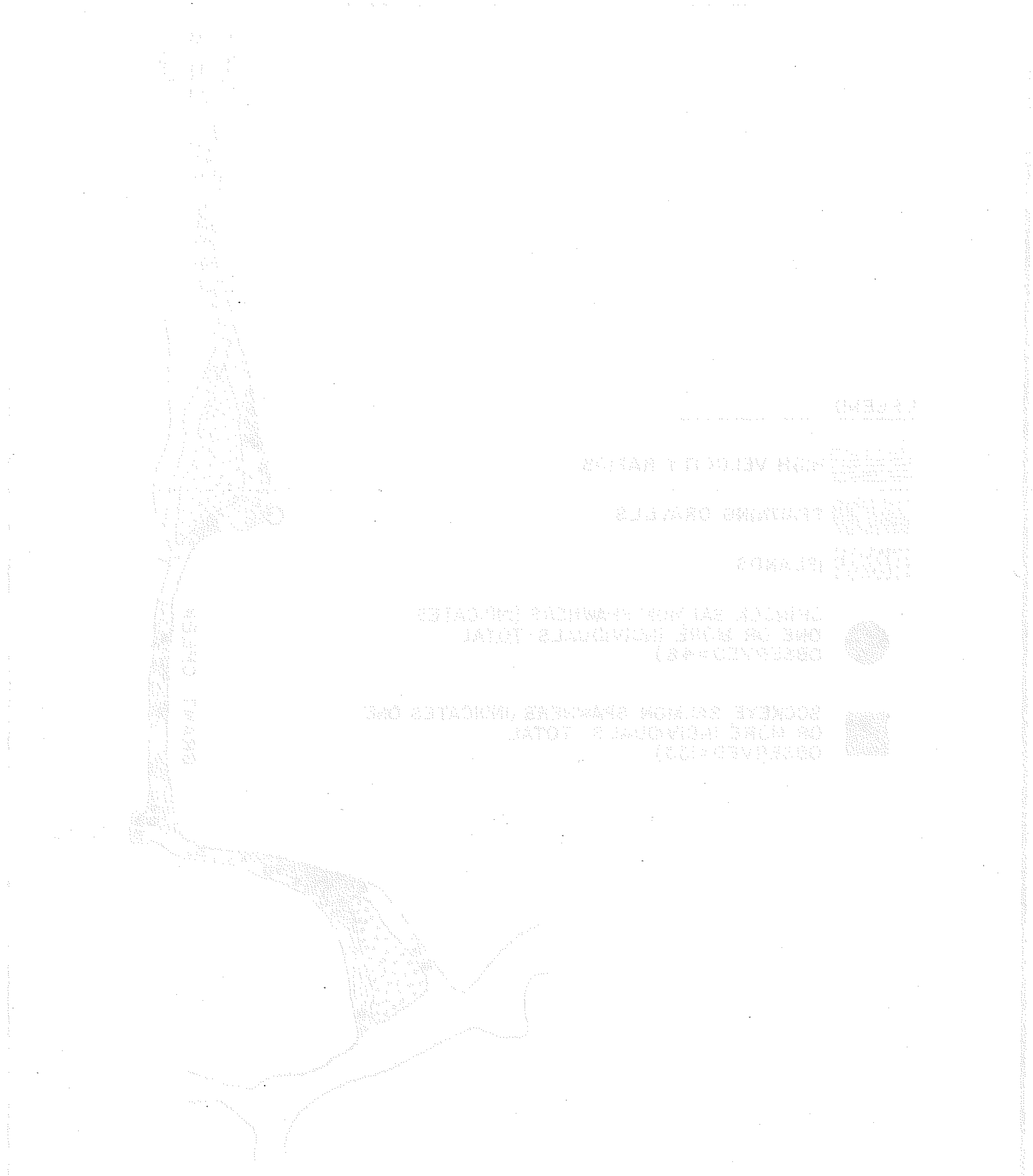

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GRANT LAKE HYDROELECTRIC PROJECT
LOCATIONS OF SPAWNING GRAVELS & OBSERVED ADULT SOCKEYE & CHINOOK SALMON IN GRANT CREEK 1981-1982
FIGURE 5-5
EBASCO SERVICES INCORPORATED

period 1952 to 1983. Present information suggests that this would equal approximately 250 adult chinook salmon and 1,650 adult sockeye salmon, considering catch plus escapement.

The USFWS (1961) periodically sampled Grant Creek using minnow traps from July 1959 through January 1961. Fish captured included chinook salmon, coho salmon, Dolly Varden, and sculpin. The results of this trapping effort are presented in Table 3-10. The USFWS (1961) also reported that sport fishing pressure was light due to the turbidity and inaccessibility of the stream from the Anchorage-Seward Highway. This report indicates that anglers usually caught one to five fish, mostly Dolly Varden, with occasional catches of 10 to 15 fish per trip. The only known creel census was conducted by ADF&G at the mouth of Grant Creek during 1964 (Table 3-11). No other reliable estimate of fishing efforts is available.

Moose Pass area residents estimated that 500 to 600 angler-days of fishing occur on Grant Creek each year, primarily for Dolly Varden and rainbow trout (AEIDC 1982). Residents also reported that the population of Dolly Varden has dropped considerably over the years. ADF&G (McHenry 1981) indicated that actual fishing pressure is probably much lower than local residents estimate and is due to access difficulty. Grant Creek is closed to sport fishing for salmon by ADF&G regulations, although evidence of illegal fishing was observed during field sampling.

The results of minnow trapping and electrofishing Grant Creek by AEIDC (1982) are shown in Table 3-12. Catches of trout, salmon, and char were generally higher in the fall and summer than in winter and spring. Dolly Varden were generally the most abundant in minnow traps followed by juveniles of chinook salmon, rainbow trout, and coho salmon. Cooler temperatures in winter and spring may have been partly responsible for lower catches since minnow traps are passive gear that require fish to come to them and fish are generally less active at cold temperatures. Electrofishing results (Table 3-12) found juvenile

TABLE 3-10
JUVENILE FISH COLLECTED BY MINNOW TRAP IN GRANT CREEK
JULY 1959 THROUGH JANUARY 1961[a]

Month	Chinook Salmon	Coho Salmon	Dolly Varden	Sculpin
	Species			
January	X[b]	--	--	--
February	X	--	--	X
March	--	--	--	X
April	X	--	X	--
May	N.S.[c]	N.S.	N.S	N.S.
June	X	--	X	X
July	X	--	X	X
August	X	X	X	X
September	X	X	--	--
October	X	X	--	X
November	X	X	--	--
December	N.S.	N.S	N.S	N.S

a/ USFWS 1961.

b/ Denotes presence, -- denotes absence.

c/ Not surveyed = N.S.

TABLE 3-11

SPORT FISH CATCH FOR GRANT CREEK AS REVEALED BY CREEL CENSUS AT THE MOUTH 1964[a]

Date	No. of Anglers	Species[a]	No. of Fish	Catch per Effort
5/21/64	2	Round whitefish	1	0.25 per hour
6/4/64	3	Rainbow trout	3	
		Dolly Varden	3	0.67 per hour
		Round whitefish	1	
6/9/64	3	Rainbow trout	2	0.26 per hour

a/ McHenry 1981.

TABLE 3-12
RESULTS OF MINNOW TRAPPING AND ELECTROSHOCKING EFFORTS IN
GRANT CREEK, OCTOBER 1981 AND MARCH, JUNE, AND AUGUST 1982[a/]

Location[b/]	Species[c/]	October	March	May	June	August
Minnow Trapping						
1. Near mouth	Dolly Varden	10	0	3	15	21
	Rainbow trout	12	3	0	2	4
	Chinook salmon	3	5	1	0	21
	Coho salmon	0	4	0	2	5
2. Mid-lower quarter mile	Dolly Varden	1	0	6	5	34
	Rainbow trout	2	0	7	1	1
	Chinook salmon	17	1	1	0	3
	Coho salmon	0	0	0	0	6
3. Mid-half mile	Dolly Varden	9	0	0	1	26
	Rainbow trout	6	0	3	1	2
	Chinook salmon	37	0	0	0	8
	Coho salmon	2	0	0	0	0
4. Mouth of canyon	Dolly Varden	2	1	0	3	32
	Rainbow trout	3	0	0	0	0
	Chinook salmon	14	0	0	4	2
Total Catch[d/]	Dolly Varden	22	1	9	24	113
	Rainbow trout	23	3	10	3	7
	Chinook salmon	71	6	2	4	34
	Coho salmon	2	4	0	2	11
Trap Hours		80	306	162	108	126
Catch Per hour	Dolly Varden	0.28	0.01	0.06	0.22	0.90
	Rainbow trout	0.29	0.01	0.06	0.03	0.06
	Chinook salmon	0.89	0.02	0.01	0.04	0.27
	Coho salmon	0.03	0.01	0	0.02	0.09

TABLE 3-12 (Continued)

Location b/	Species c/	October	March	May	June	August
Electroshocking						
From first bend upstream to U.S.G.S. gaging station	Dolly Varden	3	1	22 e/		
	Rainbow trout	15	1	7 e/		
	Chinook salmon	21	6	79 e/		
	Coho salmon	8	0	11 e/		

a/ AEIDC 1982.
b/ Minnow traps fished between the lake outlet and the falls caught no fish.
c/ All species but coho salmon, which were collected only in quiet pools or eddies, were collected in all stream sections having suitable habitat. Sculpins were also occasionally captured.
d/ Twenty additional Dolly Varden (20 to 30 cm) three rainbow trout (20 to 30 cm), and two chinook salmon (70 and 81 mm) were taken by angling in Grant Creek.
e/ Taken while performing the block and removal method (Zippin 1958). Most of the chinook caught were young-of-the-year less than 45 mm in length that appeared to have been stimulated out of the gravel from shocking activities.

chinook salmon to be the most abundant. Comparison of relative abundance between seasons can not be made, however, because intensity of sampling was different during the three electrofishing sample periods.

Dolly Varden were generally more abundant near the mouth of Grant Creek except during peak abundance in August when distribution was fairly uniform (Table 3-12). They were distributed in a wide variety of habitats, including shallows, slow water, deep pools, stream margins in sections with high velocities, mid-channel in areas where large boulders or debris protected them from high velocities, and in temporary backwaters and side channels during high flows. A variety of size classes were captured ranging from 55 mm to 30 cm (2.2 to 11.8 in). As stated before, no spawning Dolly Varden have been observed in Grant Creek; therefore it is possible that the high abundance of fish, particularly in August, may be from fish moving into the stream from Trail Lakes to feed and avoid the high turbidity. Although the lack of small fish less than 70 mm (2.75 in) in minnow traps in May and June suggests that spawning does not occur in Grant Creek, small chinook or sockeye, which do spawn there, were also not captured by minnow trapping. It is therefore possible that Dolly Varden had not emerged from the gravel at the time of sampling.

Chinook juveniles were observed most often in the lower half of the sampling area of Grant Creek, but during the period of highest abundance (October 1981) were distributed throughout the sampling area. The large size of fish caught by minnow trap in March, May, and June [greater than 65 mm (2.6 in)] suggests they would probably smolt in June. Captured fish ranged in size from 56 to 96 mm (2.2 to 3.8 in) in length. The catch of chinook salmon juveniles was second to Dolly Varden in minnow traps (Table 3-12). Although the fish are present all year, the low number of juveniles captured in March, May, and June suggests they are either very inactive during these months or they have left the system to rear elsewhere prior to downstream migration, possibly overwintering in the river or Kenai Lake. Rearing in the Trail Lakes is believed unlikely because of the high turbidity of the lakes (Dudiak 1980).

It was apparent during the winter 1982 investigations that chinook salmon collected by electroshocker were primarily utilizing habitat in the interstitial spaces of the large and medium size cobble substrate (AEIDC 1982). Juveniles caught in October, 1981 generally exhibited a preference for habitat possessing moderate velocity (1 to 2 ft per second), such as the margin of the main channel. Chinook also were present in areas of generally high velocity, but where large substrate or organic debris provided cover and protection from high velocities.

Natural emergence of chinook salmon may be later than June because no young of the year were captured in minnow traps until August. Young of the year, however, were captured in May during electrofishing but these appeared to have been stimulated out of the gravel from the shocking activities. It is possible that juvenile chinook were present but were not being caught by minnow traps. Bloom (1976) caught almost no juvenile coho less than about 50 mm (2 in) in length in the minnow traps even though that size fish was highly abundant in the stream.

Exclusive of two fish captured in October, coho salmon were always present in the lower two sampling areas of the stream but were generally low in abundance (Table 3-12). Coho juveniles were less abundant than chinook salmon juveniles and did not utilize as wide a range of habitat as juvenile chinooks. They showed a preference for shallow water with little or no velocity and an abundance of detrital cover. This type of habitat was generally found only in the deep pools and backwater areas in the lower sampling areas except at very low flow. The extremely small size (40 mm) (1.6 in) of several of the coho juveniles trapped in August 1982 strongly suggests that cohos spawn in Grant Creek. These small fish generally do not venture far from their natal areas, and the stretch of rapid water near the mouth of Grant Creek would pose a major impedance to the immigration of such small fish. These data would indicate that coho juveniles utilize Grant Creek for rearing but are present in small numbers. Older, large juvenile cohos may be recruited to Grant Creek from the turbid waters of Trail Lake during the late summer and fall. Coho captured ranged from 42 to 106 mm (1.6 to 4.2 in) in length during the study.

Rainbow trout appear to be evenly distributed in Grant Creek and are found in most habitat types. Rainbow captured during the study ranged from 43 to 106 mm in length (1.7 - 4.2 in). Highest abundance, including many small young-of-the-year of 45-50 mm length (1.8 - 2 in), occurred in October, which suggests that spring spawning of rainbow may occur in Grant Creek. Like other salmonid young-of-the-year, many of these rainbow may move upstream from the Trail Lakes area to rear and they are generally inactive in the winter months. Both grayling, which were caught during October angling surveys, and whitefish have been reported in Grant Creek, but they are not believed to spawn there.

Because Project field studies were designed to index relative population size rather than estimate the stream's annual sport fish production, estimates of annual production in Grant Creek were derived from studies of other trout streams. The Grant Creek field data was used as one measure of the reasonableness of the production estimate. Estimates for cold-water Pacific Northwest streams, all of which possessed mixed populations of salmon, trout, and other species, were used because no such estimates are available for Alaska. These estimates may be expected to overestimate Grant Creek's trout and char production because conditions in more southern streams (e.g., higher water temperature and total dissolved solids or nutrients) are more conducive to fish growth. Estimates used are shown in Table 3-13. Trout production for these streams averaged 3.5 grams per m^2 per year. Assuming that Grant Creek averages 25 ft (8 m) in width and has 0.5 mile (805 m) suitable for rearing, the rearing area would be approximately 6,134 m^2. This would equate to 21,725 grams of trout, which in terms of an 8 in (104 gram) trout, would equal 209 trout. This represents the number produced each year rather than the number existing at any point in time (i.e., the standing stock) and assumes that large trout that are harvested, die, or leave the creek are replaced by other trout that contribute to the stream's production.

TABLE 3-13

ESTIMATES OF TROUT PRODUCTION
FROM SOME NORTHWEST STREAMS

Species	Annual fish production, grams of fish/m^2/year	Stream	Reference
Cutthroat trout	4	Deer Creek, Oregon	Chapman (1965)
Steelhead trout	1.5	Deer Creek, Oregon	Chapman (1965)
Rainbow trout	4.3, 5.5, 2.4 (different years)	Big Springs Creek, Idaho	Bjornn (1978)
"Salmonids"	4.6	Northern California	Burns (1971)

3.1.2 Potential Impacts

3.1.2.1 Construction Impacts

Some minor temporary impacts to the aquatic resources of the study area may occur from construction activities. The magnitude and longevity of the impacts will depend on the specific construction activity, and the time of the year in which it occurs.

Lower Trail Lake

Increased fine sediment runoff from access road, powerhouse, and penstock construction may temporarily impact Lower Trail Lake. Effects would be expected to be slight because Lower Trail Lake is already glacially turbid, so slight additions of sediment probably would not significantly alter ambient levels. Although fine sediment can affect survival and drift of benthic invertebrates that serve as food for salmon, trout, and char in these systems, it is expected that minimal sediment should enter these systems from Project construction and the quantity entering the system would be flushed away with high water flow in the summer.

Grant Lake

Deepening of the sill between the upper and lower basins of Grant Lake will not affect any important aquatic resources as none are present. This construction activity will occur in the winter using explosive charges to blast the rock bottom. These explosives may cause mortalities of sculpin and stickleback from shock waves. For the same reason, some mortalities may occur if ADF&G proceeds with its plans to stock Grant Lake with salmon beginning in the spring of 1983 (see Section 3.1.3 for details).

Toxic materials associated with construction activities, such as petroleum products, cement, and wastewater are not expected to enter the Trail Lakes and Grant Lake under anticipated circumstances.

3.1.2.2 Operation Impacts

Project impacts on aquatic resources of the study area are summarized by Project alternative and water body in the following sections.

Grant Lake

Presently there are no economically important aquatic resources in Grant Lake, and minimal impact should occur to any potential aquatic resources in Grant Lake from the Project. It is anticipated that the littoral zone will experience a reduction in species diversity due to the increased drawdown, resulting in some loss of macrophytes and desiccation of benthic organisms. Often the loss of diversity is augmented by an increase in abundance of organisms, typically chironomids and oligochaetes (Hildebrand 1980), but abundance in the littoral zone should still be below pre-Project levels (Geen 1974). Chironomids and oligochaetes are more successful in reservoirs because they are able to survive well in medium and fine sediment environments, typical of reservoirs, and to avoid desiccation by burrowing (Hildebrand 1980). Because of the relatively small littoral area in Grant Lake, reduced littoral productivity should be minor compared to total production of the lake (Hildebrand 1980).

Plankton production and water chemistry typically change very little when lakes are used as reservoirs (Geen 1974). A flushing rate increase can have an adverse effect on plankton if it occurs during plankton blooms (Vernon 1958), but significant loss of phytoplankton usually only occurs at high flushing rates (Welch 1980, Hildebrand 1980). Grant Lake has a fairly slow flushing rate (once every 672 days), and even with drawdown to 660 ft, flushing will still occur only once every 518 days.

During studies of Grant Lake in 1982, the highest phytoplankton density occurred during a high runoff period (August). The operational plan for the Project calls for reduced discharge during this period which could have a positive effect on primary production. Increased turbidity could also adversely affect primary production. It would be expected that minor turbidity increases may occur from the first drawdown period as the fine littoral sediments are resuspended. Since the littoral zone is so limited in Grant Lake, the impact of sediment would be expected to be minor and would reequilibrate after several drawdown periods (Hildebrand 1980).

Deepening the sill between the two basins of Grant Lake should not significantly impact primary production in the lower basin. Suspended solids do not appear to stratify with depth and subsequent drawdown of the lake level will reduce the amount of turbid water inflow into the lower basin to at or below pre-Project levels (see Section 2.0).

Food supply for any salmonids planted into Grant Lake should not be affected because zooplankton, the main food source, will probably not be adversely affected. Increased flushing rate has been found to reduce zooplankton abundance, but probably only in rapidly flushed reservoirs (flushing time of weeks or months) (Hildebrand 1980). Although some adverse effects may result from a potential loss of littoral benthic food organisms, these items are most often a small portion of the diet of lake or reservoir dwelling fish like sockeye or coho salmon juveniles (Crone 1981; Rodgers 1968; Hamilton et al. 1966). Sculpins, which depend mainly on benthic organisms, may be reduced in number due to impacts to littoral benthos. It is also possible that sculpin may predate juvenile salmonids planted in the lake.

Temperature regimens in Grant Lake should not change significantly, so no adverse temperature effects on fish should occur (see Section 2.0). Duthie (1979) examined two former lakes converted to reservoirs in subarctic Canada and found no change in temperature regimens. However, there may be a slight increase in epilimnion temperature during July, August, and September during operation. This may occur because water is being withdrawn from a depth of 43-48 ft, removing cooler water from the reservoir and leaving warmer surface water.

Once juvenile salmon are planted in Grant Lake, impacts could occur when the fish attempt to migrate to sea as smolts. If no fish passage or bypass facilites are installed, fish passing through the turbine could suffer significant mortality. A Francis type turbine will be used for the Project. Mortalities from this type of turbine are most often from mechanical effects. It is not known what those mortalities will be from the present design, but most studies on Francis turbines have found juvenile mortalities in excess of 20 percent. These studies were conducted on larger turbines (Turbak et al. 1980). No information is available on fish mortalities resulting from fish passage through the small turbines and very little recent information has been developed on any turbines since 1969 (Turbak et al. 1980). To alleviate this potetial impact, a bypass facility will be used (see Section 3.1.3) to prevent passage of smolts through the turbine.

It is not known if downstream migrating smolts will have difficulty finding the lake exit during spring outmigration. During May and June the intake depth will be a relatively shallow 6-26 ft, but by July the depth will be about 43 ft. Studies in Washington and Oregon found that salmonid smolts preferred the upper 15 ft of the water column during spring (Korn and Smith 1971). However, sockeye salmon can make substantial vertical migrations and go well below 67 ft during certain times of the year (Eggers 1978, Goodlad, et al. 1974). Studies at dams on the Elwha River in Washington have shown that chinook salmon outmigrants will enter a tunnel outlet at a depth of 65 ft (Schoeneman and Junge 1954). At Baker Lake Dam in Washington sockeye smolts entered a tunnel at a depth of 85 to 107 ft; however, they preferred a surface outmigration over a spillway if available (Andrew, et al. 1955). The range of depth distribution of fish in lakes varies. In some lakes presmolt sockeye have been found from surface to bottom (Cultus Lake, B.C.), but in another, only in the upper 39 ft (Shuswap Lake, B.C.) (Goodlad et al. 1974). Whether smolts will emigrate naturally from Grant Lake cannot be predicted. Because the intake is relatively shallow (6 to 26 ft) during the expected smolt emigration period of May - June and salmon smolts elsewhere use submarine outlets, it is believed that they will find and use Grant Lake's submerged outlet.

Grant Creek

Because Grant Creek will be dewatered except for minimal periods during overspills, essentially all aquatic resources presently in Grant Creek will be displaced or lost. Most spawning chinook and sockeye salmon or other fish that return to Grant Creek to spawn should instead return to the proposed tailrace (Johannesson 1982, Krema and Farr 1974) but may be unable to successfully spawn in that area. Under adverse natal stream conditions some salmon have been found to wander to other streams and spawn (Whitman et al. 1980, Sumner and Smith 1940). However, the fate of straying salmon cannot be predicted for Grant Creek stocks. Juvenile chinook and coho salmon, rainbow trout, and Dolly Varden that utilize Grant Creek may be lost entirely or displaced to other areas, possibly the powerhouse tailrace or the Trail lakes. Some habitat may still remain from surface and groundwater infiltration below Grant Lake, but the extent is expected to be minimal. Therefore, as a conservative assumption, the entire fish population of Grant Creek was assumed to be lost.

All aquatic habitat suitable for fish is assumed to be lost by dewatering the creek. The dewatering of Grant Creek will cause an annual loss of an estimated 100 chinook and 500 sockeye spawners corresponding to approximately 250 and 1,650 adult chinook and sockeye salmon, respectively. Habitat for trout (rainbow trout and Dolly Varden char), some of which are migratory, will be eliminated, resulting in the loss of approximately 209 8-in fish. Dewatering Grant Creek will result in lost sport fishing opportunities. The exact amount of fishing pressure is not known, but is estimated to be less than 500 angler days per year.

Although no sport fish inhabit Grant Lake the Alaska Department of Fish and Game intends to stock coho salmon fry into the lake in 1983 to determine its potential for rearing. Without a bypass device, these fish could suffer substantial mechanical injury and mortality by passing through the Francis turbine on their seaward migration as smolts (Turbak et al. 1980). There is the possibility that they also may be entrained and lost before they are ready to migrate or be unable to find the lake exit and residualize after the Project is operational.

3.1.3 Mitigation of Impacts

The Alaska Power Authority has a policy that their projects cause "no net losses" to fisheries resources. Significant Project impacts will be mitigated in the manner that is best biologically and economically. Fishery elements expected to incur significant impact without mitigation are summarized below.

3.1.3.1 Mitigation Process

Development of the fish mitigation plan involved many telephone conversations and visits with agency personnel, but the major planning process occurred during discussion of three fish mitigation "Planning Documents" during four meetings with personnel principally from the following agencies: Alaska Department of Fish and Game, U.S. Fish and Wildlife Service, National Marine Fisheries Service, Forest Service, and Cook Inlet Aquaculture Association. Agency contacts are chronicled in Section 3.4. These documents and minutes of each meeting are presented in chronological order in the Technical Appendix, Part X, and are summarized below.

Planning Document No. 1

Published July 2, 1982, this document examined the effect on Project economics of providing various streamflows in Grant Creek to sustain its salmon runs. Also examined were the feasibility of several artificial propagation options for mitigating fish impacts on Grant Creek and approaches to providing safe egress of salmon smolts from Grant Lake. This document was discussed at a July 9, 1982 meeting with fisheries agencies.

Tennant's (1976) "Montana method" was used to scope streamflows providing various levels of fish protection. This document also explained how raising the reservoir height would have little effect on the amount of water available for fish migration over what would be passed through the turbine. Estimated costs of eight levels of instream flow were shown to increase overall costs of power from the Project from 9.5 to 108 percent. The alternative of moving the powerhouse to an area in Grant Creek above the most usable fisheries habitat was projected to increase Project cost by 33-34 percent.

Several alternatives for mitigating impacts to salmon were considered, assuming Grant Creek would be dewatered (e.g., spawning channel, egg incubation boxes, hatchery rearing of fry, hatchery rearing of smolts, and other stream improvements). Methods of passing salmon smolts safely out of Grant Lake were extensively discussed (e.g., minimum streamflow in Grant Creek, screening of intakes, and artificial attraction flow). Estimated cost was determined for several of the mitigation measures presented.

During discussion of Planning Document 1 (see minutes of July 9 meeting, Technical Appendix, Part X), there were several comments raised by agency personnel that led to development of a second fish mitigation planning document. The National Marine Fisheries Service (NMFS) did not want minimum streamflow dismissed until all mitigation measures were evaluated and wanted consideration of a minimum streamflow of 15 cfs. The Forest Service said the decision makers need a full evaluation of alternatives in the feasibility report so effectiveness and cost could be properly assessed. Agency representatives recommended prioritization of all alternatives in the evaluation. Also, the ADF&G representative mentioned that the Alaska

Power Authority (APA or Power Authority) should consult with ADF&G's Fisheries Research, Enhancement, and Development Division (F.R.E.D.) as well as with the Cook Inlet Aquaculture Association to learn their preference concerning off-site mitigation.

Concern over fish being entrained by the intake to the turbine in Grant Lake was expressed by NMFS and ADF&G, although APA and AEIDC staff felt the fish would not leave the lake unless carrying capacity was exceeded. At the end of the meeting it was agreed to address agency concerns in a second planning document and meeting.

Planning Document No. 2

Planning Document No. 2 for fisheries mitigation was presented August 17, 1982 in a second meeting attended by 18 people. This document mainly dealt with fish mitigation measures other than a minimum streamflow in Grant Creek (see Technical Appendix, Part X). The level of mitigation set for the Project was 200 chinook and 500 sockeye which was based on the salmon spawning ground survey results from 1952 to 1980 and in accord with the Power Authority's policy of no net loss to fisheries resources. The Cook Inlet Aquaculture Association recommended that fish mitigation measures for the Project be restricted to the Kenai River system. This document dealt mainly with conceptual engineering and biological assessments of mitigation feasibility and less on costs, as costs could only be approximately estimated at this stage of planning. Maintenance of 15 cfs flow in Grant Creek would increase Project cost by about 10 percent, which was considered by the Power Authority to be the maximum increment economically feasible. However, this mitigation option was not considered feasible biologically because of a low probability that it could sustain existing fish stocks. Several mitigation options were dismissed because they were regarded as either too expensive, impractical biologically, or inferior to other options. Discussion was limited to egg incubation boxes, spawning channels, lake fertilization and monetary replacement as alternatives for fish mitigation for Grant Creek.

It was mentioned that because the ability of Grant Lake to rear salmon fry has yet to be determined, final development of a method providing safe egress of smolts would have to await the results of the fry plantings. ADF&G indicated it plans to stock Grant Lake with salmon fry in spring 1983 and to evaluate their survival and condition upon seaward migration as smolts in spring 1984. The document suggested that the best method for fish passage would consist of installing louvers or passive screens in the power tunnel and diverting fish into a bypass pipe that would carry about 11 cfs and discharge within the tailrace. A fish collection barge or "gulper" was also considered for capturing smolts instead of the bypass pipe, but was judged less desirable because of cost and lower probability of collecting a high percentage of smolts.

During the August 17, 1982 meeting, many questions and statements were presented by agency personnel. There was much discussion on the value of Grant Creek for rearing chinook. Concern over low water temperature at the tailrace having adverse effects on fish rearing at this location was also expressed. Subnormal water temperatures would delay hatching and emergence and may even prove lethal. The Power Authority stated it was monitoring lake temperatures through September to enhance the data base for this parameter. Use of an existing Trail Lakes Hatchery module for rearing Grant Lake stock was suggested. ADF&G agreed to consider this option and determine its compatibility with Department objectives. ADF&G suggested that a smolt rearing pond be considered. Many other mitigation options were suggested by ADF&G, including use of egg incubation boxes, rearing ponds, and use of Trail Lakes Hatchery and Grant Lake for rearing.

It was agreed that the next fish mitigation planning document (No. 3) would cost all alternatives in comparable units. The USFWS asked the Power Authority to consider the total potential of Grant Creek salmon production (i.e., potential number of salmon spawners that could use Grant Creek). USFWS suggested that a cost-benefit ratio be developed for the Project. The City of Seward representative advocated developing improved fish habitat as mitigation.

Discussion then focused on providing safe egress of salmon smolts from Grant Lake and post-operational monitoring of the efficacy of the fish mitigation. It was stated that either the passive screen or "gulper" appeared best for passing smolts around the turbine. ADF&G said it had requested state money to study the success of salmon stocking in Grant Creek, a study planned independent of the Grant Lake Hydroelectric Project). ADF&G suggested that it and the Power Authority meet again after ADF&G had sufficient time to study the fish mitigation options that had been discussed to determine which ones it preferred.

Further discussion of fish mitigation concerned minimum streamflows in Grant Creek. The USFWS opposed the abandonment of instream flow as a mitigation option. The agency felt more habitat information was needed and asked if IFIM (Instream Flow Incremental Method) studies provide data on rearing potential. The Power Authority questioned whether this was needed, given the wide disparity between economically feasible flow (less than 15 cfs) and that suggested as good habitat using Tennant's (1976) method (42 cfs). It was stated that an IFIM would provide useful habitat information (depth, velocity, substrate), but likely would not materially reduce the estimate of how much flow would be needed in Grant Creek to sustain its existing fish stocks.

September 15, 1982 Meeting

A meeting was held between APA and ADF&G on September 15, 1982 to discuss the mitigation options favored by ADF&G and to obtain ADF&G estimates on cost of rearing fish in a module at the Trail Lakes Hatchery. The principal options discussed included use of one of the existing hatchery modules at the Trail Lakes Hatchery, adding a module to the hatchery, building a mini-hatchery at the Project tailrace, or installing egg boxes at the tailrace. It was agreed that an adult holding facility would be needed for any option. It was decided that it was important to determine the thermal regime of the Grant Lake reservoir as this would likely affect the survival and growth of fish. The cost of rearing salmon smolts was presented by Loren Flagg of

ADF&G. More cost and engineering information for hatchery rearing juveniles was requested of ADF&G by the Power Authority. It was suggested by ADF&G that Grant Lake may be stocked with rainbow trout to mitigate for the lost sport fishery in Grant Creek. ADF&G indicated its plans to plant sockeye from Quartz Creek into Grant Lake. It was stated by the APA that this would rule out any special mitigation for the Grant Creek sockeye salmon stock because intermingling of Grant and Quartz Creek sockeye would destroy the genetic uniqueness of the former stock. ADF&G indicated it did not consider the stock unique.

ADF&G indicated it was prepared to commit one of the four fish production modules at the Trail Lakes Hatchery for rearing Grant Creek chinook. This commitment would last 10 years, the time the Department estimated it would take to build the Grant Creek chinook run to the point where it equalled the fish production capacity of the module. The Department also suggested that APA consider building a mini-hatchery at the tailrace. Problems with putting a hatchery at the powerhouse were mentioned by APA in that it would be a remote unattended site. The Power Authority thought it would be better to build a new facility (i.e., module) at Trail Lakes Hatchery. ADF&G said there was room at the hatchery for adding more modules. More information was requested by USFWS on rearing salmon juveniles in Grant Creek after incubation of eggs at Trail Lakes Hatchery. ADF&G was more confident in hatchery rearing than in egg boxes as a mitigation option. Courses of action were discussed should the fish mitigation options implemented fail to achieve their desired objectives. The Power Authority agreed that it would meet again with the agencies to define a new strategy for correcting any deficiencies.

Planning Document No. 3

Planning Document No. 3 was presented at a meeting on November 10, 1982. It considered the biological, engineering, and cost feasibility of 22 mitigation options. Nine options considered various flow regimes for Grant Creek, 11 addressed juvenile salmon rearing and adult spawning, and two discussed methods providing safe egress of fish from Grant Lake. These options were all priced in equivalent units for easy comparison.

This document summarized all major agency discussions from the previous three meetings and telephone and personal communications. The five options that APA believed most feasible economically and biologically were:

Option 13 Chinook salmon fry reared in an existing Trail Lakes Hatchery module and planted into Grant Lake,

Option 17 Chinook salmon fry reared in new module at Trail Lakes Hatchery and planted into Grant Lake,

Option 10 Chinook salmon fry reared to smolts at existing Trail Lakes Hatchery module and planted from imprinting pond at Project tailrace,

Option 18 Chinook salmon fry produced in egg incubation boxes and planted into Grant Lake, and

Option 20 Spawning channel.

All options included the passive screen smolt bypass, which was belived to be superior to the fish collection barge in providing safe egress of salmon smolts from Grant Lake.

ADF&G reiterated its main concerns at the meeting (see minutes in Technical Appendix, Part X). They favor mitigation for 1) losses of physical habitat in Grant Creek and some in Grant Lake, 2) losses to commercial and sport fishing opportunities, and 3) losses of potential enhancement value. They were concerned about low water temperature affecting Grant Lake's rearing potential. They want a rainbow trout fishery and boat access in Grant Lake. This sport fishery can be maintained either by planting fry or catchable size rainbow trout. The latter is favored should fry plants experience poor survival. Lost sport fishing opportunities could be mitigated by planting fish in other lakes should competition with sockeye or other species occur. ADF&G did not think chinook plants would do well in Grant Lake because of insufficient food in the littoral zone. They also want to maintain the genetic integrity of Grant Creek chinook. The Power Authority expressed concern about trout preying on salmon in Grant Lake, which would hamper interpretation of pre- and post-operational assessments of the lake's smolt production. At the end of the meeting ADF&G supported the following actions on the assumption that Grant Lake was unsuitable for salmon rearing:

- producing smolts in the Trail Lakes Hatchery (existing module)
- planting Grant Lake or another lake with catchable size fish to mitigate for lost sport fishing opportunities
- planting another lake with sockeye fry

If it was suitable for salmon rearing then they would support:

- producing chinook from an existing Trail Lakes Hatchery module and planting them in Grant Lake
- planting Grant Lake or another lake with rainbow trout fry
- planting Grant Lake with sockeye fry
- providing safe egress for salmon smolts from Grant Lake.

The USFWS indicated that it opposes off-site mitigation if enhancement is already occurring there. The USFWS reiterated its concern that the fish mitigation plan incorporate a plan for monitoring the efficacy of fish mitigation post-operationally. The plan should also provide a contingency action should any of the mitigation options fail to perform as expected.

3.1.3.2 Proposed Mitigation

Based upon the planning and coordination process described above and summarized in Planning Document No. 3, a substantial part of the proposed mitigation for the Project is Option 17 (see Technical Appendix, Part X), rearing chinook fry in a new module at Trail Lakes Hatchery and planting them into Grant Lake. Under this option, APA will pay for all aspects of rearing, planting of fry, and maintenance of equipment. This option is both biologically sound and within economic limits of Project feasibility. Option 13 and 10 are no longer viable because ADF&G has withdrawn its offer of the use of an existing module at Trail Lakes Hatchery. Part of mitigation option 17 is a passive screen smolt bypass facility at Grant Lake (see Technical Appendix, Part X). Option 14 (rearing fry to smolts at Trail Lakes Hatchery in a newly constructed module) was tentatively identified by ADF&G as its preferred option, but was rejected because it would make the Project unfeasible economically.

Mitigation is also planned for the other important fish species of Grant Creek. The mitigation for adult sockeye is based on a total of 1,650 fish, of which an estimated 1,150 will be harvested and 500 will escape to spawn. Because of the agencies' desired emphasis on chinook, in-kind mitigation for sockeye is not provided. However, the Power Authority will replace the value of the sockeye production with an equivalent value of chinook. The relative value of the two species will be defined in meetings with the agencies in subsequent phases of project development.

As part of the mitigation for lost sport fishing in Grant Creek, a boat launch facility capable of handling 14-18 ft boats will be constructed on the lake, as requested by ADF&G. In addition, the

Power Authority agrees to plant 209, 8-in rainbow trout or equivalent species into lakes or streams designated by ADF&G and cooperating fish resource agencies. The number of fish planted can be adjusted upward or downward, depending upon the size of planted fish desired. It is assumed that an arrangement can be made such that these fish, including costs of planting, can be purchased directly from ADF&G. It should be noted that if trout are planted in Grant Lake, it will not be possible to make an unambiguous assessment of the effect of the Project on juvenile salmon survival in Grant Lake because larger trout can be significant predators on small salmon and the extent of predation cannot be easily quantified.

The above plan assumes that ADF&G will monitor its experimental salmon enhancement program in Grant Lake prior to construction of the Project. If its studies indicate salmon are experiencing poor survival in Grant Lake, another plan to mitigate for the loss of sockeye, chinook, and sport fishing opportunity in Grant Creek will have to be formulated in conjunction with the agencies.

Should Grant Lake prove suitable for salmon rearing, post-operational studies of salmon smolts migrating from the lake should be conducted to assess survival and condition (e.g., size) of the smolts. Details of a program to monitor efficacy of mitigation would be defined in consultation with the agencies during development of the FERC License Application.

3.2 TERRESTRIAL BOTANICAL RESOURCES

3.2.1 Existing Conditions

The Kenai Peninsula-Prince William Sound region is the northern limit of the coastal hemlock-spruce forest which stretches nearly two thousand miles from Oregon to Alaska. The primary species present in the coastal forest are western hemlock[a/] and Sitka spruce. Mountain hemlock often takes the place of western hemlock, and white spruce often replaces Sitka spruce as major components of this forest type on the Kenai Peninsula. White spruce/Sitka spruce hybrids are found on the Kenai Peninsula (Viereck and Little 1972). Common understory plants include Sitka alder, rusty menziesia, various blueberries, and highbush cranberry. Areas of poor drainage often support open bogs, typically vegetated with low shrubs, mosses, and sedges (Viereck and Little 1972). Timberline on the Kenai Peninsula is generally at 1,000 to 1,500 ft (Ruth and Harris 1979).

Grant Lake lies in a valley with steep, avalanche-prone slopes. The mountain tops are essentially barren of plant life and have numerous permanent snowfields. Barren areas are common above and near timberline in the form of talus slopes, cliffs, rock outcrops, and drainage areas. Alpine vegetation areas are restricted and often interspersed with barren areas. The subalpine mosaic of alder thickets and grass/forb meadows is by far the most dominant vegetation pattern in the Grant Lake basin and in the Falls Creek drainage. The Grant Lake inlet stream valley supports a mature balsam poplar stand on the deltas and conifer stands further up the valley. Conifer stands occur in some avalanche-free sites around the lake. The area between Grant Lake and the Trail Lakes is forested with conifers and mixed conifer/broadleaf stands which are broken by several ponds and numerous bogs.

High snowfall and frequent avalanche activity are important forces governing the distribution of plant communities in the Project vicinity. Tall stiff-stemmed plants, such as trees, are usually absent from avalanche chutes because they are regularly broken off by the force of an avalanche. Shorter, relatively flexible plants, such as alder and grasses, are not as easily damaged and are often pioneer species in revegetation of highly disturbed sites.

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a/ A species list appears in Table 3-14.

TABLE 3-14

PLANT SPECIES IDENTIFIED FROM THE GRANT LAKE STUDY AREA[a]

Scientific Name[b]	Common Name
Lichens	
Cladonia spp.	
Stereocaulon spp.	
Clubmosses	
Lycopodium complanatum	creeping jenny
Horsetails	
Equisetum arvense	horsetail
Ferns	
Cryptograma crispa	parsley fern
Athyrium filix-femina	ladyfern
Woodsia ilvensis	
Gynmocarpium dryopteris	
Coniferous Trees	
Picea sitchensis	Sitka spruce
P. glauca	white spruce
P. mariana	black spruce
Tsuga heterophylla	western hemlock
T. mertensiana	mountain hemlock
Grasses and Allies	
Calamagrostis canadensis	bluejoint
Trisetum spicatum	spike trisetum
Festuca altaica	tufted fescue
F. rubra	
Eriophorum sp.	cottongrass
Rhynchospora alba	white beakrush
Carex microchaeta	finely-awned sedge
C. rhynchophysa	
Luzula walenbergii subsp. piperi	woodrush
Lily Family	
Veratrum viride	false hellebore
Allium schoenoprasum	wild chive
Fritillaria camschatcensis	chocolate lily
Streptopus amplexifolius	claspleaf twistedstalk

a/ AEIDC 1982.
b/ Botanical nomenculature follows Hulten (1968).

TABLE 3-14 (Continued)

Scientific Name	Common Name
Poplars and Willows	
Populus balsamifera	balsam poplar
Salix arctica	arctic willow
S. stolonifera	ovalleaf willow
S. barclayi	barclay willow
S. alaxensis	feltleaf willow
S. pulchra	diamondleaf willow
S. sitchensis	Sitka willow
Birches and Alders	
Betula nana	dwarf birch
Alnus crispa subsp. sinuata	Sitka alder
Nettle Family	
Urtica gracilis	slim nettle
Buckwheat Family	
Oxyria digyna	mountain sorrel
Water-Lily Family	
Nuphar polysepalum	yellow pond lily
Buttercup Family	
Aconitum delphinifolium	monkshood
Anemone richardsonii	
Ranunculus trichophyllus var. trichophyllus	white water crowfoot
R. macounii	
Thalictrum sparsiflorum	fewflower meadowrue
Sundews	
Drosera angelica	sundew
D. rotundifolia	roundleaf sundew
Stonecrops	
Sedum roseum	roseroot
Saxifrage Family	
Boykinia richardsonii	Alaska boykinia
Parnassia palustris	northern grass of Parnassus
Saxifraga tricuspidata	threebristle saxifrage
S. punctata subsp. pacifica	
Tiarella trifoliata	laceflower
Currants	
Ribes glandulosum	skunk currant
R. laxiflorum	trailing black currant
R. triste	American red currant

TABLE 3-14 (Continued)

Scientific Name	Common Name
Rose Family	
Amelanchier alnifolia	serviceberry
Aruncus sylvester	goatsbeard
Luetkea pectinata	lutkea
Potentilla fruticosa	shrubby cinquefoil
Rosa acicularis	prickly rose
Rubus pedatus	strawberry-leaf blackberry
R. chamaemorus	cloudberry
R. ideaeus	red raspberry
R. spectabilis	salmonberry
Sanguisorba stipulata	burnet
Sorbus sitchensis	Sitka mountain ash
Spiraea beauverdiana	Alaska spirea
Legume Family	
Lupinus nootkatensis	nootka lupine
Geranium Family	
Geranium erianthum	cranesbill
Violet Family	
Viola epipsila subsp. repens	marsh violet
Evening Primrose Family	
Epilobium angustifolium	fireweed
E. latifolium	river beauty
Ginseng Family	
Echinopanax horridum	devil's club
Parsley Family	
Heracleum lanatum	cowparsnip
Dogwood Family	
Cornus canadensis	bunchberry
Heath Family	
Andromeda polifolia	dwarf bogrosemary
Arctostaphylos alpina	alpine bearberry
A. uva-ursi	bearberry
Cassiope stelleriana	Alaska moss heath
Empetrum nigrum	crowberry
Ledum palustre subsp. decumbens	Labrador tea
Menziesia ferruginea	rusty menziesia
Moneses uniflora	single delight
Oxycoccus microcarpus	small cranberry
Phyllodoce aleutica	Aleutian mountain heather
Vaccinium caespitosum	dwarf blueberry

TABLE 3-14 (Continued)

Scientific Name	Common Name
V. ovalifolium	early blueberry
V. uliginosum	bog blueberry
V. vitis-idaea	lingonberry
Primrose Family	
Primula cuneifolia subsp. saxifragifolia	primrose
Trientalis europaea	European starflower
Gentian Family	
Gentiana glauca	glaucous gentian
Lomatogonium rotatum	star gentian
Buckbean Family	
Menyanthes trifoliata	buckbean
Phlox Family	
Polemonium pucherrimum	Jacob's ladder
Borage Family	
Myosotis alpestris subsp. asiatica	forget-me-not
Figwort Family	
Pedicularis verticulata	lousewot
Veronica wormskjoldii	alpine speedwell
Madder Family	
Galium boreale	northern bedstraw
Honeysuckle Family	
Linnaea borealis	northern twinflower
Sambucus racemosa	Pacific red elder
Viburnum edule	highbush cranberry
Harebell Family	
Campanula rotundifolia	harebell
Composite Family	
Achillea millefolium	yarrow
Arnica frigida	arnica
Artemisia tilesii subsp. elator	mountain woodworm
A. arctica	arctic sagewort
Hieracium triste	hawkweed
Petasites hyperboreus	sweet coltsfoot
Taraxacum alaskanum	Alaskan dandelion

Currently, no indigenous Alaska plant species are listed by the U.S. Fish and Wildlife Service as threatened or endangered. However, there are 30 species under review (Federal Register, Vol. 45, No. 242, Monday, December 15, 1980), and only one, Puccinellia triflora, has been reported on the Kenai Peninsula. This alkali grass is found in the coastal wetlands of the Cook Inlet-Kenai Peninsula area (Murray 1980). Because no habitat is available within the Project vicinity, this species is not expected to occur and was not found during field investigations.

The terrestrial botanical study area for the Project was defined as the watersheds of Grant Lake and Creek and Falls Creek. Nine vegetation mapping units were identified in this area using 1978 NASA high-altitude, color-enhanced, infrared photography. Mapping units generally represent combinations of plant community types that could be delineated from the aerial photographs. A vegetation map was prepared after correcting the photographs to a scale of 1:24,000 (AEIDC 1982).

Floristic composition, structure, distribution, and the corresponding vegetation associations (Viereck et al. 1982) of each mapping unit are described below. These descriptions are based on field surveys of the study area conducted during July 1982 by AEIDC (1982), during which the preliminary vegetation map was also field-checked. Representative areas of each mapping unit, as well as questionable areas, previously disturbed areas, and sites to be directly impacted by Project development were visited. A qualitative assessment of the relative abundance of dominant plants was made.

3.2.1.1 Coniferous Forest

This mapping unit is represented in the study area primarily by pure or mixed stands of white spruce and western hemlock. Mountain hemlock occurs at higher elevations. Coniferous forest occurs primarily between Grant Lake and Upper Trail Lake, in patches along Grant Lake's shoreline, in the valley of the Grant Lake inlet stream, and between the mouth of the Falls Creek valley and the Trail River. Understory shrubs are primarily rusty menziesia, early blueberry, and Alaska spirea. Devil's club occurs in moist areas and along drainages. Forest openings may support Sitka alder, serviceberry, Pacific red elder, and Sitka mountain ash. Other common shrubs in this type are trailing black currant and American red currant. The ground cover is primarily a carpet of Sphagnum spp. and other mosses, with five-leaf bramble and lingonberry trailing over the moss carpet. This mapping unit corresponds to the Viereck et al. (1982) Level III - closed needleleaf forest, except for the black spruce bogs which correspond to Level II - open needleleaf forest.

Areas of poor drainage may support open stands of black spruce with an understory of Labrador tea, lingonberry, and dwarf blueberry growing over a layer of sphagnum moss and lichens (primarily Cladonia spp.). These black spruce stands occur along the Trail Lakes and are scattered throughout the lower elevations around ponds and adjacent to the more open wet meadows.

3.2.1.2 Broadleaf Forest

This mapping unit is dominated by balsam poplar with an understory of rather tall feltleaf willow, Sitka willow, Sitka alder, and occasional white spruce. The ground cover is extremely sparse and consists of scattered patches of horsetail and river beauty. Frequent flooding is a very important force in this type. This mapping unit corresponds with the Level IV - closed balsam poplar forest - of Viereck et al. (1982).

This type occurs in the study area only along the main Grant Lake inlet creek and on the small delta of another inlet creek to the west of the main creek. The main inlet creek has a poorly defined channel and appears to shift its course across the delta frequently. During July 1982 the main body of the stream flowed directly through a mature poplar stand.

3.2.1.3 Mixed Broadleaf/Coniferous Forest

This mapping unit is dominated by paper birch, white spruce, and western hemlock on relatively warm, dry sites, whereas cool wet sites are often dominated by black spruce. The common understory plants of this type are rusty menziesia, highbush cranberry, early blueberry, American red currant, and prickly rose. Devil's club is found in wet places and along streams. Open sites often support Sitka alder thickets. The ground cover in the mixed forest is primarily mosses, bunchberry, five-leaf bramble, and lingonberry. The mixed forest type occurs in the study area in a band along the Trail Lakes and in the Vagt Lake area. This mapping unit corresponds with Viereck et al. (1982) Level III - closed mixed forest.

3.2.1.4 Riparian Scrub

This mapping unit consists almost entirely of willows, river beauty, fireweed, horsetail, and on drier sites, bluejoint. The unit corresponds with Viereck et al. (1982) Level III - open tall shrub scrub. This unit's distribution is very restricted in the study area, occurring only along the Grant Lake inlet creek, on the Grant Lake delta, and interspersed with the broadleaf forest.

3.2.1.5 Upland Scrub

This mapping unit comprises most of the subalpine vegetation in the study area, and is composed primarily of Sitka alder thickets in a complex mosaic with the grass/forb meadow type. Because of this complexity, most of the grass/forb meadows are included in this unit on the map. This closed scrub community has an understory composed primarily of lady fern. In some avalanche chutes the alder is mixed with willows. Rusty menziesia occurs in substantial portions of this type along the conifer/scrub interface. This mapping unit corresponds with Viereck et al. (1982) Level IV - closed tall alder scrub - and generally occurs from 700 to 2,500 ft along the mountain slopes throughout the study area.

3.2.1.6 Grass/Forb Meadow

This mapping unit forms a mosaic with the upland scrub type described above; and as stated, is mostly included in the upland scrub unit on the map because of the small size of these meadows. However, larger meadows are mapped separately. The primary constituent of this type is bluejoint grass. Salmonberry, red raspberry, fireweed, cow parsnip, false hellebore and goatsbeard are found throughout these meadows but generally are sparse. Dry, rocky slopes often support prickly rose, yarrow, arctic sagewort, cranesbill, and harebells. Monkeyflower is conspicious along drainages. This mapping unit corresponds to Viereck et al. (1982) Level III - mesic graminoid herbaceous - and Level III - mesic forb herbaceous. These meadows are located primarily along the slopes of both Grant Lake and Falls Creek valleys, but small meadows also can be found in the mixed forest and coniferous forest types.

3.2.1.7 Bog (Wet Meadow)

Sphagnum mosses form the basis of this mapping unit. The bogs vary from extremely wet, floating mats to firm, treed bogs with a high proportion of shrubs. Often there is a small pond or wet spot near the center of the bog. The wettest of these communities support sphagnum, sundews, buckbean and scattered beakrush and sedges. The ponds themselves often support buckbean and yellow pond lily. The drier bogs may support scattered black spruce, dwarf birch, labrador tea, lingonberry, dwarf blueberry, crowberry, and cloudberry. This mapping unit corresponds to Level III - wet graminoid herbaceous - and Level IV - open low shrub scrub, ericaceous shrub sphagnum bog - of Viereck et al. (1982). These bogs are most common in the study area in areas of low relief in the mixed and conifer forest types, often surrounding ponds or lakes. Most of them occur between Grant Lake and the Trail Lakes. Some of the smaller or more forested bogs are included in the forest classes.

3.2.1.8 Alpine Tundra

Tundra vegetation can vary considerably depending on the microclimate of a site. In many areas, upland scrub and grass/forb meadows intergrade with tundra types, making the map delineations somewhat arbitrary. Therefore, this description is a generalization of many types which occur in patches throughout the alpine zone. Lichens are conspicuous in many alpine areas, the most prevalent being Cladonia spp. and Stereocaulon spp. Prostrate willows, such as ovalleaf willow and arctic willow form a mat over the lichens in many alpine areas, as does bearberry. Graminoids, such as woodrush, finely-awned sedge, and fescue, are interspersed throughout tundra areas, especially on moist sites. Alaska moss heath, Aleutian mountain heather, and crowberry can cover large areas on the alpine slopes. Leutkea and sweet coltsfoot grow in moist places such as snowbeds and along drainages. Bog blueberry grows in patches on sunny slopes. Shrubby willows such as barclay willow, feltleaf willow, and diamondleaf willow grow along some of the alpine drainages. The alpine tundra mapping unit correlates to Level III - open dwarf shrub scrub - of Viereck et al. (1982). Alpine tundra in the study area is limited to the steep barren mountain tops, talus slopes, and permanent snowfields. It is most extensive on south-facing slopes above 2,000 ft and is very restricted on north-facing slopes.

3.2.1.9 Barren

These areas are mountain tops, talus slopes, cliffs, and snowfields having less than 10 percent cover by plants.

3.2.2 Potential Impacts

The amount of each mapping unit to be affected by the Project is shown and compared with the amount of each type available in the study area in Table 3-15. A description of the vegetation potentially affected by each category of disturbance is provided below.

TABLE 3-15

AMOUNT AND PERCENTAGE OF MAPPING UNIT THAT WOULD BE AFFECTED BY THE PROJECT

	Conifer Forest	Mixed Forest	Broad-leaf forest	Riparian Scrub	Upland Scrub	Grass/ Forb Meadow	Bog	Alpine	Barren	Water	Total
Total Acres in Study Area[a/]	3,910	1,160	90	100	6,300	900	160	5,970	17,470	1,780	37,840
Access roads, trans. lines											
Short-term habitat loss (acres)[b/]	9	15					1				25
Long-term habitat loss (acres)[c/]	5	8					1				14
Long-term veg. management (acres)[d/]		2									2
Powerhouse, penstock/intake structures, tailrace											
Short-term habitat loss (acres)[b/]	1	2					2				5
Long-term habitat loss (acres)[c/]	1	1					1				2
Grant Lake drawdown											
Permanent drawdown (acres)[e/]										35	35
Seasonal drawdown (acres)[f/]										165	165
Total Area altered by Project											
Short-term alteration (acres)[g/]	10	17	0	0	0	0	3	0	0	200	230
Percent of total acres in Project area	0.3%	1.5%	0%	0%	0%	0%	1.9%	0%	0%	11.2%	0.6%
Long-term alteration (acres)[h/]	6	11	0	0	0	0	1	0	0	200	218
Percent of total acres in Project area	0.2%	0.9%	0%	0%	0%	0%	0.6%	0%	0%	11.2%	0.6%

a/ Study area as defined on vegetation map.
b/ Total area cleared during construction.
c/ Area permanently covered by access roads, powerhouse, or other project facilities as indicated.
d/ Area along transmission line in which vegetation height would be controlled.
e/ Area exposed by the permanent drawdown of Grant Lake surface elevation from 700 to 690 ft above msl.
f/ Area exposed by the seasonal drawdown of Grant Lake surface elevation from 690 to 660 ft above msl.
g/ Total area altered by the Project during construction and the initial years of operation.
h/ Total area permanently altered by the Project.

3.2.2.1 Grant Lake/Powerhouse Access Road

This road would provide access from Highway 9 to the powerhouse, the Grant Lake intake and the penstock gate shaft. It would be routed through conifer and mixed broadleaf/conifer forest for most of its length. There are no unique areas affected.

3.2.2.2 Powerhouse

The proposed powerhouse site is in a paper birch stand at the interface between a mixed forest and a bog community. The understory is almost entirely rusty menziesia. The ground cover is moss with lingonberry, five-leaf bramble, and bunchberry. The bog community is very shrubby with scattered black spruce. The shrubs include shrubby cinquefoil, dwarf birch, Labrador tea and dwarf blueberry. Ground cover is mosses (primarily Sphaghum spp.) and lichens (primarily Cladonia spp.) with crowberry, lingonberry and cloudberry. As with the other Project structures, the vegetation types likely to be removed are not unique in the study area.

3.2.2.3 Grant Lake Drawdown Area

The area that would be exposed by the drawdown of Grant Lake is essentally barren of macrophytes with the exception of two areas. A protected cove at the neck between the upper and lower basins of Grant Lake supports a small stand of the sedge-Carex rhynchophysa. The outlet of Grant Lake has a robust stand of white water crowfoot, which provides habitat for a great many freshwater clams and snails. Grant Lake was the only location where the white water crowfoot was found in the study area. C. rhyncophysa was also found along a Grant Creek tributary system. Approximately 35 acres would be permanently exposed by the drawdown associated with power plant operation. Most of the shoreline to be exposed by drawdown is steep and rocky; however, the area to be permanently exposed includes alluvial and avalanche deposits where riparian or upland scrub habitat or coniferous forest are likely to develop, especially in flatter areas such as near the inlet and outlet. Sitka alder is expected to be the first colonizing shrub in most areas. Fluctuation of the lake level during operation would seasonally (especially March, April, and May) expose up to an additional 165 acres. Most of this latter area is not likely to revegetate.

3.2.3 Mitigation of Impacts

Standard construction techniques would be utilized to physically stabilize all surfaces disturbed by construction and to create a surface which will promote rapid regeneration of native vegetation. Where soils are substantially disturbed, topsoils would be segregated and stockpiled for use in subsequent rehabilitation. Disturbed areas would be fertilized and seeded with fast-growing native grasses wherever rapid revegetation is required for erosion control. Riparian and wetland areas would be avoided for facility siting to the extent practical. The 35 acres to be exposed by permanent lake drawdown would be allowed to be colonized by native plants. Natural revegetation of disturbed surfaces in the Grant Lake area is relatively rapid (within a few years). Sitka alder is frequently an early and dominant colonizer, but some moist areas will be colonized by willow.

3.3. WILDLIFE RESOURCES

3.3.1 Existing Conditions

In addition to reviewing pertinent literature and interviewing knowledgeable biologists and local residents, field surveys were performed to gather information on wildlife resources in the Project vicinity (AEIDC 1982). Beginning in the fall of 1981 and extending through the summer of 1982, a series of reconnaissance-level foot and aerial field surveys were conducted to ascertain the presence, distribution, relative abundance, and use patterns of various species and species groups and to identify the distribution and relative value of important seasonally-limited habitats and their relationship to Project features. Foot surveys were conducted once-per-season on all sites likely to be disturbed or modified as a result of Project construction (e.g., access road corridors, the powerhouse site, penstock, etc.). Foot surveys were also conducted through adjacent areas to compare habitats at Project construction sites to other habitats in the study area. The total study area for wildife resources included the watersheds of Grant Lake and Creek and Falls Creek and is the same as that mapped on the vegetation map.

Data recorded during foot surveys included sightings of individual animals and sign indicative of their presence (tracks, scat, browse lines, etc.), the vegetation type in which the sighting occurred, and an appraisal of the habitat quality for each species at each observation site. Habitat quality was subjectively evaluated at each field site by interpreting the amount and quality of forage items available along with indications of past use of available food resources. Systematic aerial surveys were also conducted seasonally to assess the distribution and relative abundance of large mammals, raptors, and waterfowl in the study area. Data recorded included species, numbers, sex and age composition, location, time of day, an estimate of viewing conditions, and sign (tracks in snow, excavations by bears, etc.) indicative of an animal's presence.

3.3.1.1 Amphibians

The wood frog (Rana sylvatica) is the only amphibian known to occur in the study area. Habitat for this species is present in the area between Grant and Trail Lakes. It is doubtful that other species occur in the study area. No reptiles are found in the region.

3.3.1.2 Birds

Alaska's avifauna is vast and diverse, comprising approximately 382 species (Kessel and Gibson 1978). Of these, about 130 species are found on the Kenai Pensinsula or in its coastal waters (USDA, Forest Service, no date). It appears likely that approximately 108 species could either inhabit or migrate through the study area. Comprehensive avian studies have not previously been conducted within study area boundaries.

Table 3-16 lists birds that may occur in the study area, their scientific names, breeding status, relative abundance, and breeding habitats. Abundance ratings given in the table refer only to numbers within study area boundaries. This information was compiled from the literature and on-site investigations. Table 3-17 compares avifauna habitat types to vegetation mapping units.

During field studies, 63 species of birds were observed. This represents 48 percent of the total number of species present on the Kenai Peninsula and 58 percent of those species that may seasonally use the study area. The probability of observing all the species listed in Table 3-16 in any one year is remote. The 63 species observed probably represents the majority of the bird species that utilized the Grant Lake study area in 1981-82. They also represent the species and number of birds typically found in other mountain valleys of the Kenai Mountains. Of the 63 species observed, 43 species were known or probable breeders within the study area. Accounts of the status of the major species groups in the study area are presented below.

<u>Waterfowl, Loons, and Grebes</u>

A variety of swans, geese, and ducks utilize the Kenai Peninsula. Most nesting habitat occurs west of the study area where the Kenai Peninsula forms a broad low level plain, dotted with numerous lakes and ponds.

The study area offers varied, though limited, types of waterfowl habitat. There are areas, principally around Vagt Lake and the ponds along the bench between Grant and Upper Trail Lakes, that are suitable for such ground-nesting ducks as mallards and American wigeons. There is a possibility that these areas may be lightly utilized by nesting geese or swans; however, none were observed during field studies and there are

TABLE 3-16 AVIFAUNA WHICH PROBABLY INHABIT OR MIGRATE THROUGH THE STUDY AREA (FROM AEIDC 1982)

SHEET 1 OF 3

A - Abundant
C - Common
FC - Fairly common
U - Uncommon
R - Rare
XX - Primary breeding habitat
X - Secondary breeding habitat
(1) - Habitat types follow Kessel 1979.
(2) - Abundance categories follow the U.S. Forest Service unpublished. Applies to study area only.
* - Endangered species.

Breeding Habitats in the Grant Lake Study Area[1]

Species		Observed During 1981-82 Field Season	Breeding: Known Breeders	Breeding: Inferred Breeders	Abundance[2]	Lacustrine Waters and Shorelines	Fluviatile Waters and Shorelines	Cliffs, Cutbanks, and Block Fields	Wet Meadow	Dwarf Shrub Meadow	Dwarf Shrub Mat	Low Shrub Thicket	Medium Shrub Thicket	Tall Shrub Thicket	Deciduous Forest	Coniferous Forest	Mixed Coniferous-Deciduous Forest	Scattered Woodland and Dwarf Forest	Migratory Only
Common Loon	*Gavia immer*	X	X		FC	XX	X												
Yellow-billed Loon	*Gavia adamsii*				R														X
Arctic Loon	*Gavia arctica*	X	X		U	XX	X												
Red-throated Loon	*Gavia stellata*				R	XX	X												
Red-necked Grebe	*Podiceps grisegena*				R	XX	X												
Horned Grebe	*Podiceps auritus*				U	XX	X												
Whistling Swan	*Olor columbianus*				R														X
Trumpeter Swan	*Olor buccinator*				U	X			XX	X									
Canada Goose	*Branta canadensis*				U	X			X	XX									
Mallard	*Anas platyrhynchos*	X		X	C	XX	X		X	X									
Pintail	*Anas acuta*				FC	XX	X			X									
Green-winged Teal	*Anas crecca*	X		X	U					XX									
Blue-wing Teal	*Anas discors*				R	X			XX	X									
American Widgeon	*Anas americana*	X	X		U	X			XX	X									
Lesser Scaup	*Aythya affinis*	X			U	X			XX										
Common Goldeneye	*Bucephala clangula*	X	X		FC	X	X											XX	
Barrows Goldeneye	*Bucephala islandica*	X			FC	X	X											XX	
Buffelhead	*Bucephala albeola*				U	X	X											XX	
Harlequin Duck	*Histrionicus histrionicus*	X		X	R		XX								XX			XX	
Common Merganser	*Mergus merganser*	X			C	X	X											XX	
Red-breasted Merganser	*Mergus serrator*	X			FC	X	X		X	X									
Goshawk	*Accipiter gentilis*				U										X	X	XX		
Sharp-shinned Hawk	*Accipiter striatus*	X			C										X	XX	X		
Red-tailed Hawk	*Buteo jamaicensis*				U			X						X	X	X	X		
Rough-legged Hawk	*Buteo lagopus*				U			XX											
Marsh Hawk	*Circus cyaneus*				R				XX	X									
Golden Eagle	*Aquila chrysaetos*	X		X	C			XX									X		
Bald Eagle	*Haliaeetus leucocephalus*	X			FC										XX	X	X		
Merlin	*Falco columbarius*				R			X							X	X	XX		
American Kestrel	*Falco sparverius*	X			R										X	X	XX		
Spruce Grouse	*Canachites canadensis*	X	X		FC											X	XX		
Willow Ptarmigan	*Lagopus lagopus*	X		X	C							X	XX	X					
Rock Ptarmigan	*Lagopus mutus*	X		X	C						XX	X							
White-tailed Ptarmigan	*Lagopus leucurus*				U						XX	X							
Sandhill Crane	*Grus canadensis*				R														X
Semipalmated Plover	*Charadrius semipalmatus*				U	XX	XX												
Black-bellied Plover	*Pluvialis squatarola*				U					X	XX								
Common Snipe	*Capella gallinago*	X		X	FC				X	XX									

TABLE 3-16 (CONTINUED)

A - Abundant
C - Common
FC - Fairly common
U - Uncommon
R - Rare
XX - Primary breeding habitat
X - Secondary breeding habitat
(1) - Habitat types follow Kessel 1979.
(2) - Abundance categories follow the U.S. Forest Service unpublished. Applies to study area only.
* - Endangered species.

Species		Observed During 1981-82 Field Season	Breeding: Known Breeders	Breeding: Inferred Breeders	Abundance[2]	Breeding Habitats in the Grant Lake Study Area[1]: Lacustrine Waters and Shorelines	Fluviatile Waters and Shorelines	Cliffs, Cutbanks, and Block Fields	Wet Meadow	Dwarf Shrub Meadow	Dwarf Shrub Mat	Low Shrub Thicket	Medium Shrub Thicket	Tall Shrub Thicket	Deciduous Forest	Coniferous Forest	Mixed Coniferous-Deciduous Forest	Scattered Woodland and Dwarf Forest	Migratory Only
Whimbrel	*Numenius phaeopus*				R				XX	X	X								
Spotted Sandpiper	*Actitis macularia*	X		X	FC	XX	XX			X	X								
Least Sandpiper	*Calidris minutilla*				U														X
Wandering Tattler	*Heteroscelus incana*	X			U	X	XX												
Greater Yellowlegs	*Tringra melanoleuca*	X		X	C				X	XX									
Lesser Yellowlegs	*Tringra flavipes*	X		X	C					XX									
Long-billed Dowitcher	*Limnodromus scolopaceus*				U														X
Northern Phalarope	*Phalaropus lobatus*				U				XX	X									
Glaucous-winged Gull	*Larus glaucescens*				U			XX											
Herring Gull	*Larus argentatus*				R														X
Mew Gull	*Larus canus*	X			U			X	XX										
Arctic Tern	*Sterna paradisaea*	X			FC				XX	X									
Great Horned Owl	*Bubo virginianus*				U			X							X	X	X		
Great Grey Owl	*Strix nebulosa*				U										X	XX	X		
Hawk Owl	*Surnia ulula*				U										X	X	XX		
Boreal Owl	*Aegolius funereus*				U											XX	X		
Saw-whet Owl	*Aegolius acadicus*				U										X	XX	X		
Belted Kingfisher	*Megaceryle alcyon*	X		X	C			XX											
Yellow-shafted Flicker	*Colapter auratus auratus*	X			U										XX	X	X		
Hairy Woodpecker	*Picoides villosus*	X		X	U										XX	X	X		
Downy Woodpecker	*Picoides pubescens*				R										XX	X	X		
Northern Three-toed Woodpecker	*Picoides tridactylus*	X		X	FC											XX	X		
Traill's (Willow) Flycatcher	*Empidonax traillii*	X		X	FC							X	XX	X				X	
Olive-sided Flycatcher	*Nuttallornis borealis*				U											XX	X	X	
Violet-green Swallow	*Tachycineta thalassina*	X		X	A			X							X	X	X	X	
Tree Swallow	*Iridoprocne bicolor*	X		X	A										X	X	X	X	
Bank Swallow	*Riparia riparia*	X		X	C			XX											
Cliff Swallow	*Petrochelidon pyrrhonata*				U			XX											
Grey Jay	*Perisoreus canadensis*	X		X	C										X	XX	X	X	
Black-billed Magpie	*Pica pica*	X			C									XX	XX		X	X	
Northern Raven	*Corvus corvax*	X			C			X							X	X	X		
Black-capped Chickadee	*Parus atricapillus*	X	X		A									X	XX	X	X		
Boreal Chickadee	*Parus hudsonicus*				FC									X	X	XX	X		
Dipper	*Cinclus mexicanus*	X	X		A		XX												
Red-breasted Nuthatch	*Sitta canadensis*				R										X	XX	X		
Brown Creeper	*Certhia familiaris*				U										X	XX	X		
Winter Wren	*Troglodytes troglodytes*				U										X	X	X		

TABLE 3-16 (CONTINUED)

SHEET 3 OF 3

A - Abundant
C - Common
FC - Fairly common
U - Uncommon
R - Rare
XX - Primary breeding habitat
X - Secondary breeding habitat
(1) - Habitat types follow Kessel 1979.
(2) - Abundance categories follow the U.S. Forest Service unpublished. Applies to study area only.
* - Endangered species.

			Breeding			Breeding Habitats in the Grant Lake Study Area[1]														
Species		Observed During 1981-82 Field Season	Known Breeders	Inferred Breeders	Abundance[2]	Lacustrine Waters and Shorelines	Fluviatile Waters and Shorelines	Cliffs, Cutbanks, and Block Fields	Wet Meadow	Dwarf Shrub Meadow	Dwarf Shrub Mat	Low Shrub Thicket	Medium Shrub Thicket	Tall Shrub Thicket	Deciduous Forest	Coniferous Forest	Mixed Coniferous-Deciduous Forest	Scattered Woodland and Dwarf Forest	Migratory Only
American Robin	*Turdus migratorius*	X		X	C									X	XX		X	X	
Varied Thrush	*Ixoreus naevius*	X		X	C									X		XX	X	X	
Hermit Thrush	*Catharus guttatus*	X	X		C									X	X	XX	X	X	
Swainson's Thrush	*Catharus ustulatus*	X		X	FC									XX		XX	X	X	
Grey-cheeked Thrush	*Catharus minimus*	X		X	R								XX	X				X	
Golden-crowned Kinglet	*Regulas satrapus*				U											XX	X		
Ruby-crowned Kinglet	*Regulas calendula*	X		X	A											XX	X		
Water Pipit	*Anthus spinotetta*	X		X	C					X	XX								
Bohemian Waxwing	*Bombycilla garrulus*	X	X		U											XX	X	X	
Northern Shrike	*Lanius excubitor*	X			U							X	X	XX	X	X	X	X	
Orange-crowned Warbler	*Vermivora celata*	X		X	C							X	XX		X				
Yellow Warbler	*Dendroica petechia*	X		X	C							X	X	XX					
Myrtle Warbler	*Dendroica coronata*	X		X	A											XX	X		
Townsend's Warbler	*Dendroica townsendi*	X	X		A									X		XX	X		
Blackpoll Warbler	*Dendroica striata*				U											XX	X		
Northern Waterthrush	*Seiurus noveboracensis*				FC	X	X		XX	X									
Wilson's Warbler	*Wilsonia pusilla*	X	X		A							X	XX	X					
Pine Grosbeak	*Pinicola enuncleator*	X		X	C											XX	X		
Grey-crowned Rosy Finch	*Leucosticte tephrocotis*	X			FC						XX								
Hoary Redpoll	*Carduelis hornemanni*				U						XX	X	X						
Common Redpoll	*Carduelis flammea*				C						XX	X	X	X		X		X	
Pine Siskin	*Carduelis pinus*				U											XX	X		
White-winged Crossbill	*Loxia leucoptera*				U											XX	X		
Savannah Sparrow	*Passerculus sandwichensis*	X		X	C					XX	X	X	X						
Slate-colored Junco	*Junco hyemalis*	X		X	FC												XX	X	
Tree Sparrow	*Spizella arborea*	X			FC														X
White-crowned Sparrow	*Zonotrichia leucophrys*	X		X	C							XX	X	X				X	
Golden-crowned Sparrow	*Zonotrichia atricapilla*	X		X	A						X	XX	X	X					
Fox Sparrow	*Passerella iliaca*	X			U								XX	X				X	
Lincoln's Sparrow	*Melospiza lincolnii*	X			U					X		XX	X						
Song Sparrow	*Melospiza melodia*	X			U				XX	X									
Lapland Longspur	*Calcarius lapponicus*				U					X	XX								
Snow Bunting	*Plectrophenax nivalis*				U														X

Sources: Kessel 1979
Gabrielson and Lincoln 1959
U.S. Forest Service unpublished.
Tarres 1980
Bellrose 1978
Kortright 1967

TABLE 3-17

COMPARISON OF AVIFAUNA HABITAT TYPES TO VEGETATION MAPPING UNITS[a/]

Vegetation Mapping Units	Avifauna Habitat Types: Lacustrine waters and shorelines	Fluviatile waters and shorelines	Cliffs, cutbanks, and block fields	Wet Meadow	Dwarf shrub meadow	Dwarf shrub mat	Low shrub thicket	Medium shrub thicket	Tall shrub thicket	Deciduous forest	Coniferous forest	Mixed coniferous/ deciduous forest	Scattered woodland and dwarf forest
Conifer forest	X	X		X	X						X	X	X
Broadleaf Forest	X	X							X	X			
Mixed Broadleaf/ Needleleaf Forest	X	X						X	X			X	X
Riparian Scrub	X	X					X	X	X				
Upland Scrub		X						X	X				
Grass/forb meadow		X		X									
Bog (wet meadow)	X	X		X	X						X		X
Alpine tundra		X		X		X	X						
Barren			X										

a/ AEIDC 1982.

no published reports documenting their nesting in the Grant Lake area. In addition, there are standing dead trees suitable for tree-nesting species such as mergansers and goldeneyes. These nest sites are scattered throughout the study area adjacent to water sources.

Nine duck species were observed during field studies. An American wigeon nest was found along the shores of Upper Trail Lake and a common goldeneye with a single down young was observed in Grant Lake. Harlequin ducks and green-winged teal were observed and suspected to be nesting in the Grant Lake Inlet Creek area.

During the period when Grant Lake is iced-over, an area at the outlet of the lake remains ice-free. This area proved to be a winter feeding area for a flock of mallards. As many as 30 birds were observed in the opening during winter 1981-82 field studies. The lake bottom in this area was found to be rich with white-water crowfoot, to which was attached an abundance of freshwater snails, clams, and insect larvae. With the exception of two pools in Grant Creek, this was the only area within the study area boundaries remaining ice-free and possessing an abundant, available food supply during the 1981-82 winter.

Four loon and two grebe species inhabit the Kenai Peninsula. Nesting habitat in the study area is limited; but Vagt Lake, Grant Lake, and, to a lesser extent, the ponds along the bench between Grant and Upper Trail Lakes provide some nesting habitat. Several common loons were observed during field studies and a pair was assumed to be nesting at Vagt Lake. A pair of arctic loons nested near the east end of Grant Lake during 1982. This is an unusual occurrence as most arctic loon nesting takes place further north. Although limited nesting has been reported to occur on the Kenai Peninsula, there are no published records.

Gulls, Terns, and Shorebirds

Gulls, terns, and shorebirds are more common along the outer Kenai Peninsula than in inland areas, such as the study area. The mew gull was the only gull species observed during field studies in the study area. It did not appear to be nesting. Arctic terns were also observed in the study area. This species commonly nests on the Kenai Peninsula, but did not appear to be nesting in the study area. The mew gull and arctic tern both nest at Kenai Lake and a breeding colony of arctic terns occurs at Tern Lake (Sowls et al. 1978). Both lakes are only short distances from the study area.

Numerous shorebird species potentially occur in the study area. Five species were observed during field studies and four were assumed to be breeding. The four probable breeders are both species of yellowlegs (in the bogs on the bench between Grant and Upper Trail Lakes), the spotted sandpiper (along the Grant Lake inlet creek), and the common snipe (along Upper Trail Lake).

Raptors

There are five hawk species, two eagle species, two falcon species, and five owl species that breed or migrate through the Kenai Peninsula. Of the hawk species, only one -- the sharp-shinned hawk -- was observed within the study area. This bird was observed in a small forested drainage along the south shore of Grant Lake's upper basin. Nesting habitat for this species, as well as the goshawk and red-tailed hawk, occurs within the forested portions of the study area. Several cliffs in the study area appear to have suitable nesting habitat for rough-legged hawks and nesting habitat for marsh hawks is present in bog areas.

A single American kestrel was observed on the north slopes of Grant Lake's upper basin. It gave no indications of breeding. Peregrine falcons, which were not observed in the study area, are discussed under threatened and endangered species (Section 3.3.1.4).

A single bald eagle was observed during field studies. This sighting was along Grant Lake during October 1981. No nesting platforms were observed. Bald eagles regularly congregate along streams with salmonid runs, generally in proportion to the quality of feeding areas and suitability of nesting habitat. The small Grant Creek fish run is not believed to be of sufficient magnitude to sustain fish-eating birds in concentrated numbers.

Juvenile and adult golden eagles were regularly observed in the alpine zone of the study area. Nesting is assumed to occur in this habitat, although nest sites remain undocumented.

Five species of owls are known to inhabit the Kenai Peninsula (Gabrielson and Lincoln 1959). Studies by Lewandoski and Rice (1980) indicated that great-horned owls are the most abundant species and exhibit a preference for coniferous forest habitat. No owls were observed during field studies; however, suitable habitat exists throughout the Grant Lake area.

Grouse and Ptarmigan

Four grouse species inhabit Alaska, but only the spruce grouse occurs on the Kenai Peninsula. Mixed forests of black and white spruce along with birch and poplar, at varying successional stages, provide ideal habitat for this species (Ellison 1974). The mixed forest communities along the Trail Lakes and the Vagt Lake Trail provide the best habitat in the study area. The remainder of the area provides marginal habitat. Only eight adults and one chick were observed in the study area during field studies. These observations, contrasted with the high production figures indicated in the literature (Ellison 1974), suggest that the study area supports a low population. The fact that most of the better spruce grouse habitat in the study area is located in areas easily accessible to hunters suggests that hunting may be a limiting factor to spruce grouse numbers.

Three species of ptarmigan inhabit the Kenai Peninsula. Habitat for these species is found throughout alpine or subalpine zones near or above timerline. Populations of rock and willow ptarmigan in the Grant Lake area are probably average for the Kenai Peninsula as a whole. Neither species appears overly abundant, but both were commonly observed in appropriate habitats during field studies. Although no white-tailed ptarmigan were seen, they may be present along steep slopes and ridges above timberline. Hunting does not appear to be a major controlling factor for ptarmigan numbers in the study area because of the relative inaccessibility of alpine and subalpine zones.

Other Birds

A variety of other bird species, including kingfishers, woodpeckers, and passerines, occupy the study area (Table 3-16). Pertinent field observations include the following. Belted kingfishers were commonly observed during field studies around the Trail Lakes and Grant Creek. Several dippers were observed along flowing creeks within the study area and young were seen along Grant Creek and the Grant Lake inlet creek, indicating breeding in these areas. A large flock of Bohemian waxwings containing many young birds was observed feeding on insects at the mouth of Grant Creek. Five warbler species were commonly seen throughout the upland scrub and riparian scrub communities of the area, as well as the small patches of scrub vegetation that occurred on the bench between Grant and Trail Lakes; all were suspected to be breeding.

3.3.1.3 Mammals

The mammalian fauna of the study area is comprised of a nearly equal mix of herbivore and carnivore species (Table 3-18). This circumstance is not unique in Alaska and is representative of the mammalian fauna of the Kenai Peninsula as a whole. In general, the habitat is marginal for mammals and supports few individuals of most species. Notable exceptions are some south-facing alpine and subalpine communities, which are important to resident bovids.

TABLE 3-18

MAMMALS OF THE STUDY AREA

Common Name	Scientific Name	Occurrence in Study Area	Relative Abundance	Subjective Population Estimates, Summer, 1982	Source[c/]
<u>Shrews</u>	Soricidae				
Masked shrew	*Sorex cinereus*	P	?	NE[a/]	1,2[d/]
Dusky shrew	*Sorex obscurus*	?	?	NE	2[d/]
Water shrew	*Sorex palustris*	?	?	NE	1,2[d/]
Vagrant shrew	*Sorex vagrans*	?	?	NE	1[d/]
Pygmy shrew	*Microsorex hoyi*	P	?	NE	1,2
<u>Bats</u>	Vespertilionidae				
Little brown myotis	*Myotis lucifugus*	P	?	NE	1,2
<u>Hares</u>	Leporidiae				
Snowshoe hare	*Lepus americanus*	Y[a/]	C[b/]	NE	1,2,3
<u>Squirrels</u>	Sciuridae				
Hoary marmot	*Marmota caligata*	Y	C	NE	1,2,3
Red squirrel	*Tamiascirus hudsonicus*	Y	C	NE	1,2,3
Northern flying squirrel	*Glaucomys sabrinus*	P	?	NE	1,2
<u>Beavers</u>	Castoridae				
Beaver	*Castor canadensis*	Y	C	8-40	1,2,3
<u>New World Mice</u>	Cricetidae				
Northern red-backed mouse	*Clethrionomys rutilus*	Y	?	NE	1,2,3
Meadow vole	*Microtus pennsylvanicus*	P	?	NE	1,2[e/]
Tundra mole	*Microtus oeconomous*	P	?	NE	1,2[e/]
Singing vole	*Microtus gregalis*	P	?	NE	1,2[e/]
Brown lemming	*Lemmus sibiricus*	?	?	NE	2
Northern bog lemming	*Synapotomys borealis*	P	?	NE	1,2
<u>Jumping Mice</u>	Zapodidae				
Meadow jumping mouse	*Zapus hudsonicus*	?	?	NE	1,2
<u>Porcupine</u>	Erethizontidae				
Porcupine	*Erethizon dorsatum*	Y	C	NE	1,2,3

Common Name	Scientific Name	Occurrence in Study Area	Relative Abundance	Subjective Population Estimates, Summer, 1982	Source[c/]
Wild Canines	Canidae				
Coyote	Canis latrans	Y	C	NE	1,2,3
Gray wolf	Canis lupus	Y	C	6	1,2,3
Red fox	Vulpes vulpes	Y	R[b/]	NE	1,2,3
Bears	Ursidae				
Black bear	Ursus americanus	Y	C	20-40	1,2,3
Brown bear	Ursus arctos	Y	C	10	1,2,3
Weasels and Allies	Mustelidae				
Marten	Martes americana	Y	R	10-100	1,2,3
Ermine	Mustela erminea	Y	C	NE	1,2,3
Weasel	Mustela nivalis	Y	C	NE	1,2,3
Mink	Mustela vison	Y	R	<5	1,2,3
Wolverine	Gulo gulo	Y	C	<5	1,2,3
River otter	Lutra canadensis	Y	R	<5	1,2
Wild Cats	Felidae				
Lynx	Lynx lynx	Y	R	NE	1,2,3
Cervids	Cervidae				
Moose	Alces alces	Y	C	20-30	1,2,3
Bovids	Bovidae				
Mountain goat	Oreamnos americanus	Y	C	50	1,2,3
Dall's sheep	Ovis dalli	Y	C	30	1,2,3

a/

NE = No Estimate
Y = Yes (sight records extant)
P = Probable
? = Unknown

b/

Key
C = Common - species appears to be utilizing all available habitats
R = Rare - species present in low density; it does not appear to be realizing the maximum potential of the habitats

c/ Sources: 1 - Manville and Young 1965, 2 - Hall and Nelson 1959, 3 - AEIDC, 1982.

d/ Sorex tracks were observed, but it was not possible to differentiate between species.

e/ Microtus tracks were observed, but it was not possible to differentiate between species.

The mammalian fauna present is highly mobile; most species are migratory, moving seasonally between disparate ranges in response to changing environmental and physiological conditions. Movements between ranges are influenced to some degree by the rugged physiography of the region and by the phenology of snow melt. Several distinct traditional movement corridors of large mammals were noted.

Table 3-18 lists observed and likely components of the mammalian fauna, their scientific names, and their relative abundance in the study area. The list represents a synthesis of published and unpublished reports, interviews with long-time area residents, and results of field surveys. Subjective study area population estimates have been provided for select species and species groups.

Small Mammals

Twelve species of shrews and mice are possible residents of the study area. Shrews appeared to be ubiquitous in all forest and scrub associations based on field observations of sign. Shrew sign was most abundant in older forest communities, becoming conspicuously less noticeable, but still present, above timberline.

Vole tracks were observed on snow in March throughout the study area to the 2,000 ft level, the altitudinal limit of foot surveys. The tundra and singing voles are probably the most common microtines in the area. Three northern red-backed mice were found in July 1982 along the Vagt Lake Trail. This is a common mammal throughout the Kenai Peninsula.

Bats

The little brown myotis is a common summer resident of southcentral Alaska. None were sighted during field surveys of the study area but they are undoubtedly present.

Snowshoe Hare

Low numbers of snowshoe hares inhabit all forest and low-lying scrub associations within the study area based on the abundance of tracks observed during midwinter foot surveys. Areas bordering Trail Lakes appear to constitute the center of hare distribution and abundance in the study area. Despite their relatively low numbers, hares form the dietary mainstay of coyotes and lynx based on cursory field examination of scats.

Marmots and Squirrels

Hoary marmots are conspicuous, common residents of alpine tundra communities throughout the study area. In general they were observed at elevations between 1,500 and 3,000 ft. Highest marmot concentrations were observed in the Upper Falls Creek drainage and in local areas north and northeast of Grant Lake.

Red squirrels are conspicuous throughout the coniferous forests of the study area, being most abundant in areas of larger spruce timber. Although northern flying squirrels were not observed during field studies they probably occur in forests within the study area.

Beaver

Although beavers are one of the most abundant furbearing mammals in Alaska, litte prime beaver habitat exists in the study area. Evidence of beaver was scarce and, with few exceptions, was confined to Grant Lake proper and its terminal tributaries. The only area within the study area meeting all criteria for prime beaver habitat is the northern portion of the Grant Lake inlet stream delta. Four lodges were observed in this area although only one appeared to be active.

Small numbers of beaver also reside in Grant Lake proper, but these habitats are of low quality and appear incapable of sustaining beaver populations. Four lodges, including one apparently active lodge, and a lodge apparently under construction were observed along the Grant Lake shoreline. These shoreline lodges are exposed to the influence of predators, floating ice in spring, waves, avalanches, and lake level fluctuations resulting from periodic heavy rains and spring breakup, and are not near appreciable food resources. These beavers are probably offspring of the colony located on the delta of the inlet stream. A single beaver was also observed in Lower Trail Lake near its outlet.

Assuming all observed lodges are active and all represent colonies of average size (Libby 1954, Boyce 1974), then 32 to 40 beavers inhabit the area. A minimum population estimate, assuming only two active colonies, would be 8 to 10 beavers.

Limited trapping of beavers does occur in the area. Interviews with local residents indicate that trapping intensity varies considerably between and within years, depending on market conditions. At least one beaver trapper was active in the area during the winter of 1981-1982. Beaver trapping appears to be more of a recreational pursuit than a commercial one in the study area.

Porcupine

Porcupines are common throughout the coniferous areas of the Kenai Peninsula, particularly in mountainous regions near timberline. Populations are highly variable and fluctuate radically over relatively long intervals. Occasional scattered porcupine sign was noted in the study area, generally at altitudes of 500 to 1,000 ft. The species does not appear to be abundant at this time in the study area.

Wolf, Coyote and Red Fox

Three types of wild canines range in the Grant Lake-Falls Creek-Trail Lakes region: wolf, coyote, and red fox. The wolf is a frequent transient; the coyote is probably a resident or common transient; and the red fox is a rare or occasional visitor or recent resident.

Peterson and Woolington (1979) reported an early winter population of 185 wolves on 5,300 square miles of the Kenai Peninsula. The wolves in the Grant Lake area are probably the group known as the Mystery Creek pack (Peterson 1982), ranging in the mountain area from Mystery Creek as far east as Grant Lake or perhaps, on occasion, as far as Nellie Juan Lake. Wolves have occasionally been reported and taken in the Grant Lake-Trail Lakes area in recent years. In January 1982, six wolves were observed during an aerial survey along Grant Lake's north shore. In late February 1982 a mountaineering party, en route up Lark Mountain via the west ridge, observed two wolves harassing a moose along the shore of Grant Lake (Babcock 1982). Tracks were also noted in February and March around the northwest corner of Grant Lake and east of Vagt Lake. A single wolf was observed in the upper valley of the inlet creek during an April 1982 aerial bear denning survey. The wolf preys upon a large number of animals, including moose, Dall's sheep, mountain goat, snowshoe hare, beaver, and other canids such as coyote and fox. No wolf kills were noted in the Grant Lake-Falls Creek area during field studies; however, moose remains were found in several wolf scats.

The coyote has increased rapidly in numbers since colonizing the Kenai Peninsula around 1930 and has been a prominent and widely distributed member of the local fauna since then. Coyote sign was noted over much of the area on all field trips. Like the wolf, the coyote is wide-ranging and will travel and hunt throughout all habitat types of the study area. It is probably a much more frequent transient or resident of the Grant Lake-Falls Creek area than the wolf. The delta of the Grant Lake inlet creek was a center of coyote activity during the winter of 1982. Coyotes were observed hunting for hares and ptarmigan in the area. A frequently used coyote travel route was noted on the bench between Falls Creek and Grant Lake in the timberline region at the base of the mountain slope.

The red fox is an indigenous member of the Kenai Peninsual fauna. Apparently, fox populations on the Kenai have remained low through much of this century. The species has been neither taken nor observed by any of the trappers in the Grant Lake-Falls Creek region. A single series of fox tracks was noted in March 1982 in the Vagt Lake area.

Black Bear

Black bears are one of the most widely distributed and abundant large mammals on the Kenai Peninsula. Timbered and brushy areas of the region afford good protective cover, which probably accounts for their ability to withstand the intense hunting pressure typifying this part of southeastern Alaska. Black bear within the study area are generally associated with valley floors, small alluvial plains, lakeshores, and intervening streams and these are limited in the study area.

Ground-level reconnaissance surveys during the fall, spring, and summer assessed the relative abundance and general distribution of black bears within the study area. Track, scat, and actual bear sightings were recorded to estimate the intensity of habitat use relative to proposed Project facilities.

Nine black bears, two track sets, and about 10 scats, presumably of black bear origin, were noted during the three field surveys. In June, 1982, the majority of bears and sign was observed near Grant Lake; one bear was sighted in the timbered area downstream of the Grant Lake outlet. Two track sets were also noted along the edge of Lower Trail Lake during the October 1981 reconnaissance. Scat was evenly distributed between 500 and 1,000 ft in the area between and around the lake systems. Surprisingly, no evidence of black bear activity in the upper Grant Lake valley was discovered.

As with brown bears the activity patterns of black bears appear to be regulated by the temporal and spatial distribution of food resources. Food resources within the Grant Lake study area appear to be moderate at best. Important black bear habitat in the study area includes the lower alpine zone near the shrubline, which is important in July and August for the young, succulent forbs and sedges it produces. During August and September, salmon present in Grant Creek are sought by black bears. Because salmon are unavailable in great numbers, bears intermittently forage in the subalpine zone and on lowland berries at this time. Elderberries, blueberries, rosehips, salmon berries and low and highbush cranberries are probably utilized heavily. Recreational facilities and the Moose Pass population center are often visited by foraging black bears during spring.

Likely denning habitat in the Grant Lake area includes spruce-covered slopes and hillsides. Wet places and open terrain would likely be avoided as places to den. Primary denning habitat for black bears probably occurs in the Trail Lakes and Moose Creek valleys; the forested habitat along the Trail Lakes appears less suitable because of human disturbance. The bench between Grant and Trail Lakes south to and including the Ptarmigan Creek drainage appears to be usable denning habitat for those black bears residing locally year-round.

Information obtained through field reconnaissance can be used to speculate on black bear numbers present in the study area. Based on actual sightings, tracks and scat, from 10 to 40 black bears appear to range within the study area. Considering the area's size and the relatively small home range of black bear compared to brown bear, it seems reasonable that 10 to 15 animals range within the study area year-round, with approximately 20 more being transients.

The lack of stable, concentrated food resources and continuous interaction with the human inhabitants of Moose Pass constitute the most prominent limiting factors to black bears in the Grant Lake area. Increased human activity would likely trigger a decline in the number of resident bears, but transient animals probably would be little affected over the long term. The adaptability of black bears to the human element implies that the current number of black bear represent a stationary population. A less serious limiting factor appears to be the number of bears killed in defense of life and property and those harvested incidental to the taking of other game species by sport hunters. Although the study area is not considered good bear hunting area, moderate hunting pressure is exerted on Dall's sheep, mountain goat, and moose, so black bears are subject to some exploitation.

Brown Bears

Brown bears are sparsely distributed throughout much of the region surrounding the study area. The study area is adjacent to areas containing much higher brown bear densities such as the mountainous areas of Prince William Sound and other areas of the Kenai Peninsula.

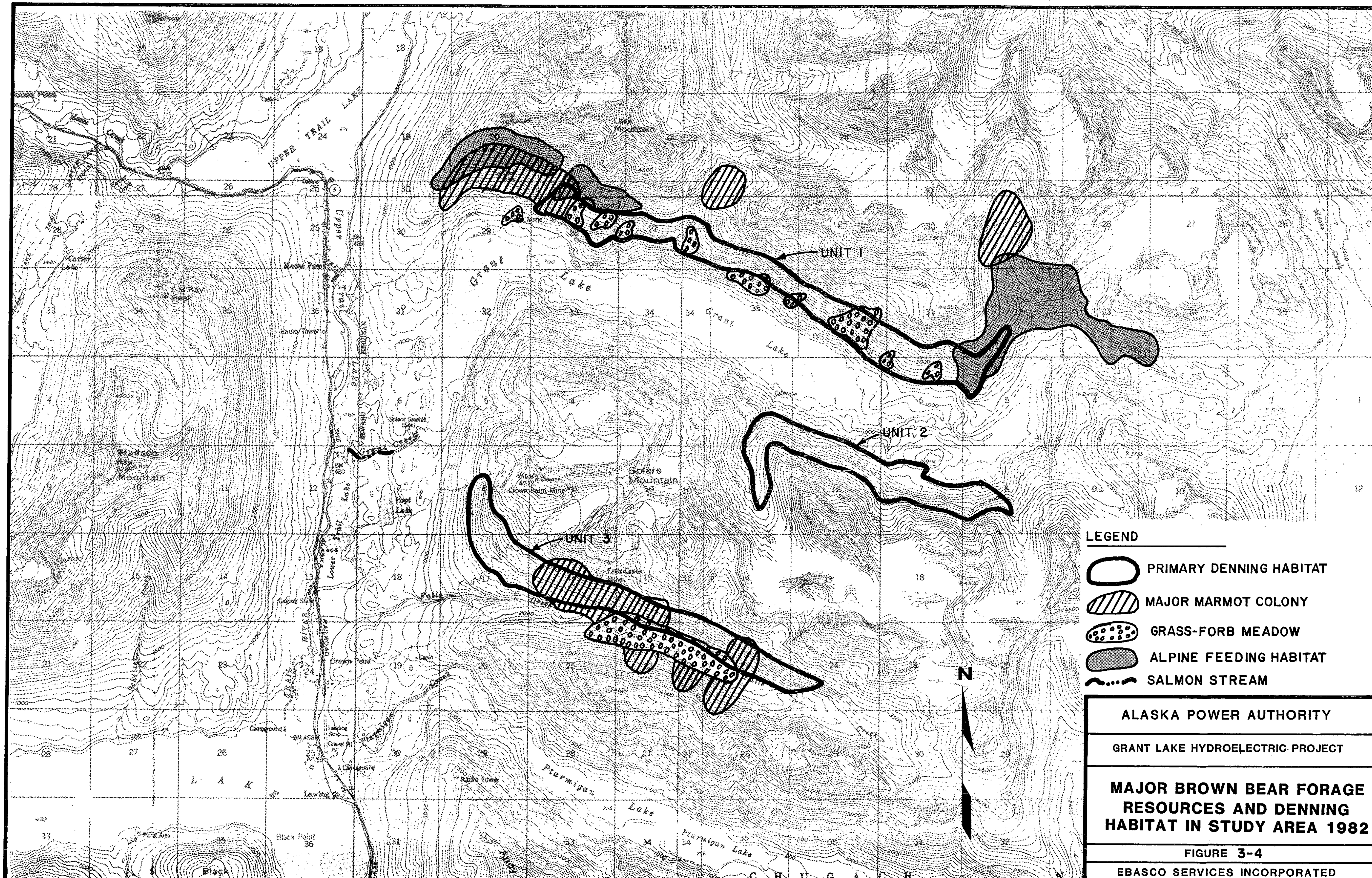
Grant Lake field studies emphasized the delineation of habitats and general movement patterns of bears inferred from observed seasonal distribution and abundance. Data obtained during fall and summer ground-level surveys and three aerial surveys conducted in early spring provided information on the relative number and seasonal distribution of brown bears.

Considering the study area's physiography, its proximity to human developments, and the limited amount of usable habitat and forage resources within the Project vicinity, brown bear numbers were expected to be low, representing but a fraction of the region's total population. The 1981-82 field studies confirmed this expectation. During the study period only 16 widely scattered sets of brown bear tracks and three individuals were observed: a family group (female with one yearling) and a mature individual. Alaska Department of Fish and Game (ADF&G) authorities reported insufficient forage as probably the primary factor for the low density of brown bears in this region (ADF&G 1973). The highest reported brown bear harvest since 1961 for the years 1976, 1980, and 1981 for all of Game Management Unit 7 (Seward) was three bears. For the past 21 years, the annual harvest averaged approximately one bear per year (ADF&G 1982). Considering the intensive hunting pressure in southcentral Alaska, these extremely low harvest figures reflect the low density of brown bears in this region.

Forage resources primarily include the following: herbaceous plants (grass-forb meadow variety) found in scattered sites above the north side of Grant Lake, at intermediate elevations of the upper valley's north side, and in the upper Falls Creek drainage; marmot colonies located in most alpine and subalpine areas, particularly along the south side of Solars and Lark Mountains; and at least two salmon species known to spawn in Grant Creek (Figure 3-4). The scattered, low-quality forage resources suggest that the study area is used mainly by transient brown bears.

Denning habitat was delineated on the basis of sightings of individual bears and their sign at the time of den emergence, and on the basis of certain geomorphic and vegetation characteristics. Three units of potential denning habitat were delineated in this manner (Figure 3-4).

Unit 1 appears to have the most potential, based on observed bear activity, slope conditions, substrate, and vegetation. Denning would likely occur at elevations of about 1200 to 2500 ft in hilly terrain bordering the alder zone. Extensive areas of surface bedrock, precipitous slopes, and sparse vegetation cover along the westward section reduces habitat potential. Available denning habitat in Unit 2 is limited to areas having less rugged relief, mainly ridges paralleling the lower part of the two lateral tributaries entering the southeast section of Grant Lake. Rocky outcroppings and large boulders provide some caves or natural cavities for denning, but these sites are



ALASKA POWER AUTHORITY

GRANT LAKE HYDROELECTRIC PROJECT

MAJOR BROWN BEAR FORAGE RESOURCES AND DENNING HABITAT IN STUDY AREA 1982

FIGURE 3-4

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part of the Falls Creek valley, has some potential for denning. Bear activity occurred in this area during the den emergence period. The vegetation, snowpack, and soils of the unit appear adequate for denning; however, available space is limited, and the unit probably is not heavily used.

The most important denning habitat is present in the 2.1 square mile Unit 1, which represents about 47 percent of the total habitat available for denning. Presumably no more than one or two families and possibly two or three solitary animals would den within the study area in any given year.

The slopes west of Solars and Lark Mountains and the bench partitioning Grant and Trail lakes constitute the principal travel routes to and from the Grant Lake valley. Of secondary importance to interdrainage travel is the pass intersecting the headwater areas of Moose Creek and the Snow River. The extent these areas are used remains unknown. The period of greatest activity noted during field studies occurred in the last half of May, coinciding with den emergence and breeding. The May 21 aerial survey, when three brown bears and eight individual sets of brown bear tracks were noted, suggested that up to 10 different brown bears visited the study area around mid-May. Few, if any, brown bears apparently reside year-round within the study area due to low quality food sources, limited denning habitat and residential development along limited. Unit 3, extending along the south-facing slope of the upper Trail Lakes. Interchange between regional subpopulations is relatively intensive, and the use of the area by transient bears is common and primarily related to the seasonal availability of limited food resources.

Mustelids

Martens are indigenous to the Kenai Peninsula and once were prominent in the fur trade. The animal is present over much of the mountain and foothill area of the Kenai Peninsula. A professional trapper and resident of Moose Pass related that he had not taken marten in the Grant Lake basin, but reported a sizeable marten population in the Snow River country southeast of the study area (Candit 1981). Judkins, also a trapper and resident of Moose Pass, reported that the marten was relatively common in the lower Falls Creek drainage (Judkins 1982). Tracks of a single marten were observed at two locations during the March 1982 survey: one on the Inlet Creek delta at the east end of Grant Lake and another on the timbered ridge north of Falls Creek.

Weasels are widely distributed throughout the Kenai Peninsula. The Grant Lake area is no exception, and tracks of this mammal were noted throughout all habitat types of the study area. There is considerable variation in density. Sign was most abundant in grassy areas near timberline and around lake margins, probably a reflection of the abundance of voles, their principal prey species.

No mink were sighted during the surveys and very little sign was noted. Tracks and scats were seen along the shoreline of Upper Trail Lakes near the mouth of Grant Creek and in Grant Creek. During March 1982, a single set of mink tracks was noted along the west shore of Trail River. Habitat suitable for mink appears limited to the lower reaches of Falls and Grant creeks and to the shoreline of Trail lakes. Habitats along Trail lakes are probably important only following salmon runs when spawned-out salmon are washed into the shallows. Trail lakes are so glacially turbid that mink may be unable to effectively locate prey in them at other times.

Wolverine are relatively abundant predators on the Kenai Peninsula. Wide-ranging by nature, they can be found in all habitat types, most commonly in mountain areas. In March 1982 wolverine tracks were noted in a number of locations: Grant Lake inlet creek delta and eastward; the bench below timberline between Falls Creek and Grant Lake; and the timberline area on the west ridge of Lark Mountain. Candit (1981) reported trapping "seven or eight" over 20 years in the Grant Lake drainage basin. At present, the Grant Lake-Falls Creek area is evidently within the travel and hunting range of one or more wolverines. In particular, the Grant Lake Inlet Creek delta was the site of considerable wolverine foraging activity in March of 1982. Several prey species were in the area at the time.

River otter are relatively abundant and widespread on the Kenai Peninsula, but no sign of their presence was found in the study area. Suitable habitat for otter is limited to the lower reaches of Grant Creek. Lack of habitat probably precludes the establishment of a resident population. Otters are probably present as transients throughout the area, however.

Lynx

Lynx are widespread over the Kenai Peninsula. Dependent as they are on the snowshoe hare as a primary food source, lynx distribution and population levels closely shadow that of the hare. Forest and shrubland country, where there is an abundance of hardwood browse plants available for hares, is prime lynx habitat. Currently, the hare population on the Kenai Peninsula and thus that of the lynx are high. The Grant Lake-Falls Creek area has a relatively low hare population, however, and few areas of concentration, so lynx are correspondingly few. Tracks of a single lynx were noted in the timberline area east of Vagt Lake.

Moose

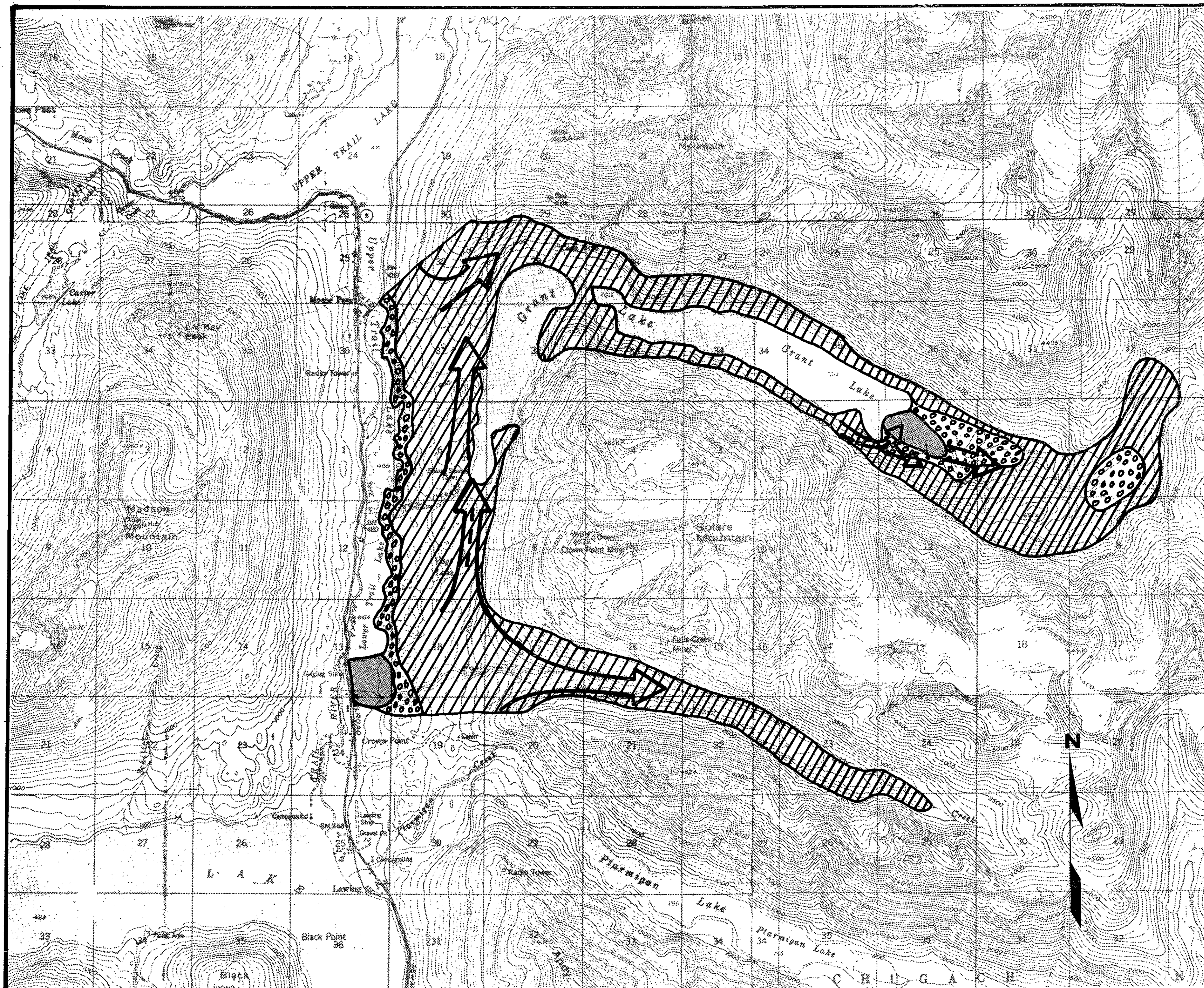
Moose inhabit the Grant Lake study area, but are not particularly abundant at this time. Several factors discussed below are probably responsible for limiting study area moose numbers.

Summer range does not appear to be a limiting factor (Figure 3-5). Ponds and lakes between Grant Lake and the Trail lakes produce abundant aquatic plants and much evidence of their use by moose was observed during field studies. Lower slopes adjacent to Grant Lake support vigorous stands of bluejoint, and suitable browse, while not abundant, occurs throughout the study area.

The chief natural factor limiting moose numbers in the study area appears to be the amount and quality of winter range (Figure 3-5). With few exceptions plant succession has advanced beyond the stages favoring palatable browse. As a consequence, few places within the study area meet all of the criteria collectively describing good winter range. Remaining winter range is largely confined to the active floodplains of lower Falls Creek and the Grant Lake inlet creek. In these locations the plant succession is periodically retarded by the action of flood waters. Both areas support palatable riparian willows, but neither is being utilized to its potential. Examination of browse lines indicates a much greater use in the recent past than at present.

Most moose within the study area appear migratory. Sightings of individuals and sign were more common during the warmer seasons than during winter, despite the severe limitations on visibility imposed in summer by the leaves of deciduous trees and shrubs. Several clearly defined traditional travel routes were found, providing a clue as to the normal means of ingress and egress used by moose. One such travel route follows across the bench between Grant and Trail lakes, near Grant Creek (Figure 3-5). Some disruption of movement patterns of moose using this route may result from the development of project facilities in this area.

Several factors may be responsible for lack of greater recent use of the study area in winter by moose. Snow depths could occasionally exceed the height of willow stands, even though many plants exceed 12 ft in height. Although moose can easily reach browse 10 ft above ground level (Wolff 1976), they have difficulty traveling in snow deeper than 3 ft (Coady 1974). Alternately, access to these isolated stands of winter range could be restricted by snow depth, avalanches,



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GRANT LAKE HYDROELECTRIC PROJECT

MOOSE RANGES IN STUDY AREA 1982

FIGURE 3-5

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or glare ice on the lakes. The winter of 1981-82 was not particularly severe, however, and it seems likely that other explanations must be sought to explain why most moose left the study area during the winter. Lack of use in recent years might reflect predator losses or hunter-induced mortality (Hinman 1979, 1980a, 1980b; Chatelain, 1950; Franzman et al. 1980), but lack of abundant food resources due to advancing plant succession in all probability is the chief reason few moose overwinter in the study area.

Based on the results of field and literature surveys, moose numbers within the study area during summer probably fluctuate between 20 and 30 individuals. Assuming these estimates are correct, stocking densities range from 2.3 to 3.5 per square mile on summer range. As noted above, few moose overwinter in the study area. Stocking densities in this range are relatively low compared to other areas on the Kenai Peninsula.

From a statewide perspective the moose resources of the study area are relatively insignificant. Viewed from a local perspective, however, the resource takes on added importance. Moose are nowhere abundant in the mountains of the eastern half of the Kenai Peninsula and, consequently, the study area's population is biologically significant to the area as a whole. The population also is important to humans. Hunting pressure is relatively high due to its location adjacent to the road system. Most hunters are local residents; however, in past years Grant Lake attracted as many as four fly-in hunting parties per year (Judkins 1981). Moose harvest figures are unavailable for the area, but based on the results of field surveys, the legal annual take probably does not exceed five. Considering the proximity of the area to human habitations, there is a decided potential for illegal hunting.

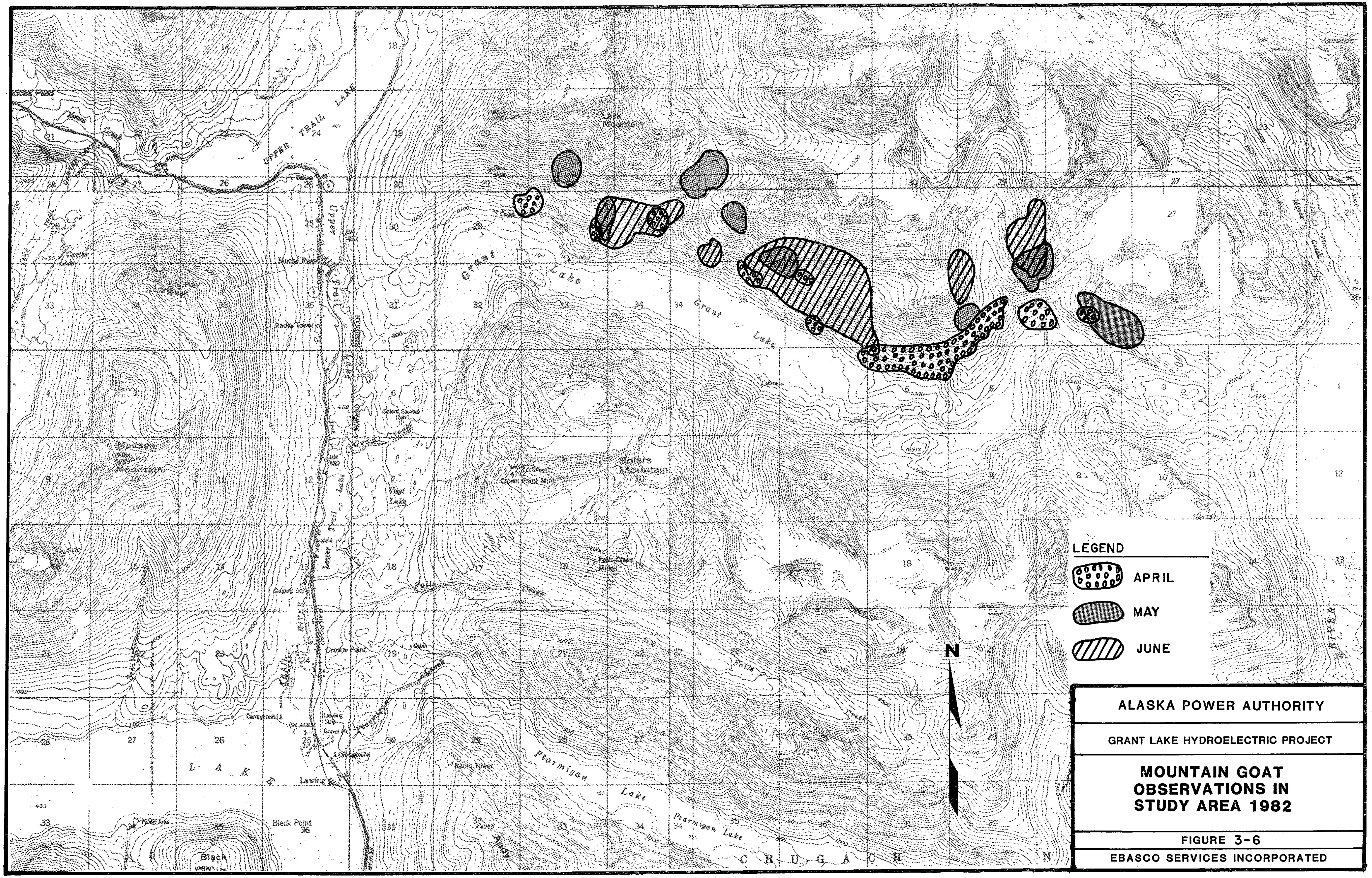
<u>Mountain Goats</u>

Mountain goats inhabit the entire mountain area of the Kenai Peninsula, but densities are greatest east of the railroad. The Kenai Peninsula goat population is subject to considerable short-term annual fluctuations and shifts in ranges occur due primarily to winter weather conditions and recently to hunting pressures. Although the population has been relatively stable over the long-run, a general overall decline has been noted over the past 10 years. A current total Kenai mountain goat population estimate is not available, however.

In 1979, 1980, and 1981, a total of 41 goats were captured and equipped with radio collars and subsequently monitored to obtain life history information by the ADF&G in the Grant Lake drainage and surrounding areas (Nichols 1982). The entire area under study by ADF&G had an estimated population of 246 goats in the summers of 1979 and 1981; a winter of heavy snow and severe avalanche conditions in 1980 induced considerable mortality and reduced productivity. Of this group, about one-quarter (an average of 50) commonly use the Grant Lake basin through much of the year.

Although the entire drainage is used by goats, the most important sections are located on the south-facing slopes of the north half of the drainage--generally small vegetated benches and ridges in the 1,000 to 3,200 ft altitudinal range (Figure 3-6). The principal area of goat use in the Grant Lake basin is the north side of the lake. These south-facing slopes are utilized in fall, winter, spring, and into early summer. Occupied areas reach from alpine benches downslope into stringers of mountain hemlock. This plant was present in 70 percent of all fecal samples collected from alpine winter ranges at Grant Lake (Hansen and Archer 1981). The primary area of interchange between Grant Lake and other subpopulations is into the Moose Creek drainage to the northeast and across the glacier to the east to the Kings River-Kings Bay area.

The southern half of the Grant Lake drainage and Falls Creek drainage are used to a much lower degree than the north part of the Grant Lake drainage. These slopes are evidently subject to intense avalanche activity and this factor, by itself or in combination with other factors, may limit their utility to mountain goats.



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GRANT LAKE HYDROELECTRIC PROJECT

MOUNTAIN GOAT OBSERVATIONS IN STUDY AREA 1982

FIGURE 3-6

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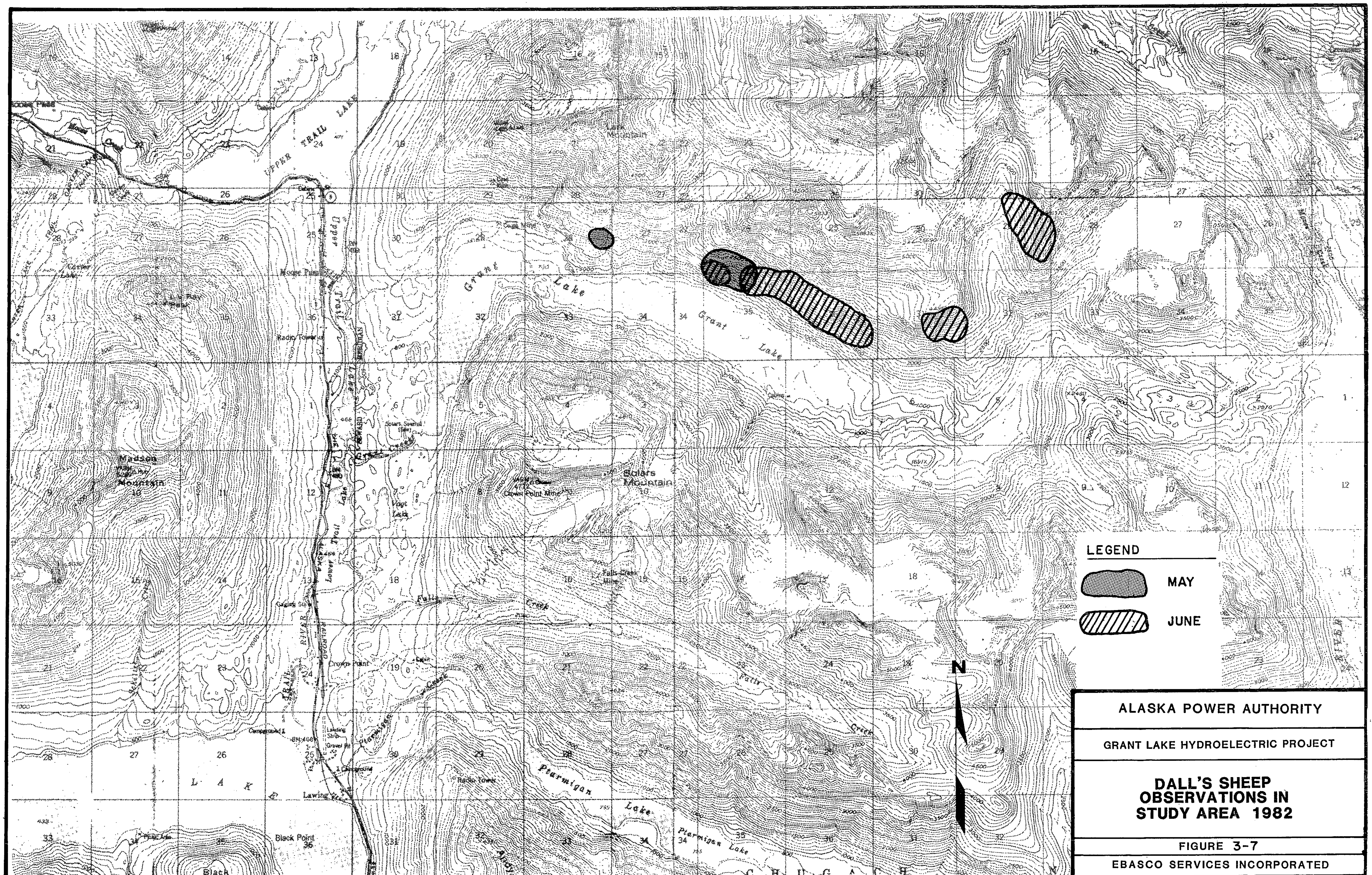
Goat hunting on the Kenai Peninsula is presently rigidly controlled by a permit system that allocates a limited harvest to each unit of range. In 1982, 16 goat hunting permits were issued for the Ptarmigan Lake-Trail Creek-Moose Creek area, including the Grant Lake drainage (Area 839).

Dall's Sheep

The Dall's sheep is a wilderness animal residing for the most part in rugged alpine and subalpine mountain habitat. Dall's sheep on the Kenai Peninsula are relatively more abundant in the interior sections of the Kenai Mountain range than elsewhere. The Grant Lake area constitutes the outer boundary of sheep range in this area. Dall's sheep reportedly range over the entire Grant Lake and Falls Creek drainages in several small bands. During field studies, however, they were only noted on the northern half of the Grant Lake drainage. This is evidently their most favored range (Figure 3-7).

In May of 1980 and 1981, 14 and 47 sheep, respectively, were recorded on the Grant Lake ranges (Nichols 1982). In early June 1982 field surveys, 30 sheep were recorded on the slopes north of Grant Lake. Based on extant trend counts and the results of this survey, Dall's sheep numbers appear to vary annually from about 10 to 50 animals.

Frequent interchange apparently occurs with the Moose Creek herd, particularly during the summer. As with goats, mid-elevations of the slopes constitute favored range, especially vegetated benches, and the upper edges of timbered areas and exposed ridges where some forage plants are available. Sheep were observed at various seasons from the Lark Mountain ridge line above Moose Pass to slopes in the upper basin of the drainage.


UPPER TRAIL LAKE
Grant Lake
Lake Mountain
Madson Mountain
Solars Mountain
Crown Point Mine
Falls Creek Mine
Falls Creek
Ptarmigan Lake
Ptarmigan Creek
Crown Point
Black Point
Lower Trail Lake
Vagt Lake
Radio Tower
Moose Pass
K E N A I   L A K E
C H U G A C H
LEGEND
MAY
JUNE
N
ALASKA POWER AUTHORITY
GRANT LAKE HYDROELECTRIC PROJECT
DALL'S SHEEP OBSERVATIONS IN STUDY AREA 1982
FIGURE 3-7
EBASCO SERVICES INCORPORATED

Winter range generally comprises a small sector of the overall range, and thus represents the principal limiting factor. Good winter range in the Grant Lake basin consists of snow-free sites near escape terrain at the mid-altitudinal level of the basin. In early spring, sheep sometimes must move to lower altitudes into subalpine tree cover, where emergent vegetation appears soon after the snow recedes. Within the study area, sheep scats were found in open bluejoint meadows as low as 1000 ft. in altitude. Movement to mineral licks is an important phase of seasonal movements but no licks were found in the study area.

While coyotes, wolverines, bears, and eagles may prey on sheep, the wolf appears to be the principal predator. Wolves, however, do not appear to exert much influence on sheep numbers in the study area except when sheep may be forced by competition to feed distant from escape terrain at the time wolves move through the area.

3.3.1.4 Threatened or Endangered Species

A subspecies of Canada goose, the Aleutian Canada Goose, Branta canadensis leucopareia, is noteworthy as it is one of three Alaska birds listed as an endangered species. Its breeding range is limited to the Aleutian Islands hundreds of miles southwest of the study area. The fall migration apparently proceeds nonstop directly across the Gulf of Alaska to northern California. It appears highly unlikely that any members of this race would occur in the Peninsula area.

Three races of peregrine falcon, two of which are endangered, are present in Alaska. Falco peregrinus anatum and F. p. tundrius, the endangered races, breed in moderate numbers throughout interior and arctic Alaska, respectively (Roseneau 1982). Records presented by Gabrielson and Lincoln (1959) indicate that these birds were once fairly common migrants through the Kenai Peninsula. Few have been seen in recent years. Most sightings are reported from recognized migration corridors which parallel the outer coasts. It appears unlikely that these birds occur within the study area. The nonendangered race, F. p. peali, is primarily a coastal species and also has not been sighted in the interior of the Kenai Peninsula.

The Eskimo curlew (Numenius borealis) is listed on the endangered species list and has occasionally been observed on the Kenai Peninsula. Accounts of these birds are mainly historical, and many people believe it may be extinct. Principal breeding grounds appear limited to the arctic coastal plains. Few have been sighted in recent years.

3.3.2 Potential Impacts

Although the proposed Project arrangement involves a lesser amount of wildlife impacts than most other alternatives considered, the wildlife resources of the study area may be affected in a variety of ways. Each of the general types of impacts are discussed under separate subheadings in the following paragraphs.

3.3.2.1 Construction Phase

Project construction would have a short-term impact on many species, particularly big game mammals and large predatory birds and mammals because of disturbance from human activities and construction equipment. Individual animals near construction areas would temporarily leave the areas or otherwise modify their behavior until construction activities ceased. Construction during the breeding season may negatively affect the breeding success of some species near construction activities. If construction activities occur during late winter or early spring, disturbance impacts may be relatively high because of the stressed physiological condition of many animals during this period; however, construction activities are not expected to be scheduled during this period. Because of the small percentage of the total study area potentially disturbed by construction activities, impacts are not expected to be significant.

Access Roads, Transmission Line, and Other Project Facilities

The Grant Lake Project design involves about 1.2 miles of access road and 1.2 miles of transmission line. In addition the Project includes a powerhouse, penstock, tailrace, recreation facilities, and fish mitigation facilities. Construction of these features would produce short-term wildlife habitat losses, especially along access roads where extra right-of-way width would be required. These areas would be allowed to revegetate or would be reseeded following construction. Long-term wildlife habitat losses would also occur in areas covered by access roads, the powerhouse, and other permanent Project facilities. Although wildlife habitat would not be totally lost along areas occupied by the transmission line, habitat would be permanently modified in these areas because only a low-growing plant community would be allowed. A total of about 30 acres of short-term habitat loss and 18 acres of long-term habitat alteration are expected as a result of construction of these facilities, as shown on Table 3-15.

The short-term and long-term habitat losses described above would affect many wildlife species by temporarily or permanently lowering area carrying capacities. This impact would mainly affect small birds and mammals and would have little affect on larger vertebrates because habitat losses would be distributed along narrow corridors for the most part, indicating that the extent of habitat loss within individual home ranges would be small relative to home range size. Overall, this impact is not expected to be significant because of the small area of each vegetation type potentially affected relative to the amount of each type available in the study area (Table 3-17).

Long-term habitat modification caused by maintenance of a low-growing plant community along the transmission line would also have minimal impacts because of the small area involved. The impacts that do occur would likely be positive for species preferring early successional habitats such as moose, and negative for forest-inhabiting species, such as certain species of woodpeckers and owls.

Effects on Grant Lake Habitats

Project operation would involve lowering the average Grant Lake level by approximately 5 ft from 696 ft to 691 ft above msl and then allowing it to fluctuate between 691 and 660 ft above msl (in unusually high runoff situations, the level may briefly exceed 691 ft). Maximum lake elevations would occur in August, September, and October and minimum elevations in March, April, and May (see Vol. 1, Figure IV-16).

This mode of operation would have long-term positive and both short- and long-term negative impacts on wildlife. Long-term positive impacts would accrue from the creation of additional terrestrial habitat due to the initial 5 ft of vertical drawdown. About half of the area to be exposed has substrate conducive to colonization by plants which would produce additional riparian scrub and potentially upland scrub or conifer forest habitat. Because of the steep nature of the shoreline, most of the new terrestrial habitat would be added at the inlet and outlet of the lake and a few other locations where the shoreline is somewhat flatter. The total area of additional potential habitat is approximately 35 acres.

Short-term negative impacts would also result from exposing 5 vertical ft of shoreline. Some erosion would occur before revegetation. Several years would be required for this strip to revegetate to the extent needed to provide substantial cover for birds and mammals which now use the shoreline cover. During movement between water and cover, some species would become more vulnerable to predation.

Long-term negative impacts would result from the 31 ft vertical fluctuation of water surface elevation each year. This fluctuation would virtually eliminate the value of shoreline habitat along Grant Lake for beaver because of their need for underwater entrances to their bank dens or lodges. However, as previously indicated, the small number of beavers that currently utilize the marginal shoreline habitat of Grant Lake are believed to be recruits from the Grant Lake inlet creek rather than a self-sustaining population. In addition, reservoir fluctuation would severely restrict the use of Grant Lake's shoreline as nesting habitat by waterfowl and loons. Although this use is light at present it is doubtful that the pair of arctic loons that nested in 1982 (at the southern edge of their breeding range) would successfully renest during Project operation. Similarly, the extent of the drawdown that would occur in spring and early summer would increase the vulnerability to predation of animals inhabiting shoreline habitats during this period. The spring-early summer drawdown may have a slight positive effect on breeding spotted sandpipers and migrating shorebirds by increasing the amount of foraging habitat.

Another long-term impact on Grant Lake habitats occurs in the area at Grant Lake's outlet that currently remains unfrozen during winter. This area provided a good quality feeding area for a flock of 30 or more mallards during the 1981-1982 winter. Many additional ice-free areas were present during the relatively mild 1982-83 winter. With the exception of pools in Grant Creek, this was the only area within the study area boundaries remaining ice-free and possessing abundant, available food during the 1981-82 winter. Although the area at the mouth of the tailrace in Upper Trail Lake should remain ice-free during Project operation and partially mitigate this loss, a reduction in the winter mallard carrying capacity is likely during moderate or severe winters.

The lower floodplain of the Grant Lake inlet creek, which provides important habitat to moose, beaver, other mammals, and a variety of birds, should continue to provide important habitat under the current Project design. Habitats in this area are currently affected by the scouring, depositing, and flooding of the inlet creek, and by beaver dams. The floodplain area will be substantially larger when the level of the lake is lowered. It will be affected by the same forces, and, although some degradation of channels will probably occur in the newly exposed area, new habitat similar to that currently existing on the floodplain is expected to develop.

Dewatering of Grant Creek

The dewatering of Grant Creek would have negative impacts on many wildlife species. Immediate effects would be felt by those species depending on food sources provided by the creek. Habitat for dippers and mink (which are uncommon) would be reduced in the study area since Grant Creek appears to provide the best habitat for both species. The existing limited use of this stream by waterfowl would be eliminated. Small insectivorous birds (e.g., flycatchers and warblers) would also be impacted as a result of the reduction in aquatic insect production along the stream. Some aquatic habitat should be present, however, as a result of surface runoff and groundwater infiltration below Grant Lake and occasional Grant Lake overspills.

A less immediate impact would be a decrease in the quality and quantity of the narrow fringe of riparian habitat present along the lower portions of the stream. This change would reduce wildlife diversity along the stream and would slightly reduce study area carrying capacity for many small birds and mammals, snowshoe hare, moose, and other wildlife.

Transmission Line Collisions and Electrocution

Approximately 1.2 miles of three-conductor transmission lines would be constructed along the powerhouse access road. Bird collisions with conductors are not expected to be a problem for most of this length because the area is generally forested and conductor height would be below tree height. However, waterfowl collisions may occur at the location where the line would cross the narrows between Upper and Lower Trail Lakes. The extent of this collision potential would depend on the precise design of the line and its proximity to the bridge at this location.

Studies of avian collision mortality with larger transmission lines at ten sites in Oregon and Washington, many of which were selected to represent "worst case" situations, have not found the levels of collision-induced mortality to be biologically significant (Beaulaurier et al. 1982). In addition, most collisions were believed to occur with the small overhead groundwires, which would not be used on this transmission line, rather than with the larger more visible conductors (Meyer and Lee 1981). For these reasons and because of the low populations of waterfowl and other water birds that use the study area, collision impacts are expected to be insignificant.

Eagle or other large raptor electrocutions would not be a problem with this transmission line because the conductors would be spaced sufficiently far apart or insulated and the poles would be designed to prevent electrocution.

3.3.2.2 Wildlife Disturbance During Operation

Project operation will increase human activity along access roads, at the Grant Lake intake and at the powerhouse. The level of activity due to Project operation is expected to be insignificant except at the powerhouse and along its access road. As a result, moose and other large mammals would not use habitats adjacent to these two areas to the same degree as at present. Because of the small area involved, however, this impact would be insignificant.

The greatest source of wildlife disturbance resulting from Project operation would likely be due to recreational use of access roads and the Project recreation area as well as increased recreational use of Grant Lake and its watershed. It should be noted, however, that this impact is controllable to a large extent by restricting public access. Big game mammals and large predatory birds and mammals are the species most likely to be affected. Improved access into the Grant Lake area would increase trapping and hunting pressure and harassment of wildlife. Increased legal and illegal trapping pressure may have a significant effect on beaver, several of the mustelids, and possibly the canids. Increased hunting pressure may significantly impact moose populations in the study area, especially since they already appear low and may be limited by present hunting pressure. Although a higher harvest of mountain goats or Dall's sheep may occur as a result of improved access, the fact that concentration areas for these species would still be sufficiently remote and that hunting of these species is controlled by permit would minimize this impact. Similarly, increased black and brown bear hunting pressure may occur, but it is unlikely to be significant because the study area is not considered as a good bear hunting area. Increased human harassment of wildlife may also cause some impacts, especially if snow machine use substantially increases. This could be most severe during winter and early spring when animals are under physiological stress due to bad weather and poor food conditions. However, because of the low human population in the Project area the level of this impact is not expected to be significant.

3.3.3 Mitigation of Impacts

Project impacts on wildlife would generally fall into three categories: habitat losses, increased hunting, trapping, and human disturbance pressures on the wildlife resources; and transmission line collision mortality. Habitat loss impacts would be generally due to construction of access roads, the powerhouse and associated facilities, and other Project features, and the loss of some open-water waterfowl habitat during winter. Much of this habitat loss would be temporary and would be mitigated by preparing areas disturbed by construction but not usurped by Project features for natural revegetation and by seeding areas in which erosion may be a problem. Only about 18 acres would be permanently occupied by Project features and much of this area would eventually become at least partially vegetated. Project habitat losses would also be mitigated by the permanent drawdown of Grant Lake. Approximately 35 acres of riparian scrub and potentially upland scrub and conifer forest would be created by this drawdown.

Increased hunting, trapping, and human disturbance pressures on wildlife of the study area would result partially from operation of the Project. However, the major source of this impact would be the increase in non-Project related activities resulting from improved human access into the study area. This impact could be essentially eliminated by closing all Project access roads to public use by motorized vehicles. These closures, however, would eliminate the potential of the Project to enhance human recreational opportunities in the study area.

3.4 SUMMARY OF AGENCY CONTACTS

Definition of potential impact and development of plans for mitigating significant unavoidable impacts to aquatic, botanical, and terrestrial biological resources of the Project vicinity was made largely after consultation with representatives of a number of state, federal, and local agencies, namely:

- o Alaska Department of Fish and Game,
- o U.S. Department of the Agriculture, Forest Service,
- o U.S. Department of the Interior, Fish and Widlife Service,
- o National Marine Fisheries Service,
- o Cook Inlet Aquaculture Association, and
- o Alaska Department of Environmental Conservation.

The agency consultation process commenced with the Power Authority asking all agencies shown above except Cook Inlet Aquaculture Assocaation to review the Power Authority's interim feasibility report in February 1982. Agency comments were used to scope further analysis of Project impacts and development of mitigation plans for fish. No major mitigation actions for botanical and terrestiral biological resources beyond those identified in the interim feasibility report were recommended. Based on the initial aency comments and follow-up conversations with agency representatives, additional limited studies of water temperature regimens and sedimentation potential in Grant Lake were instituted. Agency representatives visited the site with the Power Authority in June 1982. In the summer and extending into autumn, an extensive series of meetings with agency personel was held primarily to discuss fish mitigation. Some of the elements discussed affected development of the Project recreation plan.

The following is a summary of pertinent agency contacts made in support of this report. Correspondence between the Alaska Power Authority and various agencies is included in the Technical Appendix, Part VIII.

Alaska Department of Environmental Conservation

1) <u>Date:</u> December 22, 1981

   <u>Agency Representative:</u> Robert Martin (Anchorage)

   <u>Location:</u> (Memorandum)

   <u>Subject:</u> Agency request to review and comment on Environmental Study Plan

2) <u>Date:</u> December 28, 1981

   <u>Agency Representative:</u> Robert Martin (Anchorage)

   <u>Location:</u> (Letter)

   <u>Subject:</u> Transmittal of Environmental Study Plan

3) <u>Date:</u> January 6, 1982

   <u>Agency Representative:</u> Robert Martin (Anchorage)

   <u>Location:</u> (Memorandum)

   <u>Subject:</u> Request to study changes in flow regimes to Grant and Falls Creeks

4) Date: April 29, 1982

Agency Representative: Hon. Ernest Mueller (Juneau)

Location: (Letter)

Subject: Transmittal of Environmental Study Plan for comment

5) Date: June 3, 1982

Agency Representative: Dan Wilkerson (Anchorage)

Location: (Telephone conversation)

Subject: Review of Environmental Study Plan, definition of potential problems

6) Date: June 9, 1982

Agency Representative: Robert Martin (Anchorage)

Location: (Memorandum)

Subject: Agency comments on Environmental Study Plan

Alaska Department of Fish and Game

1) Date: November 17, 1981

Agency Representative: Carl M. Yanagawa (Anchorage)

Location: (Letter)

Subject: Request for recommendations for mitigation of fish, wildlife, and botanical resources impacted by the Project

3) Date: February 1, 1982

Agency Representative: Tom Arminski (Anchorage)

Location: (Telephone conversation)

Subject: Effects of road development on goat and sheep hunting

4) <u>Date:</u> April 29, 1982

<u>Agency Representative:</u> Hon. Ronald O. Skoog (Juneau)

<u>Location:</u> (Letter)

<u>Subject:</u> Transmittal of Environmental Study Plan for comment

5) <u>Date:</u> May 14, 1982

<u>Agency Representative:</u> Tom Arminsky (Anchorage)

<u>Location:</u> (Telephone conversation)

<u>Subject:</u> Receipt of Environmental Study Plan, plans for mitigative measures

6) <u>Date:</u> May 20, 1982

<u>Agency Representative:</u> Hon. Ronald O. Skoog (Juneau)

<u>Location:</u> (Letter)

<u>Subject:</u> Agency comments on Interim Environmental Assessment, Interim Report and Environmental Study Plan (DNR comments attached)

7) <u>Date:</u> June 30, 1982

<u>Agency Representative:</u> Carl M. Yanagawa (Anchorage)

<u>Location:</u> (Letter)

<u>Subject:</u> Transmittal of cost of power data associated with Project alternatives, notice of meeting 9 July 1982 to discuss the Project

8) <u>Date:</u> June 30, 1982

<u>Agency Representative:</u> Loren Flagg (Soldotna)

<u>Location:</u> (Telephone conversation)

<u>Subject:</u> Discussion of plans for Trail Lakes Hatchery

9) Date: July 29, 1982

Agency Representative: Loren Flagg (Soldotna)

Location: (Telephone conversation)

Subject: Discussion of fish mitigation alternatives for Grant Creek

10) Date: July 30, 1982

Agency Representative: Tom Arminsky (Anchorage)

Location: (Telephone conversation)

Subject: Discussion of fish mitigation alternatives for Grant Creek

11) Date: August 6, 1982

Agency Representative: Dave Daisy (Anchorage)

Location: (Letter)

Subject: Transmittal of Interim Engineering and Environmental Reports

12) Date: August 6, 1982

Agency Representative: Hon. Ronald O. Skoog (Juneau)

Location: (Letter)

Subject: Agency comments on Instream Flow Evaluation Letter Report

13) Date: August 24, 1982

Agency Representative: Loren Flagg (Soldotna)

Location: (Letter)

Subject: Agency cost estimate for conducting an evaluation project for Grant Lake Salmon Studies

14) Date: August 1982 (day unknown)

Agency Representative: Dave Daisy (Anchorage)

Location: (Telephone conversation)

Subject: Discussion of fish mitigation alternatives for Grant Creek

15) Date: September 1, 1982

Agency Representative: Tom Arminski (Anchorage)

Location: (Letter)

Subject: Invitation to attend fish mitigation planning meeting September 15, 1982

16) Date: September 21, 1982

Agency Representative: Dave Daisy (Anchorage)

Location: (Letter)

Subject: Estimating costs of fish mitigation facilities

17) Date: September 21, 1982

Agency Representative: Loren Flagg, Jeff Hartman

Location: Anchorage

Subject: Summary of meeting held September 15, 1982, cost estimates for fish mitigation facilities

18) Date: September 28, 1982

Agency Representative: Loren Flagg (Soldotna)

Location: (Letter)

Subject: Clarification of position - cost estimation for salmon monitoring program

19) Date: October 11, 1982

Agency Representative: Jeff Hartman (Anchorage)

Location: (Letter)

Subject: Acknowledgement of contribution to cost estimates for fish mitigation facilities

20) Date: October 21, 1982

Agency Representative: Jeff Hartman

Location: Anchorage

Subject: Summary of meeting held October 6, 1982, cost estimates for fish mitigation facilities

21) Date: November 3, 1982

Agency Representative: Phil Brna (Anchorage)

Location: (Telephone conversation)

Subject: Review of fish mitigation plan

22) Date: November 15, 1982

Agency Representative: Phil Brna (Anchorage)

Location: (Telephone conversation)

Subject: Confirmation of ADF&G position on fish mitigation plan

23) Date: December 3, 1982

Agency Representative: Hon. Ronald O. Skoog (Juneau)

Location: (Letter)

Subject: Transmittal of summary of minutes of meeting on fish mitigation held November 10, 1982

Alaska Department of Natural Resources, Division of Parks

1) Date: December 3, 1982

Agency Representative: Ms. Judy Marquez (Anchorage)

Location: (Letter)

Subject: Transmittal of summary of minutes of meeting on fish mitigation held November 10, 1982

City of Seward

1) Date: December 3, 1982

Agency Representative: Mr. Ronald A. Garzini

Location: (Letter)

Subject: Transmittal of summary of minutes of meeting on fish mitigation held November 10, 1982

Cook Inlet Aquaculture Association

1) Date: August 4, 1982

Agency Representative: Tom Walker (Soldotna)

Location: (Telephone conversation)

Subject: Discussion, cost estimation of fish mitigation facilities

2) Date: August 5, 1982

Agency Representative: Tom Walker (Soldotna)

Location: (Telephone conversation)

Subject: Discussion of fish mitigation facilities

3) Date: August 6, 1982

Agency Representative: Tom Walker (Soldotna)

Location: (Telephone conversation)

Subject: Discussion of fish mitigation facilities, alternate projects

4) Date: July 14, 1982

Agency Representative: Sidney Logan (Soldotna)

Location: (Letter)

Subject: Invitation to attend mitigation planning meeting

5) Date: August 27, 1982

Agency Representative: Tom Walker (Soldotna)

Location: (Letter)

Subject: Transmittal of summary of meeting minutes August 17, 1982, Grant Lake Hydroelectric Project

6) Date: December 3, 1982

Agency Representative: Tom Walker (Soldotna)

Location: (Letter)

Subject: Transmittal of summary of minutes of meeting on fish mitigation held November 10, 1982

Kenai Peninsula Borough

1) Date: December 3, 1982

Agency Representative: Hon. Stan Thompson

Location: (Letter)

Subject: Transmittal of summary of minutes of meeting on fish mitigation held November 10, 1982

National Marine Fisheries Service

1) Date: November 17, 1981

Agency Representative: Ronald Morris (Anchorage)

Location: (Letter)

Subject: Request for recommendations for mitigation of fish, wildlife and botanical resources impacted by the Project

2) Date: January 25, 1982

Agency Representative: Ronald Morris (Anchorage)

Location: (Telephone conversation)

Subject: Status of Environmental Study Plan

3) Date: April 29, 1982

Agency Representative: Robert McVey (Juneau)

Location: (Letter)

Subject: Transmittal of Environmental Study Plan for comment

4) Date: June 2, 1982

Agency Representative: Robert McVey (Juneau)

Location: (Letter)

Subject: Agency comments on Environmental Study Plan

5) Date: June 30, 1982

Agency Representative: Ronald Morris (Anchorage)

Location: (Letter)

Subject: Transmittal of cost of power data associated with Project alternatives, notice of meeting July 9, 1982 to discuss the Project

6) Date: July 15, 1982

Agency Representative: Robert McVey (Juneau)

Location: (Letter)

Subject: Summary of Letter Report and meeting on Instream Flows

7) Date: August 10, 1982

Agency Representative: Brad Smith (Anchorage)

Location: (Telephone conversation)

Subject: Comments on Fish Mitigation Planning Document No. 2

8) Date: August 11, 1982

Agency Representative: Robert McVey (Juneau)

Location: (Letter)

Subject: Agency comments on instream flow studies, Letter Report and meeting

9) **Date:** September 1, 1982

Agency Representative: Brad Smith (Anchorage)

Location: (Letter)

Subject: Invitation to attend fish mitigation planning meeting September 15, 1982

10) **Date:** October 28, 1982

Agency Representative: Brad Smith (Anchorage)

Location: (Telephone conversation)

Subject: Agency position on fish mitigation facilities

11) **Date:** December 3, 1982

Agency Representative: Robert McVey (Juneau)

Location: (Letter)

Subject: Transmittal of summary of minutes of meeting on fish mitigation held November 10, 1982

National Park Service

1) **Date:** December 3, 1982

Agency Representative: Mr. John Cook (Anchorage)

Location: (Letter)

Subject: Transmittal of summary of minutes of meeting on fish mitigation held November 10, 1982

U.S. Environmental Protection Agency

1) **Date:** December 3, 1982

Agency Representative: Richard Summer (Anchorage)

Location: (Letter)

Subject: Transmittal of summary of minutes of meeting on fish mitigation held November 10, 1982

U.S. Fish and Wildlife Service

1) Date: November 17, 1981

Agency Representative: Ms. Mary Lynn Nation (Anchorage)

Location: (Letter)

Subject: Request for recommendations for mitigation of fish, wildlife, and botanical resources impacted by the Project

2) Date: December 10, 1981

Agency Representative: Ms. Mary Lynn Nation (Anchorage)

Location: (Letter)

Subject: Review of Environmental Study Plan

3) Date: April 9, 1982

Agency Representative: Robert Boken

Location: (Letter)

Subject: Agency comments regarding Feasibility Studies

4) Date: April 29, 1982

Agency Representative: Keith Scheiner (Anchorage)

Location: (Letter)

Subject: Transmittal of Environmental Study Plan for comment

5) Date: June 1, 1982

Agency Representative: Ms. Mary Lynn Nation (Anchorage)

Location: (Memorandum)

Subject: Summary of meeting with Ms. Nation May 25, 1982 on Environmental Study Plan

6) <u>Date:</u> June 8, 1982

<u>Agency Representative:</u> M. Monsen (Anchorage)

<u>Location:</u> (Letter)

<u>Subject:</u> Agency comments on Environmental Study Plan and Interim Environmental Assessment

7) <u>Date:</u> June 30, 1982

<u>Agency Representative:</u> Ms. Mary Lynn Nation

<u>Location:</u> (Letter)

<u>Subject:</u> Transmittal of cost of power data associated with Project alternatives, notice of meeting July 9, 1982 to discuss the Project

8) <u>Date:</u> August 17, 1982

<u>Agency Representative:</u> Gerald Reed

<u>Location:</u> (Letter)

<u>Subject:</u> Agency comments on instream flows

9) <u>Date:</u> September 1, 1982

<u>Agency Representative:</u> Ms. Mary Lynn Nation

<u>Location:</u> (Letter)

<u>Subject:</u> Invitation to attend fish mitigation planning meeting September 15, 1982

10) <u>Date:</u> December 3, 1982

<u>Agency Representative:</u> Keith Scheiner (Anchorage)

<u>Location:</u> (Letter)

<u>Subject:</u> Transmittal of summary of minutes of meeting on fish mitigation held November 10, 1982

U.S. Department of Agriculture, Forest Service

1) <u>Date:</u> November 17, 1981

<u>Agency Representative:</u> Geof Wilson (Seward)

<u>Location:</u> (Letter)

<u>Subject:</u> Request for recommendations for mitigation of fish, wildlife, and botanical resources impacted by the Project

2) <u>Date:</u> February 2, 1982

<u>Agency Representative:</u> Geof Wilson (Seward)

<u>Location:</u> (Telephone conversation)

<u>Subject:</u> Permission to access study area

3) <u>Date:</u> March 31, 1982

<u>Agency Representative:</u> Clay Beal (Anchorage)

<u>Location:</u> (Letter)

<u>Subject:</u> Special Use Permit application

4) <u>Date:</u> April 1, 1982

<u>Agency Representative:</u> John Mattson (Anchorage)

<u>Location:</u> (Letter)

<u>Subject:</u> Request to review Environmental Study Plan

5) <u>Date:</u> April 29, 1982

<u>Agency Representative:</u> Clay G. Beal (Anchorage)

<u>Location:</u> (Letter)

<u>Subject:</u> Transmittal of Environmental Study Plan for comment

6)	Date:	May 14, 1982
	Agency Representative:	Ken Thompson (Anchorage)
	Location:	(Telephone conversation)
	Subject:	Agency comments on Environmental Study Plan
7)	Date:	May 14, 1982
	Agency Representative:	Geof Wilson (Seward)
	Location:	(Memorandum)
	Subject:	Agency comments on Environmental Study Plan
8)	Date:	June 28, 1982
	Agency Representative:	Geof Wilson (Seward)
	Location:	(Letter)
	Subject:	Acknowledgement of permission to conduct field studies
9)	Date:	June 29, 1982
	Agency Representative:	Geof Wilson (Seward)
	Location:	(Letter)
	Subject:	Summary of notes from meeting on Environmental Study Plan of June 8, 1982, request for review and comment
10)	Date:	July 13, 1982
	Agency Representative:	Geof Wilson (Seward)
	Location:	(Letter)
	Subject:	Summary of meeting on Environmental Study Plan
11)	Date:	July 14, 1982
	Agency Representative:	Clay Beal (Anchorage)
	Location:	(Letter)
	Subject:	Transmittal of archaeology report

12) **Date:** August 9, 1982

Agency Representative: Ken Thompson (Anchorage)

Location: (Telephone conversation)

Subject: Discussion of fisheries mitigation

13) **Date:** October 5, 1982

Agency Representative: John Mattson (Anchorage)

Location: (Letter)

Subject: Request for comments on Cultural Resources section of Environmental Report

14) **Date:** December 3, 1982

Agency Representative: Clay Beal (Anchorage)

Location: (Letter)

Subject: Transmittal of summary of minutes of meeting on fish mitigation held on November 10, 1982

4.0 REPORT ON HISTORICAL AND ARCHAEOLOGICAL RESOURCES

This section describes archaeological studies conducted to identify sites of potential archaeological or historical significance that might be directly or indirectly affected by Project construction or operation, and measures that will be taken to protect cultural resources. Part XI of the Technical Appendix provides supplemental material, including a survey for an abandoned sawmill site in the Project vicinity and a report that was submitted to the Forest Service following the area-wide archaeological field survey. The area-wide survey report includes surveys of individual cultural sites surveyed within and near the Project. The report also provides detailed information on methods employed in conducting the survey.

4.1 SURVEYS AND INVENTORIES COMPLETED AND TO BE CONDUCTED

Cultural resources surveys and inventories are being conducted in four phases, three of which are complete. The first three phases consisted of a preliminary field survey at the outlet of Grant Lake, a literature search, and a field survey of parts of the Project vicinity identified as tentative Project facility sites. The fourth phase will be a field survey of Project lands conducted after Project facilities have been located on the ground.

A preliminary archaeological survey of one potential historic site was conducted in the fall of 1981 as a precautionary measure prior to carrying out subsurface geotechnical testing at a proposed damsite (Yarborough 1981). The site, consisting of the remains of a sawmill known as Solars Sawmill, lies on the north bank of the outlet of Grant Lake. The survey was conducted to ensure that the subsurface drilling and associated activities would not disturb any resources of potential historical or archaeological significance.

The literature search completed in January 1982 identified several sites of potential historical significance within the Project vicinity. A field survey completed in June 1982 examined these sites and searched for previously undocumented sites within the area to be affected by Project construction (Project site). A subsequent examination of aerial photos of the Project site provided no additional information.

The literature search focused upon archaeological, ethnographic, and historical information sources of the Kenai Peninsula of Alaska. Its purpose was to identify known cultural resources that might be affected by construction or operation of the Project, to assess the area's potential for containing cultural resources that remain unidentified, and to provide background data for assessing the significance of those resources. In addition, the Alaska Heritage Resources Survey (AHRS), as of July 22, 1981, and the National Register of Historic Places, up to October 4, 1982, were checked for listings of cultural resources located within the Project vicinity. The Alaska Heritage Resources Survey (1981) is a continuing program conducted by the Alaska Division of Parks. The archaeologist in the Supervisor's Office on the Chugach National Forest provided supplementary information from his files (Mattson 1982). Cultural sites within and adjacent to the Project identified through the literature search are listed in Table 4-1.

Prior to conducting the field survey, aerial photos available for the Project vicinity were examined for the presence of clearings, structures, roofs, and other departures from a natural environment in an effort to identify additional possible cultural sites. However, due to the mountainous terrain, the photos were taken from relatively high altitude (1:12,000) and therefore failed to provide any new information concerning the existence or location of cultural resources.

The field survey had two goals. The first goal was to locate and examine all sites identified in the literature search that would be directly affected by Project construction or operation. The second goal was to identify previously unknown or unrecorded sites in the

TABLE 4-1

CULTURAL RESOURCES IDENTIFIED THROUGH THE LITERATURE SEARCH

Alaska Heritage Resources Survey Number	Location
	On-site
SEW021	Crown Point/Trail Creek Station
SEW029	Alaska Northern Railway
SEW148	Iditarod Trail
none	Solars Sawmill
none	Stevenson Cabin
none	Trail between Solars Sawmill and Upper Trail Lake
	Adjacent Sites on Falls Creek
none	Baggs Cabin
none	Crown Point Mine structures, localities A, B, and C
SEW140	Crown Point Mountain Trail
SEW192	Crown Point Mine

Project vicinity. Prior to the field work, a survey plan describing the methods to be employed was submitted for comment to the Forest Supervisor of the Chugach National Forest, the State Historic Preservation Officer, and the Director of the Alaska Regional Office of the National Park Service. The Forest Supervisor accepted the plan without change. The State Historic Preservation Officer accepted the plan, but asked for a follow-up survey after actual construction sites and material sources had been identified on the ground. The National Park Service offered no formal comment.

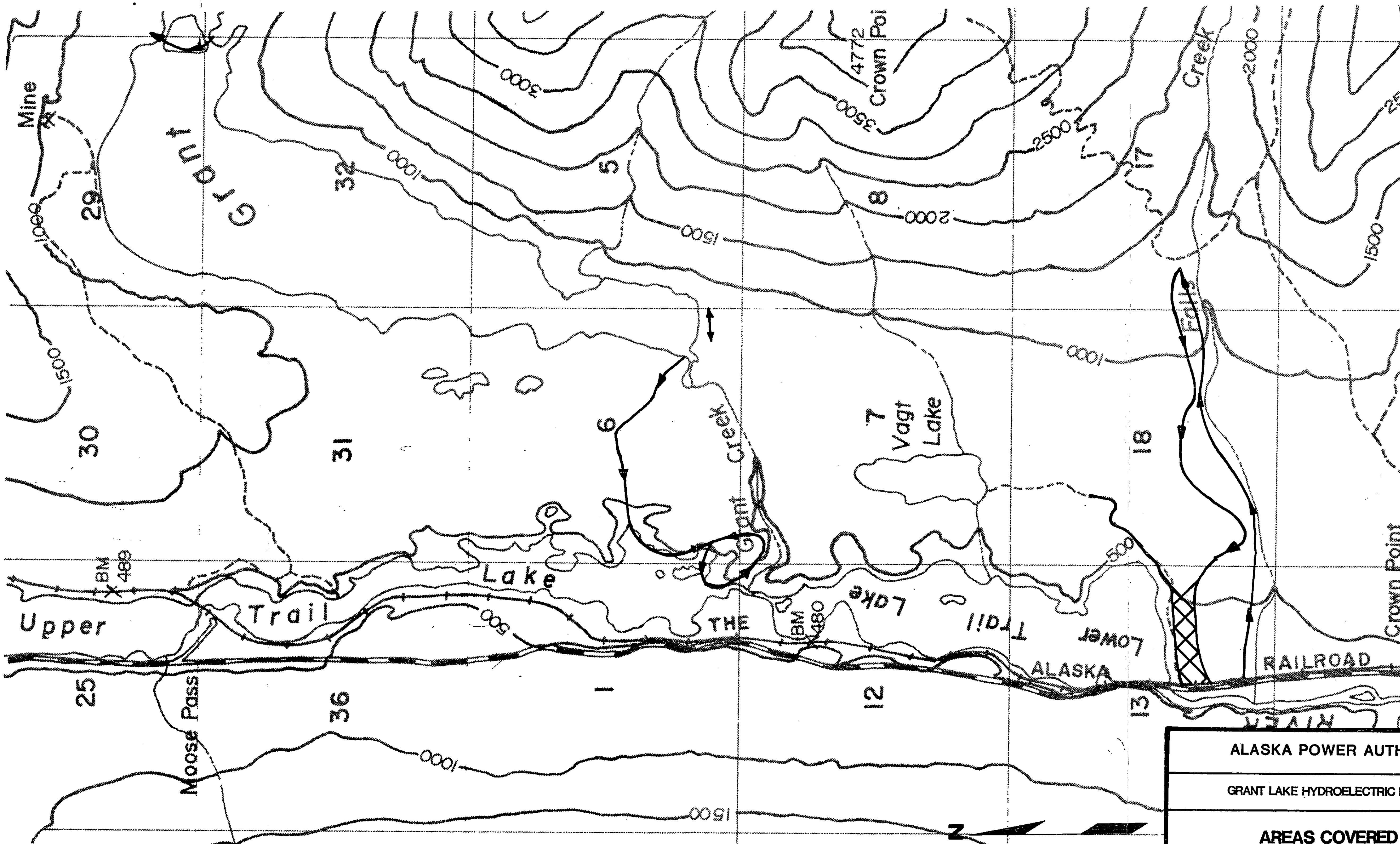
The field survey was undertaken in early June 1982. Due to a late spring the understory was just beginning to leaf out and ground visibility was extremely good for a forest environment. The only significant impediments to ground visibility were tree trunks and leafless branches. The survey began with a brief aerial reconnaissance of the Project site in a small airplane. Because none of the construction sites or routes had been marked on the ground, foot survey was confined to locations which were easily identifiable due to their proximity to natural or man-made landmarks. These locations, shown on Figure 4-1, were:

1) an area south of Vagt Lake Trail;

2) the Falls Creek area in Section 17, T. 4 N., R. 1 E., Seward Meridian;

3) the south end of Grant Lake and the Solars Sawmill site near the outlet of the lake;

4) the site of the powerhouse, substation, and tailrace in the NW1/4 SW1/4 Section 6, T. 4 N., R. 1 E., Seward Meridian, and part of what is believed to be the old trail between Solars Sawmill and the cove near which the powerhouse will be situated;



ALASKA POWER AUTHORITY

GRANT LAKE HYDROELECTRIC PROJECT

AREAS COVERED IN
ARCHAEOLOGICAL FIELD SURVEY

FIGURE 4-1

EBASCO SERVICES INCORPORATED

5) the east end of the bridge site at the narrows between Upper and Lower Trail lakes and the east shore of Upper Trail Lake from the bridge site to the powerhouse site in the NW1/4 SW1/4 Section 6, T. 4 N., R. 1 E., Seward Meridian; and

6) the island and adjacent shore between the upper and lower portions of Grant Lake.

The east shore of Lower Trail Lake was not examined as proposed in the survey plan because construction of an access road in this area was eliminated from preliminary Project design.

In general, the survey consisted of an examination on foot of the ground's surface and existing exposures such as uprooted trees, road cuts, and erosion cuts. A limited number of small test pits were dug in areas without natural exposures that appeared, on the basis of the literature search, to be relatively high in archaeological potential. Such areas were generally near identified sites, water bodies, debris, or evidence of human use. All pits were backfilled and no artifacts collected.

A final field survey will be conducted at the west end of the bridge site at the narrows, the access road to the intake facility at Grant Lake, and fill and borrow areas.

4.2 RESULTS OF SURVEYS, INVENTORIES, AND SUBSURFACE TESTING

The prehistoric and early historic periods are poorly documented for the Project vicinity. No sites relating to these periods were identified in the literature search, though it is quite possible that sites of this age do exist. Written references to the area deal primarily with the development of gold mining and the Alaska Railroad in the period after 1900. All of the historical sites identified in the Project vicinity post-date 1900 and many relate to the railroad or mining industry.

The following results of the field survey are presented by survey segment.

4.2.1 Area between Vagt Lake Trail and an Existing Access Road

This area is adjacent to the Alaska Northern Railway (SEW029) and the Iditarod Trail (SEW148), both of which roughly coincide with the present route of the Alaska Railroad track. The literature search identified two other sites in this area, Crown Point/Trail Creek Station (SEW021) and the Stevenson Cabin. These may be different names for a single site. The Crown Point Mine, which lies north of Falls Creek and east of the Project site, was known at the turn of the century as the Stephenson or Stevenson Bros. property. In 1910 this mining property was deeded to the Kenai-Alaska Gold Co., which in 1915 had a large log house with an office and warehouse at Crown Point or Trail Creek Station, a stop on the Alaska Northern Railway (Martin et al. 1915; Barry 1973). The Stevenson Cabin, shown at approximately this location on the map compiled by D.H. Sleem in 1910 (Mattson 1982), may have been associated with the earlier owners of the mining claim and simply ceded to the Kenai-Alaska Gold Co. when it took over the mine. The archaeological survey did not resolve this question. The single overgrown cabin foundation that was located in this vicinity associated with historic-age debris and several pits is not the "large log house" described in the literature. Other historic-age debris was scattered through the forest along the first north-south transect through this area, but no other structures were located. Diffuse charcoal was noted in the existing road cut, but this may be due to past forest fires in the area. A small test pit dug atop the rocky knoll where the Vagt Lake Trail makes a right-angle turn yielded 8.3 in (21 cm) of culturally sterile soil over bedrock.

4.2.2 Falls Creek

The literature search identified one site, the Baggs Cabin, on lower Falls Creek; however, it could not be be located. The survey did find a sluice, historic-age campsite, and the remains of the C.M. Brosius cabin further upstream as well as the NW and NE corner stakes for the Marathon 1, 2, and 3 placer claims, posted by Perry N., Perry S., and Thomas Buchanan of Seward in 1981, and the NW corner of the adjacent Four Jokers 1 placer claim. Slightly north of the latter, on the road leading up to the Crown Point Mine, are the remains of a log structure and some historic period debris. Other sites identified in the literature search, the Crown Point Mine (SEW192), Crown Point Mountain Trail (SEW140), and Crown Point Mine structures were not visited.

4.2.3 South End of Grant Lake

This appears to be an old slide area. A 24-cm shovel test pit dug through the sod approximately 10 m inland from the beach in line with the standing survey marker revealed very wet, fine-grained, red-brown soil above gravel or stones. No cultural material was found.

4.2.4 Solars Sawmill Overland to Powerhouse Site

The literature search identified two sites in this area, Solars Sawmill and a trail between the mill and Upper Trail Lake. The sawmill site was found to be as described by Yarborough, who visited it in October 1981 (Yarborough 1981). At least part of the trail between the mill and Upper Trail Lake, which is shown on the 1953 USGS map, was believed located. Although it had been recently brushed in places, it was flanked by old cut stumps, and some older wooden treads still bridged short wet sections. As noted above, a branch of the trail indicated on the USGS map that led to the powerhouse site on Upper Trail Lake was not found. A crew of biologists reported a well-constructed trail, with historic debris, leading east out of the next large cove to the north, but the trail was lost at the edge of a muskeg. No cultural material, other than a recent campfire, was found on the shores of the powerhouse cove. Two small 3.9 in (10-cm) deep test pits, one on the south promontory defining the cove and one on a small peninsula on the south side of the cove, revealed vegetation and culturally sterile soil above bedrock. The soil under several uprooted trees in the area yielded diffuse traces of charcoal, but there is also evidence of an old burn in the area.

4.2.5 Shoreline of Upper Trail Lake from the Powerhouse Site to the Mouth of Grant Creek

No cultural material was found other than occasional modern debris washed up on the beach. One roughly rectangular hole, approximately 3 ft by 6 ft (1 m by 2 m), was noted at the west end of the island which splits the mouth of Grant Creek. Its bottom was obscured by shallow water, but a shovel probe immediately struck gravel. It could be the natural result of fluctuating creek and lake levels. There was no associated cultural material.

4.2.6 Island Between the Upper and Lower Basins of Grant Lake and Adjacent Points of Land

Aside from old signs of small-scale logging on the north adjacent point and a recent survey marker on the south adjacent point, no evidence of human activity was noted.

As noted above, a fourth phase of archaeological survey and testing will be conducted after all construction facilities and other affected areas have been located on the ground. The following areas, shown on Figure 1-3, appear to warrant further survey:

- o The access road between the powerhouse site and the highway, especially the portion between the highway and the bridge across the Trail Lakes narrows, since the latter area was not examined in the survey; and

- o The access road to the gate shaft area that will roughly parallel Grant Creek, the proposed road passes through an area of archaeological potential.

4.3 CULTURAL RESOURCES WITHIN THE PROJECT SITE

Of the sites identified through the first three phases of study, the Alaska Northern Railway (SEW029) and Iditarod Trail (SEW148) routes, the Solars Sawmill site, and the trail between the Sawmill and Upper Trail Lake are those which are likely to be directly affected by Project construction. The Crown Point Mountain Trail (SEW140), Crown Point Mine (SEW192) and associated structures, structural remains along the lower mine access road, the Brosius cabin, sluice, and camp identified along Falls Creek, and the Baggs Cabin site will not be affected by the Project. Crown Point/Trail Creek Station and the Stevenson cabin lie to the north of the access road to Grant Lake and will be unaffected. Each of these sites is discussed in the following paragraphs. Additional information is presented in Appendix C.

The Iditarod Trail and Alaska Northern Railway roughly coincide with the present route of the Alaska Railroad through the Project site. The Iditarod Trail was blazed in 1908 by the Alaska Road Commission as a winter route between the port of Seward and the gold fields of Nome and the interior. The old right-of-way is still used by the present-day railroad (Barry 1973). It is listed in the Division of Parks' Alaska Heritage Resources Survey (1981) and has been designated as a national historic trail.

The Solars Sawmill site consists of a collapsed wooden structure; a roofless standing cabin of milled lumber with attached woodshed, both in very poor condition; an outhouse, tipped over; two small piles of rusted cans; two pairs of mining-car wheels; and assorted historic debris. Three large pulleys mounted on heavy timbers, wire cable, and two frameworks of timbers leading down into Grant Creek constitute the remains of the mill itself. The available literature provides little information on the establishment or operation of this site. A report compiled by the Forest Service in 1924 mentions that an area at the head of Grant Lake had been cut over for a sawmill at the foot of the lake, but maps accompanying the report do not show the mill site (Holbrook 1924; Quilliam 1982). When M. Yarborough visited this site in 1981, he found a date of 13 January 1958 on a magazine used as insulation in the standing cabin, but it is quite likely that the cabin was periodically occupied and modified after the mill itself was abandoned.

The Crown Point Mountain Trail, Crown Point Mine, and associated structures all lie beyond the area of direct Project impact. The Black Butte gold vein discovered here in 1906 by J.W. and C.E. Stephenson (Stevenson?), was one of the earliest major discoveries in the Falls Creek drainage. In 1910 the property was deeded to the Kenai-Alaska Gold Co., which in 1911 constructed a road from the railroad to the mine and a stamp mill, assay office, and other buildings. In 1912 an 8200-foot aerial tram was completed between the mine and mill. The mine was closed in 1917 (Martin et al. 1915; Johnson 1912, 1919). Its present name relates to the period 1935-1940 when it was operated by the Crown Point Mining Co., C. Brosius and Associates of Seward (Stewart 1937, 1939, 1941). It was opened again in the late 1950s. The mine is presently connected to the highway by a rough, fairly steep access road.

The remains of a structure of unpeeled logs located along the Crown Point Mine access road also appear to lie outside the area of direct Project impact. This structure may also have been associated with the mine. It is in very poor condition; only the southwest corner still stands a few tiers high.

The Brosius cabin and the sluice and camp identified along Falls Creek appear to be associated with mining in the area. A recent branch of the mine's access road cuts through a trash deposit between the cabin and camp. Only two walls of unpeeled logs of the roofless cabin still stand.

The Baggs Cabin site was not located. It is shown on a map compiled by D.H. Sleem in 1910 (Mattson 1982) and may be associated with mining activity in the area.

Crown Point/Trail Creek Station and the Stevenson Cabin site may be distinct sites or different names for a single site. The Stevenson cabin is shown on a map dated 1910 (Mattson 1982) and may have been associated with the Stevenson brothers who discovered gold at what became the Crown Point Mine. Trail Creek Station, in approximately the same location, was a stop at Mile 26 on the Alaska Northern Railway at a slightly later date.

4.4 POTENTIAL IMPACTS

4.4.1 Direct Impacts

The Project access road would cross the routes of the Iditarod Trail (SEW148) and the Alaska Northern Railway (SEW029). These routes are now occupied by the Alaska Railroad and are already crossed by a number of access roads. Construction and operation of the Project will not, therefore, adversely affect these resources. Project construction and operation are also compatible with the Bureau of Land Management's Comprehensive Management Plan for the Iditarod Trail (BLM 1981).

The Solars Sawmill site may be directly affected by Project construction and operation. Access roads to the gate shaft and recreation areas will pass close to the site. While these roads have been located to avoid the site, their proximity increases the potential for vandalism. The structures at the site are in poor condition and winter snows could cause the last one to collapse within a few years. The remaining pulleys from the mill will probably withstand many more years of weathering, but could easily be pushed into the creek by vandals and lost. There are also a few artifacts at the site, such as a galvanized sink, mining-car wheels, and metal parts of the pulleys, which might be attractive to collectors.

The trail between the sawmill and Upper Trail Lake will also be crossed by an access road. As noted above, the west half of this trail is poorly defined. No historic artifacts were found along the portion followed.

4.4.2 Indirect Impacts

The Crown Point Mountain Trail (SEW140), Crown Point Mine (SEW192) and associated structures at localities A, B, and C, and the structural remains along the lower mine access road all lie north and east of the Project vicinity and will not be affected by Project construction or operation. The Brosius cabin, sluice, camp, and Baggs Cabin site lie west and south of the Project vicinity.

Crown Point/Trail Creek Station (SEW021) and the Stevenson Cabin site lie near a Forest Service recreation trail and an existing access road. They are not expected to be affected by the Project.

4.5 MITIGATION OF IMPACTS

The only known site of potential historic significance warranting mitigation measures is the Solars Sawmill site near the outlet of Grant Lake. While this site and its associated trail appear unlikely to be eligible for inclusion on the National Register of Historic Places and appear to have played an insignificant role in local economic development, artifacts remaining at the site might be vandalized or stolen when access to the area is improved. Therefore, these artifacts would be salvaged from the site under the supervision of a qualified archaeologist and provided to either the Forest Service or a local historical society for preservation.

Construction areas not already surveyed for the presence of cultural resources will be surveyed after Project facilities have been located on the ground and before initiation of construction. Any cultural resources found during this final survey will be evaluated with respect to their archaeological or historical significance. The Alaska Power Authority will take steps to protect or salvage any significant cultural resources in cooperation with the State Historic Preservation Officer and the Forest Service.

4.6 SUMMARY OF AGENCY CONTACTS

Analysis of the Project's potential effects on historic and archaeological resources was conducted in close coordination and consultation with staff of the Forest Service and Office of the State Historic Preservation Officer. The National Park Service was also advised of survey plans and results and conclusions from the analysis. Staff from the Forest Service and State Historic Preservation Officer reviewed archaeological survey plans, the Special Use Permit for conducting the survey, and survey findings. They also provided information on cultural sites and assisted in assessing the significance of the Project's potential effects on identified cultural resources.

The following is a summary of pertinent Agency contacts made in support of this report. Correspondence between the Alaska Power Authority and various agencies is included in the Technical Appendix, Part VIII.

Office of State Historic Preservation Officer,
Division of Parks, Alaska Department of Natural Resources

1) Date: December 17, 1981

Agency Representative: Robert D. Shaw (Anchorage)

Location: (Letter)

Subject: Requirement to investigate Solar's Sawmill

2) Date: January 15, 1982

Agency Representative: Doug Reger (Anchorage)

Location: (Telephone conversation)

Subject: Procedures for conducting the archaeological survey for the Project and formulating mitigation measures

3) Date: January 18, 1982

Agency Representative: Robert Shaw

Location: (Telephone conversation)

Subject: Procedures and guidelines for mitigation planning for archaeological resources at Grant Lake

4) Date: February 11, 1982

Agency Representative: Ty Dilliplane

Location: (Telephone conversation)

Subject: Procedures for showing cultural site locations in report and preparing archaeological survey plan

5) Date: March 25, 1982

Agency Representative: Ty Dilliplane

Location: (Letter)

Subject: Transmittal of map of archaeological and historic sites in Grant Lake area

6) Date: April 20, 1982

Agency Representative: Ty Dilliplane

Location: (Telephone conversation)

Subject: Procedures for securing permit for archaeological survey for the Project

7) Date: April 29, 1982

Agency Representative: John Katz (Juneau)

Location: (Letter)

Subject: Transmittal of Environmental Study Plan for comment

8) Date: May 5, 1982

Agency Representative: Ty L. Dilliplane (Anchorage)

Location: (Letter)

Subject: Request for comments on Cultural Resources Study Plan

9) Date: May 24, 1982

Agency Representative: Ty L. Dilliplane (Anchorage)

Location: (Letter)

Subject: Agency comments on Cultural Resources Study Plan

10) Date: June 22, 1982

Agency Representative: Tim Smith

Location: Anchorage

Subject: Possible need for additional archaeological survey after Project facility locations are identified on the ground

11) Date: September 14, 1982

Agency Representative: Ty L. Dilliplane (Anchorage)

Location: (Letter)

Subject: Transmittal of archaeology report

12) Date: October 4, 1982

Agency Representative: Tim Smith

Location: (Telephone conversation)

Subject: Verification of no National Register registration of historic sites in vicinity of Project

13) Date: October 13, 1982

Agency Representative: Ty L. Dilliplane (Anchorage)

Location: (Letter)

Subject: Agency comments on Archaeology Reconnaissance Report

U.S. Department of Agriculture, Forest Service

1) Date: January 7, 1982

Agency Representative: John Mattson (Anchorage)

Location: (Telephone conversation)

Subject: Verification of Ebasco archaeologist's consultation with Forest Service on Cultural Resources Study Plan

2) Date: March 31, 1982

Agency Representative: Clay G. Beal (Anchorage)

Location: (Letter)

Subject: Request for Special Use Application to conduct cultural resource field investigation in 1982

3) Date: April 1, 1982

Agency Representative: John Mattson

Location: (Letter)

Subject: Transmittal of map of archaeological sites identified through literature survey

4) Date: April 20, 1982

Agency Representative: John Mattson

Location: (Telephone conversation)

Subject: Procedures for securing of Special Use Permit for archaeological survey

5) Date: May 5, 1982

Agency Representative: Clay G. Beal (Anchorage)

Location: (Letter)

Subject: Application for Permit to conduct survey

6) Date: June 1, 1982

Agency Representative: Geof Wilson (Seward)

Location: (Letter)

Subject: Letter authorizing 1982 cultural resource field work

7) Date: June 2, 1982

Agency Representative: Fred Harnisch (Anchorage)

Location: (Letter)

Subject: Amendment to cultural resource Permit

8) Date: June 21, 1982

Agency Representative: John Mattson and Arn Albrecht

Location: Anchorage

Subject: Archaeology and mining uses in Project vicinity

9) Date: June 28, 1982

Agency Representative: Geof Wilson (Seward)

Location: (Letter)

Subject: Acknowledgement of receipt of authorization to proceed with 1982 cultural resource survey

10) Date: July 13, 1982

Agency Representative: John Mattson (Anchorage)

Location: (Letter)

Subject: Due dates for Cultural Resources Report

U.S. Department of the Interior, National Park Service

1)	Date:	January 15, 1982
	Agency Representative:	Craig Davis and Floyd Sharrok (Anchorage)
	Location:	(Telephone conversation)
	Subject:	Availability of information on archaeological resources in Project vicinity
2)	Date:	April 28, 1982
	Agency Representative:	John E. Cook (Anchorage)
	Location:	(Letter)
	Subject:	Transmittal of Environmental Study Plan for comment
3)	Date:	May 5, 1982
	Agency Representative:	John E. Cook (Anchorage)
	Location:	(Letter)
	Subject:	Request for comments on Cultural Resources Study Plan

5.0 REPORT ON SOCIOECONOMIC IMPACTS

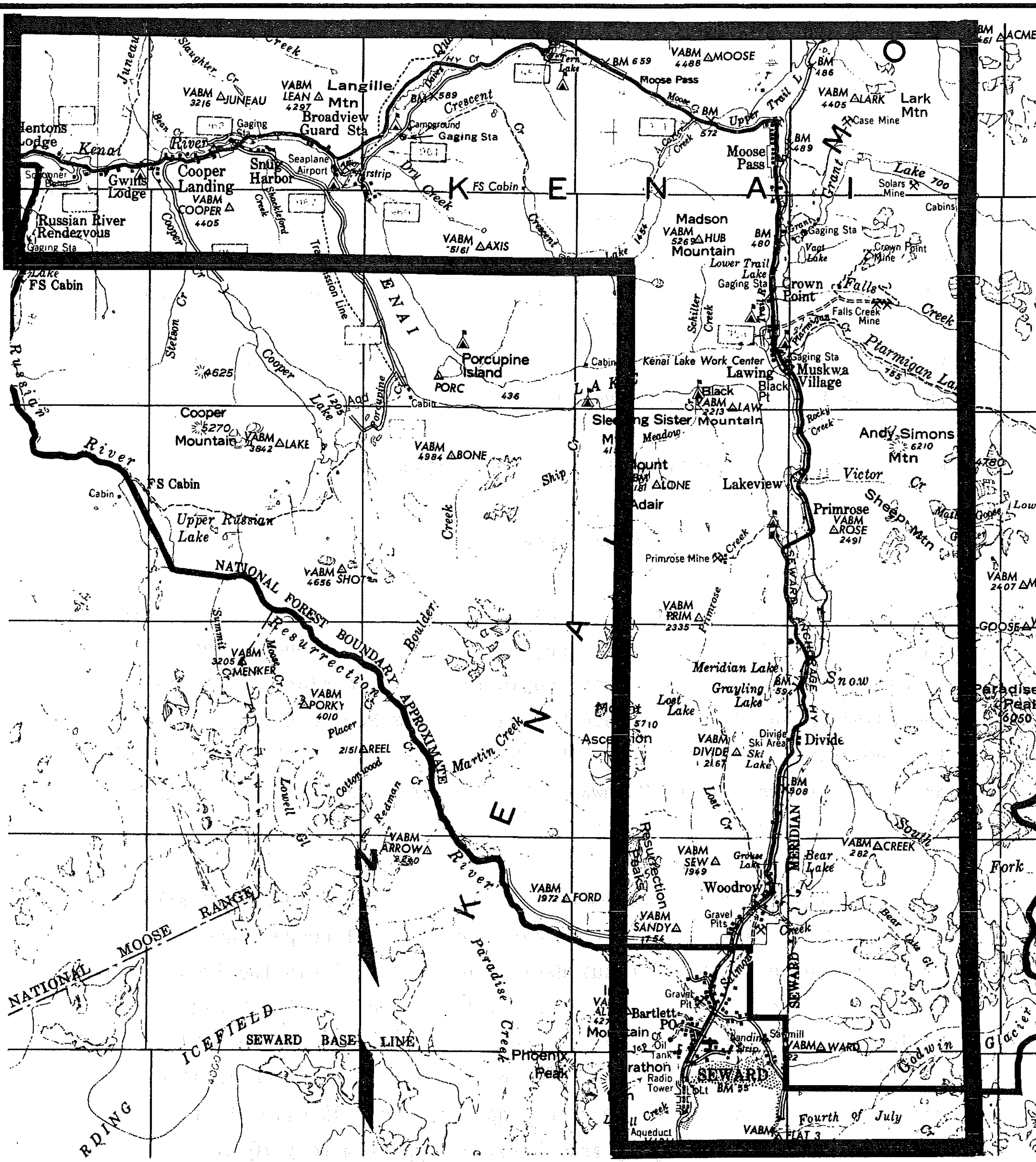
This section describes the socioeconomic impacts of the Grant Lake Hydroelectric Project and the area in which the impacts will occur. The section is divided into eight parts: 1) Socioeconomic characteristics; 2) Socioeconomic trends; 3) Impacts on local governmental, educational, and social services; 4) Project employment and payrolls; 5) Construction personnel; 6) Housing availability for temporary and new employment; 7) Residences and businesses displaced by the Project; and 8) Local government fiscal effects.

5.1 SOCIOECONOMIC CHARACTERISTICS OF THE PROJECT VICINITY

5.1.1 The Socioeconomic Impact Area

Construction of the Project will cause socioeconomic impacts primarily in the southeastern portion of the Kenai Peninsula Borough. The specific area likely to be impacted includes the corridor along the Seward-Anchorage Highway (State Highway 9) from Seward north through the community of Moose Pass to the intersection with State Highway 1, and extending west along Highway 1 to the community of Cooper Landing. This area is shown in Figure 5-1.

The Project site lies approximately 25 miles north of Seward, 2 miles south of Moose Pass, and 24 miles east southeast of Cooper Landing, which are the only three Census designated places within the impact area (U.S. Dept. of Commerce, Bureau of the Census 1981). Census designated places are the smallest geographical divisions for which 1980 Census data are published. The next closest Census designated places to the Project site are Hope, approximately 45 miles to the north and west of Highway 1, and Sterling, approximately 70 miles to the west on Highway 1. Anchorage is about 102 miles north of the Project site by way of State Highways 9 and 1.



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ALASKA POWER AUTHORITY

GRANT LAKE HYDROELECTRIC PROJECT

SOCIOECONOMIC IMPACT AREA

FIGURE 5-1

EBASCO SERVICES INCORPORATED

Virtually all construction materials should reach the Project site by way of Highways 1 and 9, from Anchorage to the north, Soldotna through Cooper Landing to the west, or Seward to the south. The construction labor force will be drawn primarily from the Seward, Moose Pass, and Cooper Landing areas, with some additional workers possibly relocating temporarily to the Project impact area from either the Soldotna or Anchorage vicinities.

5.1.2 Population Characteristics

The socioeconomic impact area includes parts of two 1980 Census subareas, the Kenai-Cook Inlet and the Seward subareas, which comprise the Kenai Peninsula Borough Census Area. Within each subarea population figures are estimated for one or more Census designated places, communities for which population and selected Census data are reported. Only one Census designated place in the Seward subarea, the City of Seward, is located in the impact area. Seward is one of two home rule cities in the Kenai Peninsula Borough. The remainder of the Kenai Peninsula Borough lies in the Kenai-Cook Inlet subarea, of which only two Census designated places, Cooper Landing and Moose Pass, lie within the socioeconomic impact area. Table 5-1 shows available 1960, 1970, and 1980 population figures for the Borough, subareas, and three Census designated places.

Because the socioeconomic impact area includes portions of two Census subareas lying outside designated places, the 1980 population of the impact area can be estimated by summing Census figures for the three designated places within the impact area and estimating the population outside these places. Most of the population within the Seward subarea outside of designated places, which totaled 650 in 1980 (U.S. Dept. of Commerce, Bureau of the Census 1981), lies within the Railbelt area around and to the north of the City of Seward, and therefore within the impact area. A very small percentage of the non-designated place

TABLE 5-1

HISTORICAL POPULATION
KENAI PENINSULA BOROUGH, CENSUS SUBAREAS,
AND CENSUS DESIGNATED PLACES WITHIN
THE SOCIOECONOMIC IMPACT AREA[a/]

Geographical Area	Population 1960	1970	1980	% Change 1960-1970	% Change 1970-80	% Change 1960-80
Kenai Peninsula Borough	--[b/]	16,586	25,282	--	52	--
Kenai-Cook Inlet Subarea	--[b/]	--[b/]	22,473	--	--	--
Cooper Landing	88	31	116	-65	274	32
Moose Pass	136	53	76	-61	43	-44
Seward Subarea	--[b/]	--[b/]	2,809	--	--	--
City of Seward	1,891	1,587	1,843	-16	16	-3
Non-Designated Place Area[c/]	674	533	650	-21	22	-4
Socioeconomic Impact Area Total Rows 3, 4, 6, and 7	2,789	2,204	2,685	-21	22	-4
State of Alaska	226,167	302,583	401,851	34	33	78

a/ From U.S. Dept. Commerce, Bureau of the Census 1981.

b/ Data not available from Census.

c/ Estimated by applying rates of change for designated places in socioeconomic impact areas to 1980 figures.

population of the Kenai-Cook Inlet subarea lies within the impact area. Total 1980 population of the impact area can be estimated by summing the populations of each Census designated place in the impact area and the non-designated place component of the Seward subarea. The results are shown in Table 5-1.

The impact area estimated population of 2,685 (69 percent of which is accounted for by the City of Seward) constitutes only about 0.7 percent of the 1980 population of the State of Alaska. The vast majority of the population in the impact area is white, as indicated by 1980 Census of Population figures for the City of Seward (U.S. Dept of Commerce, Bureau of the Census 1981):

White	1,564
Black	7
American Indian, Eskimo, Aleut	238
Asian and Pacific Islander	16
Other	18
Total Seward Population	1,843

Estimated population change in the socioeconomic impact area between 1960 and 1980 is shown in Table 5-1. While there has been considerable population change within the communities of Moose Pass and Cooper Landing during the past 20 years, the area's overall population during this period experienced little net change. However, from 1970 to 1980 definite population growth is apparent. This growth is reflected in State of Alaska's 1981 population estimate for the City of Seward of 1,943 (Alaska Department of Labor 1981), an increase of 5 percent over the 1980 Census.

The City of Seward supports a fairly large transient population, rising during the summer months and falling off in the winter. Housing vacancies, therefore, are low in summer and moderately high level during winter. There are several motels and hotels in Seward and two motels in the Moose Pass area that supplement available rental housing. However, in the past the lack of housing for year around occupancy by Project workers has caused some large contractors to transport temporary housing facilities to the area (Shaeffermyer 1982). This practice is often the case with Alaska construction projects.

5.1.3 Economic Characteristics

The Alaska Department of Labor, in cooperation with the U.S. Dept. of Labor, compiles employment information according to the Census Divisions, geographical units, used prior to the 1980 Census. The Seward Division comprises an area approximating the socioeconomic impact area shown in Figure 5-1, but extends north along the Seward-Anchorage Highway to Turnagain Arm, Cook Inlet. The majority of its population and labor force reside in or near the City of Seward. Employment figures and statistics for the area, therefore, characterize employment in the impact area.

Table 5-2 shows quarterly employment for broad non-agricultural industrial classifications in the Seward Division for seven quarters in 1979 and 1980. The table indicates that the sectors employing the largest numbers of persons, for which employment data are available, are state and local government, services, retail trade, and the federal government. Governmental offices located in Seward include the city government, Forest Service, National Park Service, and a vocational training center. Important services provided in Seward include two hospitals serving regional needs. Services and retail trade in Seward also support a locally important tourism industry.

Large employment groups are not shown on Table 5-2 due to disclosure rules. In fact the non-reported employment during 1979-80 average 39 percent of total employment, which demonstrates the significance of a small number of large employers. Moreover, these large employers operate on a largely seasonal basis, as evidenced by the significant increase in employment in the not-reported category from 267 in the first quarter of 1979 to 854 in the third quarter of that year.

TABLE 5-2

NON-AGRICULTURAL EMPLOYMENT BY QUARTER
SEWARD DIVISION 1979-1980[a/]

Industrial Classification	1979 Quarter 1st	2nd	3rd	4th	1980 Quarter 1st	2nd	3rd	Seven Quarter Average[c/]
Mining	--[b/]	--	--	--	--	--	--	
Construction	--	70	--	--	--	7	13	30[d/]
Manufacturing	--	--	--	--	--	--	--	
Trans, Commun., & Util.	33	46	63	47	53	51	41	48
Wholesale Trade	--	--	--	--	--	--	--	--
Retail Trade	142	193	215	158	131	154	194	170
Finance, Insurance, Real Est.	13	16	15	14	16	16	18	15
Services	156	176	198	187	200	174	168	180
Fed Gov't	59	74	86	55	47	59	84	66
State & Local Gov't	298	300	301	328	309	317	295	307
Miscellaneous	--	16	--	--	--	12	13	14[d/]
Not Reported	267	600	854	455	472	575	642	527
TOTAL	968	1491	1732	1244	1228	1365	1468	1,357

a/ Alaska Dept. of Labor 1979-1980.

b/ -- Not available due to disclosure rules.

c/ Figure expected to be high estimate due to lack of fourth quarter data.

d/ Average based on incomplete data series.

Unreported employment subsequently dropped to 455 in the fourth quarter. Much of this unreported employment is with two business establishments operating in the City of Seward: Seward Fisheries' fish processing plant and Louisiana-Pacific's Kenai Lumber Company (Dunham 1982).

The economy of the Seward Division and especially the City of Seward depends a great deal on three important transportation facilities: Seward's deep water port, the Alaska Railroad, and the Anchorage-Seward Highway. The deep water port supports a fishing industry and bulk cargo facility linked by the railroad and highway to Anchorage and points north. Seward's port is generally ice free during winter periods when the Port of Anchorage is forced to curtail operations.

Table 5-3 presents average monthly labor force and employment figures for the Seward Division for the period 1975 through 1981 and for 1981. These figures illustrate the highly cyclical nature of employment in the area. Average employment from 1975 to 1981 ranged from 1574 in August to 1130 in January. Unemployment rates fluctuated in a reverse manner, ranging from 7.4 percent in August to 16.1 percent in January.

Historically the labor force level has fluctuated along with employment. Labor force fluctuation is a function of two factors: a transient population in the Seward Division and particularly the City of Seward (Shaeffermyer 1982); and a lessened effort by the unemployed to find work during the winter months, thus removing themselves from being considered members of the labor force. During 1981, however, labor force seasonal variation was less than the 1975-1981 average. The difference between peak and low labor force levels in 1981 was 297, while the 1975-1981 average difference was 355. While several causes may be responsible for the declining difference between peak and low labor force levels, the decline suggests the Seward labor force may be moving toward a lower level of transience and greater seasonal stability and acceptance of seasonal fluctuation in local employment opportunities.

TABLE 5-3

HISTORICAL MONTHLY CIVILIAN LABOR FORCE AND EMPLOYMENT SEWARD DIVISION[a/]

Month	1975-1981 Average Labor Force, No.	1975-1981 Average Employment, No.	1975-1981 Average Unemp. Rate, %	1981 Labor Force, No.	1981 Employment, No.	1981 Unemp. Rate, %
Jan	1347	1130	16.1	1515	1201	20.7
Feb	1408	1195	15.1	1463	1196	18.3
Mar	1425	1224	14.1	1470	1226	16.6
Apr	1557	1344	13.7	1465	1281	12.6
May	1625	1425	12.3	1599	1384	13.4
Jun	1653	1483	10.3	1645	1463	11.1
Jul	1702	1562	8.2	1760	1610	8.5
Aug	1700	1574	7.4	1671	1531	8.4
Sep	1563	1432	8.4	1601	1410	11.9
Oct	1556	1373	11.8	1626	1374	15.5
Nov	1524	1296	15.0	1567	1298	17.2
Dec	1477	1249	15.4	1514	1261	16.7
Average	1545	1357	11.2	1575	1353	14.2

a/ U.S. Dept. of Labor, Bureau of Labor Statistics 1975-1981.

Monthly wage rates for the Seward Division are shown in Table 5-4. These wage data show a pronounced upward trend over time and reveal several sectors in which relatively high wages are paid. The construction sector pays by far the highest wages in the Seward Division, averaging $3,065 per month. At significantly lower levels are state and local government wages at $2,044 per month, transportation, communication, and utilities monthly wages at $1,709, and federal government monthly wages at $1,688. The average wage was $1,405 per month. Wage rates are thought to have increased substantially over these figures in 1981 (Dunham 1982).

5.1.4 Public Policies

Policies of the City of Seward favor economic growth in the vicinity (Shaeffermyer 1982). The city has prepared and is following a land use plan (CH2M Hill 1979) that encourages industrial expansion, emphasizing growth in marine facilities and possible development associated with outer continental shelf exploration and development. The City also strongly endorses assessing the feasibility of constructing the Project. This support is expressed in several Seward City Council resolutions (City of Seward 1980).

5.2 SOCIOECONOMIC TRENDS

Recent population forecasts applicable to the socioeconomic impact area suggest population growth rates varying from less than 1.5 percent to 5.0 percent per year (CH2M Hill 1979; Simpson Usher Jones, Inc. 1979; Kenai Peninsula Borough 1982, R.W. Beck and Associates 1982, Batelle Pacific Northwest Laboratories, 1982). Projected population growth ratios used herein are those of the Battelle Northwest Electric Power Alternatives Study (Battelle Pacific Northwest Laboratories) corresponding to a low economic scenario in the Railbelt as a whole. A population annual average growth rate of 3.49 percent is assumed for the period 1980-1985, 1.59 percent for the years 1985-1990, and 0.75 percent for the years 1900-1995.

TABLE 5-4

AVERAGE MONTHLY WAGES BY QUARTER
SEWARD DIVISION
1979-1980[a/]

Industrial Classification	1979 Quarter 1st	1979 Quarter 2nd	1979 Quarter 3rd	1979 Quarter 4th	1980 Quarter 1st	1980 Quarter 2nd	1980 Quarter 3rd	Average
Mining	--[b/]	--	--	--	--	--	--	--
Construction	--	3547	--	--	--	2775	2893	3065[c/]
Manufacturing	--	--	--	--	--	--	--	--
Trans, Commun., & Util.	2175	1377	1300	1720	1721	1819	1854	1709
Wholesale Trade	--	--	--	--	--	--	--	--
Retail Trade	838	685	866	824	921	893	870	842
Finance, Insurance, Real Est.	1092	963	1057	1037	985	1085	968	1027
Services	917	870	881	933	870	940	1031	920
Fed Gov't	1589	1651	1453	1922	1797	1538	1868	1688
State & Local Gov't	1724	1838	2025	1689	2256	2367	2410	2044
Misc	--	1472	--	--	--	1504	2226	1734[c/]
ALL CLASSIFICATIONS	1277	1251	1458	1288	1403	1557	1599	1405

Wages in Dollars.

a/ Alaska Dept. of Labor 1979-1980.

b/ Not available due to disclosure rules.

c/ Average based on incomplete data series.

The population projection of Table 5-5 suggests a total population growth between 1980 and 1995 for the impact area of 1,996, over two-thirds of which is projected for the City of Seward.

Employment projections prepared for the Kenai Peninsula Borough (Kenai Peninsula Borough 1977) assumed an employment labor participation rate for 1980 of approximately 0.39, growing to between 0.40 and 0.46 by 1992. The intermediate participation rate for 1992 was approximately 0.45. The employment labor participation rate is the proportion of the total population actually employed.

Projected employment for the impact area based on intermediate level, full employment labor participation rates and the population projections of Table 5-5 are given in Table 5-6. As Table 5-6 indicates, projected employment rises from an estimated 1980 level of 1,062 to 1,598 in the year 1995, a net increase of 536. Because this employment projection is based on intermediate growth assumptions involving no growth surge in any one industrial sector, the distribution of employment should, with one exception, continue to approximate that shown in Table 5-2. The exception is the area of marine services, in which employment may rise abruptly as a result of construction of the Fourth of July Industrial Marine Park near Seward. Growth of the Marine Park may bring additional jobs to the Seward area during the early and mid-1980s, possibly resulting in employment and population growth rates exceeding those in Tables 5-5 and 5-6. The City of Seward's municipal and utility services, including water supply, sewage, telephone, schools, police, fire protection, and medical facilities are able to support the higher growth rate (CH2M Hill 1979; City of Seward 1980).

Per capita personal income in the Seward Census Division has risen substantially during the last decade. Nominal, or current dollar, per capita personal income rose from a 1970 figure of $4,299 to $11,408 by 1979 (U.S. Dept. of Commerce, Bureau of Economic Analysis 1982), an

TABLE 5-5

POPULATION PROJECTIONS
SOCIOECONOMIC IMPACT AREA
1980-1995[a/]

Area	Numbers of People 1980	1985	1990	1995
City of Seward	1,843	2,188	2,368	2,458
Moose Pass	76	90	97	101
Cooper Landing	116	138	149	155
Other	650	772	835	967
TOTAL	2,685	3,188	3,449	3,681

a/ Projections assume average annual population growth rate of 3.49 percent for period 1980-1985, 1.59 percent for period 1985-1990, and 0.75 percent for period 1990-1995.

TABLE 5-6

EMPLOYMENT PROJECTIONS
SOCIOECONOMIC IMPACT AREA
1980-1995[a/]

Year	Employment
1980	1,062
1985	1,301
1990	1,497
1995	1,598

a/ Based on Kenai Peninsula Borough 1982.

average annual increase of 11 percent. While this rate of increase is unlikely to be sustained, the area can be expected to enjoy a continued rise in per capita personal income during the next few years. As indicated above, the socioeconomic impact area's population and employment are projected to grow at a moderate rate of economic growth that will support a commensurate rise in personal income.

5.3 PROJECT IMPACT ON LOCAL GOVERNMENTAL, EDUCATIONAL, AND SOCIAL SERVICES

The Project will generate virtually no new permanent employment in the socioeconomic impact area. Employment resulting from the Project will involve construction and be temporary. Impacts on governmental, educational, or social services associated with Project installation will be limited to the construction period.

While some temporary relocation of construction personnel to the Project site or Moose Pass area might occur, most of these personnel should commute from the Seward area. Some of the construction labor force estimated to average about 30 (see Section 5.4) may come from outside the socioeconomic impact area, because many of the major development projects in Alaska are carried out by companies and personnel based outside the development area (Dunham 1982). If any new facilities are needed in the vicinity of the Project site to support temporary construction workers, they will be provided by either the construction contractor or by the workers. Workers temporarily relocating to the Seward area can be accommodated by existing services. Local governmental services and utilities in the Seward vicinity are well equipped and accustomed to supporting temporary construction activities and personnel.

The school district in the socioeconomic impact area includes the entire Kenai Peninsula Borough. Elementary children living near Moose Pass attend school at Moose Pass Elementary School through the eighth grade, then commute to Seward for high school. In 1981 enrollment at

Moose Pass Elementary School was 34, while Seward elementary and high school enrollment totalled 448. Total school district enrollment was 6,037 (Kenai Peninsula Borough School District [No Date]). Any increase in school enrollment attributable to Project construction will therefore have a relatively minor effect on the school system.

Construction vehicle traffic, including heavy equipment and worker vehicles, on State Highway 9 between Seward and Moose Pass will increase highway wear, disrupt traffic, and inconvenience local residents. A cooperative agreement between the Alaska Power Authority and the Alaska Department of Transportation and Public Facilities should accommodate any maintenance problems on state roads.

5.4 PROJECT CONSTRUCTION EMPLOYMENT AND PAYROLLS

The construction period for the Project is estimated to be approximately 24 months. Construction will begin with clearing and building access roads, followed by tunneling activities for the power conduit. In April and May of the first year of construction, work on the transmission line, powerhouse, and tailrace will begin. Work on these facilities will continue at an intensive level into September, at which time the lake tap, tunnel, transmission line, and access roads will be completed. By December of the first year work will begin on the installation of electrical and mechanical components. Startup will take place in May of the second year.

The average labor force on the job during the 24 month construction period will number approximately 30 or approximately 2 percent of the area's labor force, but only about half that number will work during the winter months (November through March). Skills required of the construction labor force include heavy equipment operation, drilling, welding, iron working, concrete finishing, and electrical and mechanical work. Employment will peak at perhaps 50 workers during the summer of the second year of construction.

A conservative estimate of the total construction payroll in 1980 dollars using the average construction wage rates in the Seward Census Division is $1.84 million, or approximately $77,000 per month. This estimate assumes an average monthly wage of $3,065 (see Table 5-4), an average work force of 30, except during the winter months, and a construction period of 24 months. This would represent an increase in income to the socioeconomic impact area of approximately 3 percent over the 24 month construction period ($1.84 million/$11,000 est. per capita income in 1979 x 2685 est. 1980 population). Inflationary pressures, higher salaries for supervisory personnel, and competition for trained construction labor with other major construction projects in Alaska may push the total Project payroll higher than this estimate, but chronically high unemployment rates in the socioeconomic impact area would tend to reduce these pressures to some extent.

5.5 CONSTRUCTION PERSONNEL

The construction labor force is expected to come principally from the socioeconomic impact area, mainly Seward, with some additional construction workers from Anchorage and the western Kenai Peninsula. Although the average total construction employment in the Seward Census Division in 1979 and 1980 was only 30, the Seward area labor force possesses a relatively large proportion of workers with construction skills (Dunham 1982). Construction personnel will probably commute to the Project construction site, possibly by contractor bus from a central point in Seward. Since the construction skills needed to build the Project will be available primarily in the metropolitan Seward area or from outside the socioeconomic impact area, a relatively small percentage of the Project construction labor force is expected to come from nearby communities such as Moose Pass and Cooper Landing.

The capability of the Seward area to provide most of the construction labor force is supported by the decline in construction employment in the Seward area during the last few years and a rising unemployment rate in the Seward area. Unemployment rose to 14.2 percent of the labor force in 1981 (see Table 5-5). However, the number of local workers who will be employed in constructing the Project will also depend largely on the policies of the construction firm.

5.6 HOUSING AVAILABILITY FOR TEMPORARY AND PERMANENT NEW EMPLOYMENT

In 1980 the number of housing units in the Seward Census subarea totaled 1,186 (U.S. Dept. of Commerce, Bureau of Census 1981), of which 777 were located within the City of Seward. Housing in the vicinity of Seward, along with two motels in and near Moose Pass, can be expected to provide most of the housing accommodations for Project construction workers.

Temporary construction workers will be able to draw upon approximately 250 apartment units in Seward (Kenai Peninsula Borough 1982) as well as a limited number of motels and hotels located in Seward and near Moose Pass. Although some new housing is planned in Seward, recent trends suggest that the number of housing units there will rise insignificantly in the near future. Only two new single family housing units were authorized each in year 1980 and 1981. In 1979, 50 new housing units (46 of which were multiple family) were authorized for construction (Kenai Peninsula Borough 1982). However, construction of the Fourth of July Creek Industrial Marine Park is expected to stimulate some new housing demand (Gillespie 1982).

Rental vacancies in the Seward vicinity are cyclical, ranging from about seven percent in the winter to near zero in the summer (Gillespie 1982). This cyclical demand reflects the seasonal variation in several important employment sectors described above in Section 5.1, and the demand for rental housing associated with recreational pursuits in the socioeconomic impact area.

While there may be some competition for rental housing between new temporary employment associated with Project construction and other transient workers and recreationists, the combination of a relatively large stock of rental housing units and small anticipated new temporary Project construction work force should minimize the severity of such competition. Further reducing competition for rental housing will be the common occurrence of recreational demand for housing units on weekends and the occurrence of worker demand for rental units during weekdays.

Virtually no new permanent employment is expected to result from operation of the Project. The Project will be automated to operate without a large full-time staff, and maintenance of the Project will be a part time activity. Maintenance of recreational facilities is expected to be carried out by the Forest Service on a cooperative basis. The Project is therefore not expected to produce any permanent effect on the region's housing.

5.7 RESIDENCES AND BUSINESSES DISPLACED BY THE PROJECT

The Project will be constructed entirely on undeveloped federally-owned lands having few improvements. Moreover, since the Project will not result in a raised water level in Grant Lake, no business or temporary or permanent residence will be displaced.

5.8 LOCAL GOVERNMENTAL FISCAL EFFECTS

Construction and operation of the Project will produce a relatively small impact on schools and local governmental, educational, and social services. The school system and local services are adequate to address any such impacts without expansion or adverse effect.

The Project will produce virtually no direct positive local fiscal impacts because the Project's construction and operation will be exempt from local sales and property taxes (Lahnum 1982). Some positive indirect impacts will develop as a result of increased local spending of wages and the consequent positive impact on local sales taxes. The Kenai Peninsula Borough levies a two percent sales tax while the city of Seward collects an additional one percent tax on retail sales. Total local sales tax benefits will not, however, amount to more than a few thousand dollars.

5.9 SUMMARY OF AGENCY CONTACTS

The following is a summary of pertinent Agency contacts made in support of this report. Correspondence between the Alaska Power Authority and various agencies is included in the Technical Appendix, Part VIII.

Alaska Department of Community and Regional Affairs

1) Date: January 19, 1982
   Agency Representative: Gene Kane (Anchorage)
   Location: (Telephone conversation)
   Subject: Availability of data on community socioeconomic characteristics for Grant Lake vicinity

2) Date: June 22, 1982
   Agency Representative: Gene Kane
   Location: Anchorage, Alaska
   Subject: Acquisition of data on forecasts of socioeconomic characteristics in Project vicinity

Alaska Department of Labor

1) Date: January 19, 1982
   Agency Representative: Willard Dunham (Seward)
   Location: (Telephone conversation)
   Subject: Characteristics of labor force and source of labor data for Seward and vicinity

Kenai Peninsula Borough

1) Date: June 18, 1982

Agency Representative: Carolyn Thompson and Jeff LaBahn

Location: Soldotna, Alaska

Subject: Land ownership and state and Borough withdrawal plans for Project vicinity

City of Seward

1) Date: January 18, 1982

Agency Representative: Darryl Shaeffermyer, Assistant City Manager

Location: (Telephone conversation)

Subject: Potential sources of Grant Lake Project construction labor and probable area affected by Project construction

2) Date: June 17, 1982

Agency Representative: Darryl Shaeffermyer and Kerry Martin

Location: Seward, Alaska

Subject: Acquisition of data on local socioeconomic conditions and characteristics

6.0 REPORT ON GEOLOGICAL AND SOIL RESOURCES

This chapter presents the results of extensive geological and soils surveys conducted in the Project vicinity and site-specific investigations conducted for Project planning and design. In addition to describing regional and Project site geology and soils, this chapter identifies potential geologic hazards, the potential Project impacts on geologic conditions, and the need for mitigating such potential impacts.

6.1 GEOLOGY AND SOILS

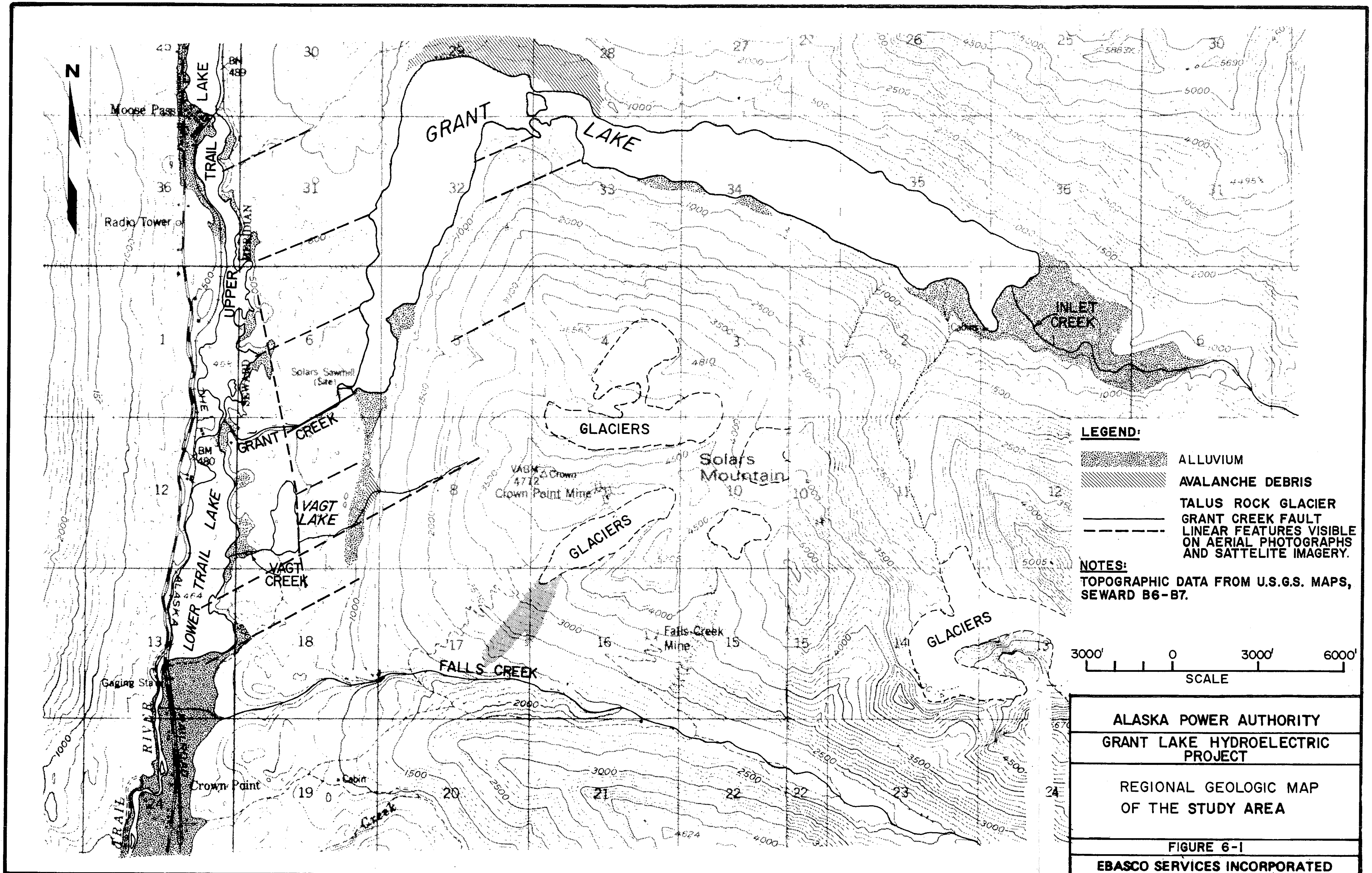
The geologic study area for the Grant Lake Hydroelectric Project is defined as the area within about 10 miles of the Project site, and for the specific sites on which Project facilities will be located.

6.1.1 Regional Geology

The morphology of the study area is typical of sub-arctic, glaciated terrains. Broad U-shaped valleys dissect the mountain ranges and form lowlands with lakes, ponds, and streams (Figure 6-1). Elevations in the study area range from 470 ft above mean sea level (MSL) at Upper Trail Lake to over 5000 ft in the adjacent mountains. Much of the region was stripped clean by the movement of glaciers, leaving bedrock exposed over large areas.

Within the mountainous areas, topography is rugged and slopes typically steep. Hanging valleys are common. Small glaciers occur at the head of most major valleys.

Lowland areas are typically elongated with varying amounts of alluvial infilling. Some of the east-west trending valleys, notably the Grant Lake and Kenai Lake valleys, have nearly right-angle bends where they intersect the major north-south trending lowlands. This morphology reflects diversion of side glaciers at their intersection with the major southward moving glaciers.


N
GRANT LAKE
Moose Pass
TRAIL LAKE
UPPER TRAIL LAKE
LOWER TRAIL LAKE
Radio Tower
SEWARD MERIDIAN
Solars Sawmill (Site)
GRANT CREEK
VAGT LAKE
VAGT CREEK
INLET CREEK
GLACIERS
Solars Mountain
VABM 4772 Crown
Crown Point Mine
Falls Creek Mine
FALLS CREEK
Gaging Sta.
TRAIL RIVER
Crown Point
Cabin
ALASKA
BM 480
BM 489
LEGEND:
ALLUVIUM
AVALANCHE DEBRIS
TALUS ROCK GLACIER
GRANT CREEK FAULT
LINEAR FEATURES VISIBLE ON AERIAL PHOTOGRAPHS AND SATTELITE IMAGERY.
NOTES:
TOPOGRAPHIC DATA FROM U.S.G.S. MAPS, SEWARD B6-B7.
3000' 0 3000' 6000'
SCALE
ALASKA POWER AUTHORITY
GRANT LAKE HYDROELECTRIC PROJECT
REGIONAL GEOLOGIC MAP OF THE STUDY AREA
FIGURE 6-1
EBASCO SERVICES INCORPORATED

Streams are common within the lowland areas, as are lakes and ponds. In several areas elongated ridges of relatively low relief form foothills to the major mountain peaks. One such ridge forms the area between Grant Lake and Upper Trail Lake. These bedrock ridges parallel the trend of the adjacent valley. Small bogs, formed in bedrock depressions resulting from glacial scour, are common on the ridge tops. Many bogs are elongated in the direction of glacial flow.

The bedrock in the study area is a complex assortment of metamorphosed sandstones, siltstones, and mudstone with some fine-grained volcanic units (Tysdal and Case 1979). Extensive glacial deposits are absent. Minor glacial till deposits may exist at the base of some of the bogs and lakes, and within some of the coves along Upper and Lower Trail lakes.

Unconsolidated surficial deposits are relatively rare in the study area (Figure 6-1). Alluvium is found at the head of Grant Lake, in the area between Lower Trail Lake and Kenai Lake, within a few of the coves around the Trail Lakes, and within the small bogs found in the low, bedrock ridges flanking the Trail Lakes valley. These deposits are typically mixtures of silt, sand, and gravel. Minor sand and gravel deposits are also found at the mouth of Grant Creek and Falls Creek.

Poorly sorted mixtures of cobbles, gravel, sand, and silt occur at the base of the major avalanche chutes and are the result of transport by snow avalanches during the winter and spring. These deposits are local and not extensive.

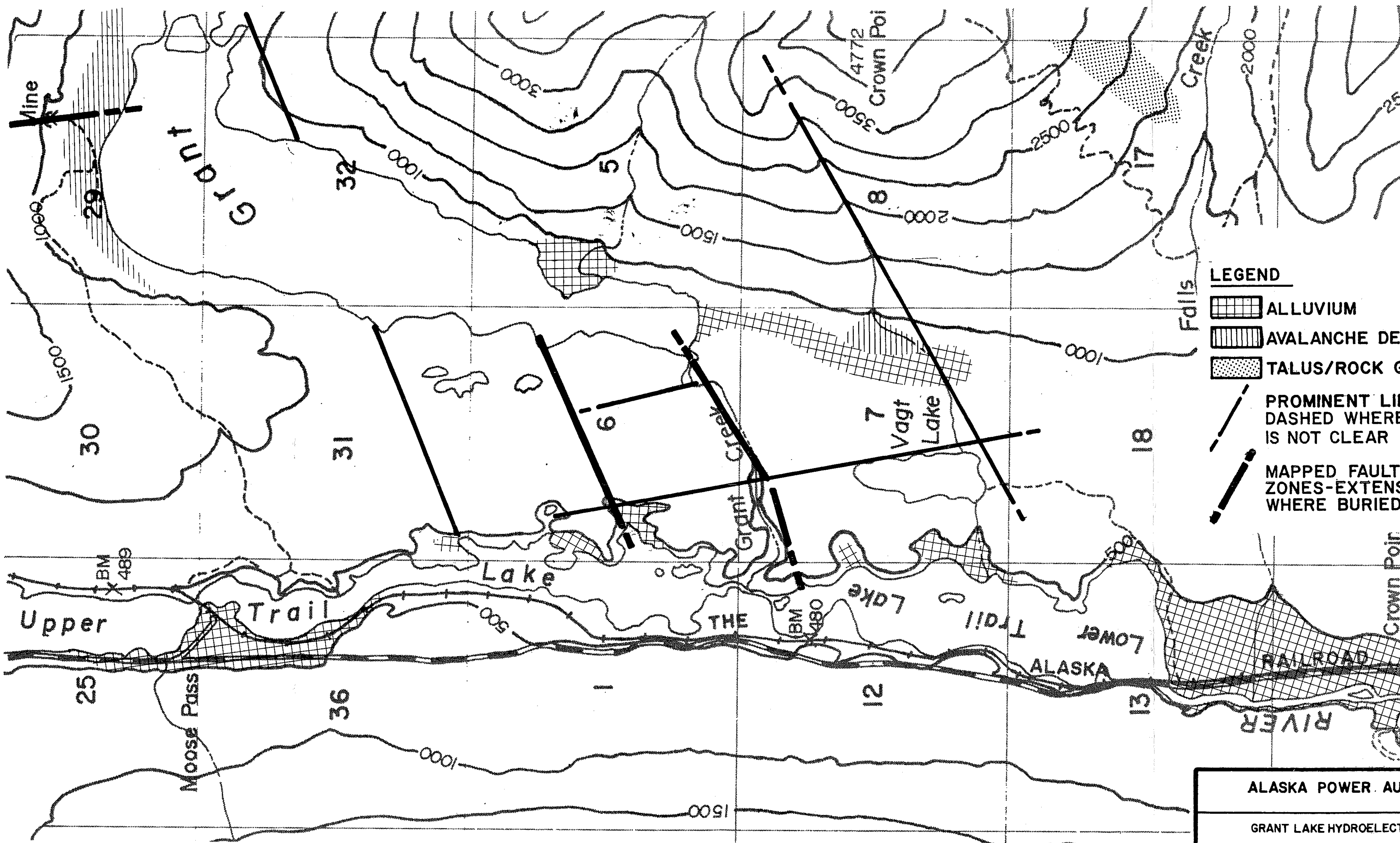
Talus deposits are rare in the study area, despite the steep slopes. The one exception is in the area between Falls Creek and Solars Mountain. In this area, large talus slopes of angular sandstone boulders and cobbles extend from the small cirque at the top of the mountain down the steep slopes into Falls Creek. The lobate morphology of the deposits suggests that they constitute a rock glacier.

The complex deformational history of the bedrock in the study area has resulted in a large number of structural features. The primary foliation in the bedrock is parallel to bedding. Most units strike approximately north 5 degrees east (N05E) and dip 45 to 55 degrees to the east. Joints are common throughout the area. Joint orientations vary widely, although there are minor maxima oriented north-south (NS) to NE-SW dipping between 50 and 90 degrees to the south or southeast.

Minor faults and fracture zones were discovered in several areas. Two fracture directions are dominant. One set trends NE and the other N-NW. Both sets are evident on aerial photographs and satellite images due to differential erosion (Figure 6-2). Grant Creek follows the most obvious of these NE trending features, which has been named the Grant Creek Fault. Other NE trending fractures are evident as discontinuous linear features.

The Trail Lakes valley is a long, north-trending valley that extends from the town of Seward northward to Upper Trail Lake. It has been called the "Kenai Lineament" since it is obvious on satellite imagery as a long, linear feature. The trend of the valley is nearly parallel to the N-NW fault, and the Kenai Lineament may represent one of these fault zones that was extensively eroded during the glacial period. It is unlikely that the Kenai Lineament represents a major, active fault. More likely it is a glacial valley whose orientation and location followed the N-NW trend of the minor fault set observed in other areas.

Several areas within the study area have been mined for gold. There are three small-scale mines in the study area. The Case Mine is just north of the main bend in Grant Lake. It consists of several hundred feet of adits following quartz veins. Although not currently active, the present owners are planning additional test adits along the trace of the shear zone. The Crown Point Mine also consists of adits, and is located near the top of the peak between Grant Lake and Falls Creek. Although not currently active, the Crown Point Mine was once a successful gold mining operation. The third mining operation is a



ALASKA POWER AUTHORITY

GRANT LAKE HYDROELECTRIC PROJECT

GEOLOGIC FEATURES OF STUDY AREA

FIGURE 6-2

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placer mine at the outlet of Falls Creek. The operation currently consists of several small dozers and sluices. Farther up Falls Creek, several mining claims exist, as well as the Old Falls Creek Mine. The extent of workings in this area is unknown.

The Case Mine, Crown Point Mine, Old Falls Creek Mine and claims on the upper part of Falls Creek probably all lie on a series N-NW trending shear zones that have been the locus of mineralization. The intersections of these shear zones and Falls Creek are the probable source of the gold that is being recovered in the placer operation at the base of Falls Creek.

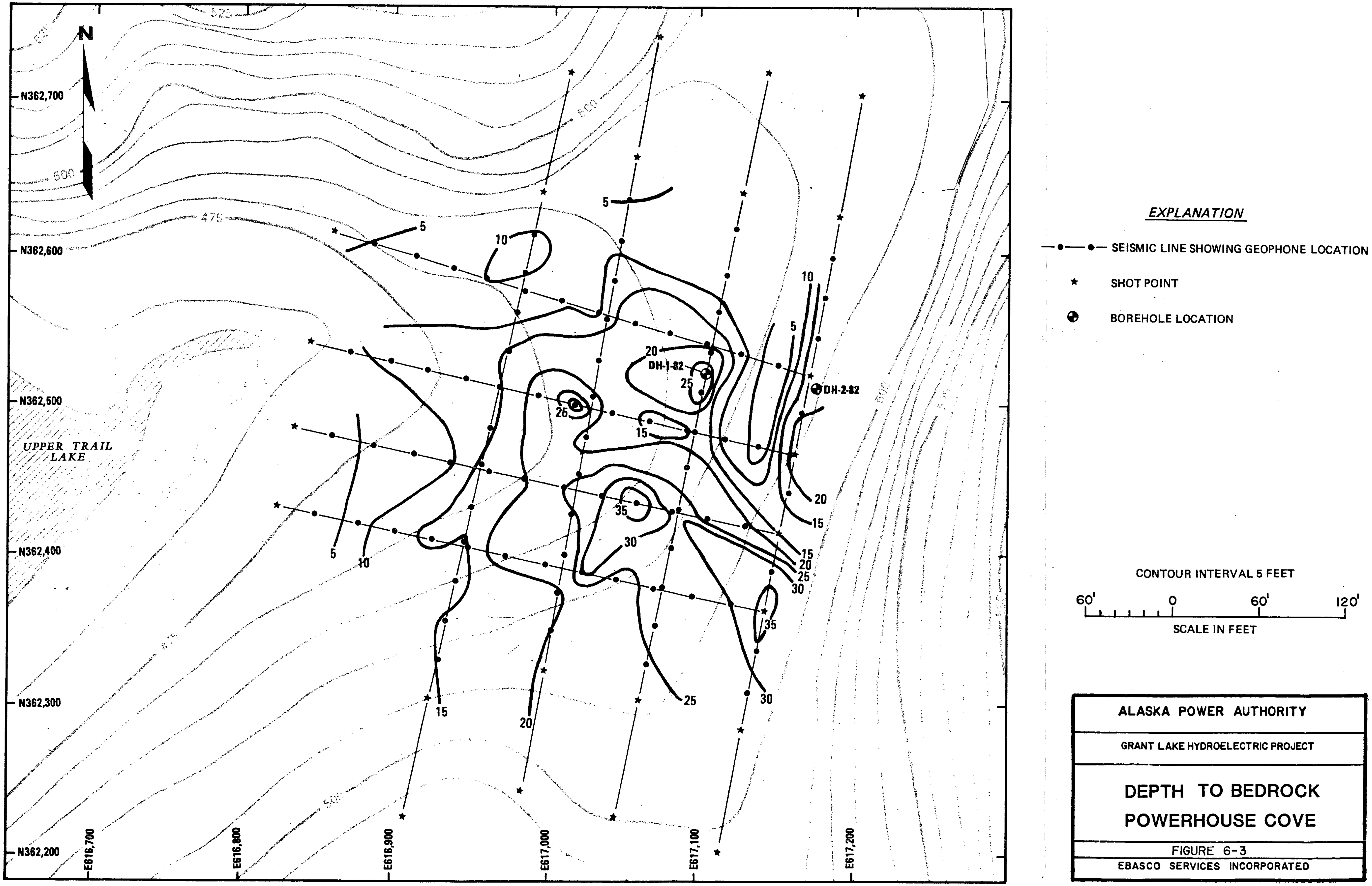
No other zones of mineralization have been identified in the study area. The field investigations and exploratory borings identified no area or zone with mineralization of potential economic value.

In addition to mineralized zones, other mineral resources include sand and gravel deposits and sites for rock quarries. The major sand and gravel operation is in a stream bed just north of Seward. No major rock quarries were found, although numerous small quarries were used as local sources of road and railbed materials.

6.1.2 Site Geology

6.1.2.1 Powerhouse Cove

The powerhouse site is within a small, elongated valley roughly 1000 ft long and 500 ft wide at the proposed powerhouse site (Figure 6-3). The valley lies within a bedrock depression formed by glacial erosion, and is adjacent to and drains into Upper Trail Lake. Elevations within the valley range from the water line of Upper Trail Lake (about 470 ft above MSL) to 500 ft above MSL along its eastern margin.



ALASKA POWER AUTHORITY

GRANT LAKE HYDROELECTRIC PROJECT

DEPTH TO BEDROCK
POWERHOUSE COVE

FIGURE 6-3

EBASCO SERVICES INCORPORATED

The bedrock within the powerhouse valley is similar to that outcropping throughout the area. Two exploratory borings indicate the presence of massively bedded greywacke with some interbedded slate and thinner greywacke beds.

Seismic refraction profiles within the valley indicate a layer of sedimentary infilling averaging 5 to 25 ft in thickness, with locally higher thicknesses over bedrock lows (Figure 6-3). The two exploratory borings penetrated 28 ft (DH-1) and 18 ft (DH-2) of soils ranging from sand and silt near the surface to poorly sorted mixtures of cobbles, gravel, sand, and silt at depth. The lower materials may represent glacial till or outwash, while the upper material is probably younger stream or lake bed sediment. None of the material is consolidated.

No direct observations of geologic structure could be made due to the overlying thickness of overburden. Data from the borings and outcrops surrounding the valley suggest that the bedding within the bedrock strikes to the north and dips at 45-55 degrees to the east, paralleling the regional trend. Joints observed in the two exploratory borings dipped between 45 and 80 degrees.

Analysis of aerial photos, satellite imagery and topographic maps indicate a long linear feature trending N-NW from the eastern side of Vagt Lake along the eastern side of the powerhouse valley, and possibly extending several thousand feet to the north. The linear feature represents a steep cliff face that forms the eastern shore of Vagt Lake and the eastern boundary of the powerhouse valley. Ground and aerial investigations of this feature along its length revealed no positive evidence of fault control, although it is likely that it is an old fault. Its present topographic expression is the result of differential erosion during glacial advances, rather than movement.

6.1.2.2 Power Tunnel and Intake

The power tunnel and intake would be completely within the bedrock that forms the ridge between Grant and Upper Trail lakes. The rocks are typical of the bedrock throughout the area, and are composed of metamorphosed sedimentary rocks of the Valdez Group. The predominant rock types are greywacke, slate, and mixtures of the two. Field investigations and exploratory borings indicate that the greywacke is an extremely hard and dense metamorphosed sandstone of varying composition.

Bedding along the tunnel alignment parallels the regional trend. Most units strike to the north, and dip 45 to 55 degrees east. Joints are common throughout the area, although their orientations vary widely.

Minor shear zones were encountered in the exploratory borings along the tunnel alignment. Most shear zones have been completely healed with calcite or quartz infilling. In addition to the minor shear zones encountered in the exploratory borings, analysis of topography and aerial photographs indicates several N-NW trending linear features crossing the tunnel alignment. It is likely that these linear features mark the trend of minor faults.

The single exploratory boring in the intake area revealed two open and weathered shear zones that parallel the bedding orientation. These two zones are interpreted as bedding-plane failure surfaces, resulting from movement of slabs of massive greywacke. The occurrence of these zones would be expected where the dipping beds face the shore of Grant Lake.

6.2 GEOLOGIC HAZARDS

6.2.1 Seismicity

Seismic hazards include vibratory ground motion, ground rupture, seismically-induced slope failure, seiche, and liquefaction. The potential occurrence of each of these hazards is discussed below.

6.2.1.1 Vibratory Ground Motion

Deterministic analysis of the sources of earthquakes, their distance from the Project site, and the potential accelerations at the site indicate that the mega-thrust zone beneath southern Alaska and the random crustal event are the primary sources of seismic hazard for the Project. Random crustal events are then considered "floating" and potentially could occur anywhere. For calculation purposes, the random crustal event is considered directly beneath the Project site.

Table 6-1 is a compilation of all the known sources of earthquakes that are close enough to the Project site to have significant impact. The maximum credible earthquake (MCE) has been calculated for each structure. The MCE for the random crustal event was chosen as magnitude 6.0, a conservative upgrade from the maximum recorded magnitude of 5.5. The peak acceleration value for each potential earthquake source was calculated using the most recent, accepted techniques. As indicated on Table 6-1, the maximum calculated acceleration at the Project site is 0.40 gravity (g) from the random crustal event and 0.37 g from the 1964-type Aleutian Arc megathrust.

Return periods for these maximum events were estimated using historical and instrumental earthquake data. Based on the estimated return periods and the time since the last major event, the likelihood of such events was estimated for the life of the Project. The likelihood of another 1964-type event on the megathrust is low for the life of the Project because the return period exceeds 160 years. The likelihood of a large random crustal event is moderate to high, with a recurrence interval of 50 to 100 years. However, the location of this event could be anywhere, so that the probability of such an event occurring at the Project site is actually quite low.

TABLE 6.1
CHARACTERISTICS OF SEISMIC SOURCES

Source	Type of Fault	Distance from Project Site	Fault Length	Estimated Rupture Length	Historical Seismicity	Displacement of Recent Sediments	MCE*	Minimum Distance to Epicenter	Estimated Depth to Focus	Peak** Acceleration in G's: 50 Percentile Value	Estimated Return Period	Estimated Likelihood of Event Within Next 100 Years
Random Crustal Event	—	3 km	—	—	Seismic activity up to magnitude 5.5	None	3) 6.0	0 km	3 km	4) 0.36 5) 0.40	50 to 100 years	Moderate to High
Aleutian Trench-Arc Megathrust (Main Thrust)	Megathrust	30 to 35 km	2,000 km	500 km	Very high magnitude 8.4 in 1964	Trace not visible but associated offset in 1964	1) 8.5 2) 8.7	0 km	30 to 35 km	4) 0.36 5) 0.37	160 to 300 years	Moderate to Low
Benioff Zone	Megathrust	71 km	—	—	Associated seismicity up to 7.5	None	3) 7.5	60 km	40 km	4) 0.06 5) 0.01	100 years	Moderate to High
Castle Mountain - Caribou Fault	Oblique Strike-slip	127 km	200 km	120 km	Associated seismicity up to magnitude 7.0	Offset Holocene sediments	1) 7.4 2) 7.4	127 km	15 km	4) 0.03 5) 0.01	Not determined	Moderate to Low
Bruin Bay Fault	Reverse	125 km	300 km	140 km	Associated seismicity up to magnitude 7.3	None	1) 7.4	125 km	15 km	2) 0.03 5) 0.01	Not determined	Moderate to Low
Knik-Border Ranges Fault	Reverse	48 km	1,700 km	120 km	None	Offset late glacial moraines	1) 7.5	48 km	15 km	4) 0.11 5) 0.01	Not determined	Low
Johnstone Bay Fault	Normal (?)	67 km	20 to 70 km	10 km	None	Scarp in Holocene talus	1) 6.4 2) 6.0	67 km	15 km	4) 0.04 5) 0.01	Not determined	Low
Hanning Bay Fault	Reverse	108 km	6 km	6 km	Active during/following the 1964 earthquake	Offset during the 1964 earthquake	1) 4.8 2) 5.4	108 km	10 km	4) 0.01 5) 0.01	Not determined	Moderate to Low
Patton Bay Fault	Reverse	118 km	500 km	62 km	Active during/following the 1964 earthquake	Offset during the 1964 earthquake	1) 6.1 2) 6.9	118 km	10 km	4) 0.02 5) 0.01	Not determined	Moderate to Low
Volcanic	—	188 km	—	—	Seismic Activity up to magnitude 5.5	None	1) 5.75	188 km	15 km	4) 0.01 5) 0.01	Not determined	Moderate to Low
Denali Fault Yaktaga & Shumigan Seismic Gaps	Strike-slip and Megathrust	255 to 300 km	1,000 to 2,000 km	400 to 500 km	High to low recent activity; Very high historic seismicity 7. to 8.+	Offset Holocene sediments	1) 8.6	280 km	15 to 40 km	4) 0.01 5) 0.01	80 to 200 years	High

* *Calculation methods used as indicated by the number*
1) MCE calculations based primarily on Slemmons (1977) using estimated rupture length instead of total length where appropriate.
2) MCE calculation based on Wyss (1980).
3) Based on the instrument recorded seismicity.

** *Ground Motion Parameters from the following sources:*
1. Page et. al., 1972
2. Krinitzsky, 1978; 80% of observed data limit
3. Bolt, 1973
4. 50 percentile value, Joyner & Boore, 1981
5. 50 percentile value, Campbell, 1981

The Campbell farfield alternative d value was used for distances over 50 km.
The Joyner & Boore equations were used for 8.0+ events without modification.

Source: Grant Lake Hydroelectric Project
Interim Geological Report
Prepared by R & M Consultants, Inc., January 1982

6.2.1.2 Ground Rupture

Ground rupture is associated with the movement of active fault zones. There are no known active faults crossing the Project features. No seismic events have been associated with known structures around the site, and no geologic data have been found to suggest the presence of active faulting. Ground rupture, therefore, is not considered a hazard for the Project.

6.2.1.3 Seismically Induced Slope Failure

One of the most common features associated with moderate to large magnitude earthquakes is slope failure. Triggered by ground motion, naturally unstable slopes can fail. Slope failures can be broadly classified into landslides, rockfalls, avalanches, and slab or tumbling failures of rock faces.

There is little material in the study area that would be susceptible to landsliding during seismic events. No evidence was found in the major landslides or their deposits, although some minor landslide debris was noted uphill from the intake area.

Rockfalls from the steep cliffs could occur during seismic shaking. Some evidence of minor rockfalls has been found in the study area, although the triggering mechanism is unknown. The cliff on the eastern side of the powerhouse valley is a potential source of rockfalls. The design of the Project and slope treatments will address this possibility.

Seismically induced avalanches could occur in the mountains above the Project. The topography around the Project facilities themselves suggests no hazard from avalanche. The effects of large landslides, rockfalls, or avalanches around the shore of Grant and Trail lakes are discussed below.

Slab or tumbling failure of rock faces during seismic events is common in areas of unstable rock slopes. The western shore of Grant Lake is particularly susceptible to such failures, as the slopes are steeply dipping slopes of bedrock. Data from the exploratory boring in the Project intake area suggest that bedding-plane slides have already occurred. The design of the Project and cut slopes will address the problem of potentially unstable slopes in the intake and gate shaft area.

6.2.1.4 Seiche

Seiches are waves in lakes that are formed by the sloshing of water back and forth as the result of ground shaking during seismic events or the catastrophic inflow of material by slope failures around the lake's rim. There are several areas surrounding Grant Lake that could be sources of earth or avalanche material for mass movements into Grant Lake, which could generate seiche waves. However, field work did not reveal any areas along the shoreline of Grant Lake where wave damage above normal high water levels was noted. This observation suggests that significant wave run-up did not occur during the 1964 earthquake. Further, the volumes of material that could enter Grant Lake are probably not sufficient to generate very large seiche waves.

Investigations around Lower and Upper Trail Lakes indicate that the surrounding topography coupled with the shallowness of the lakes themselves present significantly less hazard from seiche. There are also no areas of material that could generate large waves by mass movement into the lakes. The present design of the Project indicates that it will not be susceptible to damage by seiches that might be expected to occur in Grant or Trail Lakes.

6.2.1.5 Liquefaction

Liquefaction is the failure of loose, water-saturated sediments under seismic ground shaking. However, major Project features would be placed on or in bedrock, so no liquefaction problem will exist.

6.2.2 Seepage

The groundwater table along most of the tunnel alignment is at or near the ground surface. Bedrock permeabilities are very low so that seepage problems will only occur at the intersection of the tunnel with open joints or fractures. Seepage problems during construction are not anticipated to be severe. Tunnel design (small diameter with shotcrete lining) will be such that seepage will be minor and unimportant during Project operation.

6.2.3 Subsidence

There are no Project facilities located in areas susceptible to subsidence. Although large areas of southwestern Alaska either uplifted or subsided during the 1964 earthquake, such large scale changes would have had no impact on the Project.

6.2.4 Mining

Although there are several active and inactive mines around Grant and Trail lakes, none of these mining activities are near the Project site. No exploratory shafts or old mines exist near the Project.

6.2.5 Mass Movement

Mass movements or slope failures, including landslides, rockfalls, avalanches, and slab failure, were discussed above as possible results of seismic activity. The rock cliffs overlooking the powerhouse valley could be the source of small rockfalls, triggered either by seismic activity or seasonal freeze-thaw. Examination of the many cliffs in the area, however, suggests a high degree of stability. No potential landslide material exists around the powerhouse valley or the tunnel alignment.

Avalanche chutes are common along the steep slopes in the mountains around Grant Lake and Trail Lakes. Little evidence of avalanche was found on the ridge between Grant and Trail Lakes, indicating little direct hazard to Project facilities in these areas.

The intake area on the western shore of Grant Lake faces the greatest hazard from unstable slopes, primarily due to the steeply dipping slopes of bedrock. Evidence of bedding plane failures was discovered in the exploratory boring in the intake area, and field mapping data suggest episodes of land and rock sliding uphill from the shore. This situation is common along the entire western shore of Grant Lake due to the steep topography and the attitude of the bedding. Appropriate measures, such as rock bolting and installation of lateral drains, will be taken to ensure safety of the gate shaft and intake area.

6.2.6 Erosion

The lack of significant soil cover or alluvial deposits indicates that erosion would be a minimal problem during construction and operation of the Project.

6.2.7 Hazards Induced by Reservoir Fluctuation

6.2.7.1 Slope Failure

The operational water level fluctuation of Grant Lake could trigger slope failures, especially along the north shore of the lake where large lobes of avalanche deposits exist. Failures are not expected to be large or hazardous to safe Project operation.

6.2.7.2 Reservoir-Induced Seismicity

In many areas of the world, filling of reservoirs or large fluctuations in lake or reservoir levels trigger small to medium magnitude earthquakes. It is critical to understand, however, that the water pressure changes merely act as triggers for these events, and do not actually cause stress build-up in the rocks. The bedrock materials must already be stressed and prone to earthquake activity if reservoir-induced seismicity is to occur. Grant Lake is an existing reservoir that has already experienced a variety of changing stresses to reach its present state. Little, if any, reservoir-induced seismicity is expected during Project operation. Any shocks that might occur would likely be of small magnitude, especially compared to the general earthquake potential for the area. Therefore, this type of earthquake generation will present no hazard to the Project or surrounding areas.

6.3 POTENTIAL IMPACTS

The Grant Lake Hydroelectric Project would be a small scale power generating facility. The impacts of the Project would be small, and mitigation measures can be designed to minimize impacts both during construction and operation. Geologic impacts center primarily around erosion, slope failure, and disposal and use of excavated materials.

Primary impacts during construction would revolve around the movement and operation of personnel and equipment required to construct the Project, and handling of waste rock from the powerhouse site and the tunnel. Because the tunnel's diameter is small and the tunnel less than 3000 ft long, the volume of excavated rock, approximately 10,000 cubic yards, would not be a major problem. Furthermore, much of the rock excavated from the tunnel and the powerhouse foundation could provide an excellent source of material for construction of tailraces, the powerhouse, and associated structures. Residual material could be removed from the site and used elsewhere as rockfill or disposed of with no adverse impacts.

Excavations in the powerhouse cove will require removal of some of the sedimentary valley fill. Standard techniques would be used to prevent silt movement into Trail Lake; these include drainage ditches, retaining structures and settling ponds. As a result, the impacts of construction of the Project would be minimal.

None of the planned construction activities would likely cause slope failure around the Project site. Project design would include stabilization of the natural slopes, especially in the intake area.

Operation of the powerhouse would unlikely have any detrimental impacts in terms of erosion or slope failure.

6.4 MITIGATION OF IMPACTS

No extraordinary mitigation measures would be anticipated during construction or operation of the Project. Normal erosion control measures would be sufficient to control the minimal erosion expected during construction. Rapid recovery of the vegetation after construction is completed will finish the erosion control program.

The Project would leave no slopes more unstable than at present, and in both the intake and powerhouse areas slope stabilization measures would be undertaken to ensure safe construction and operation of the Project.

7.0 REPORT ON RECREATIONAL RESOURCES

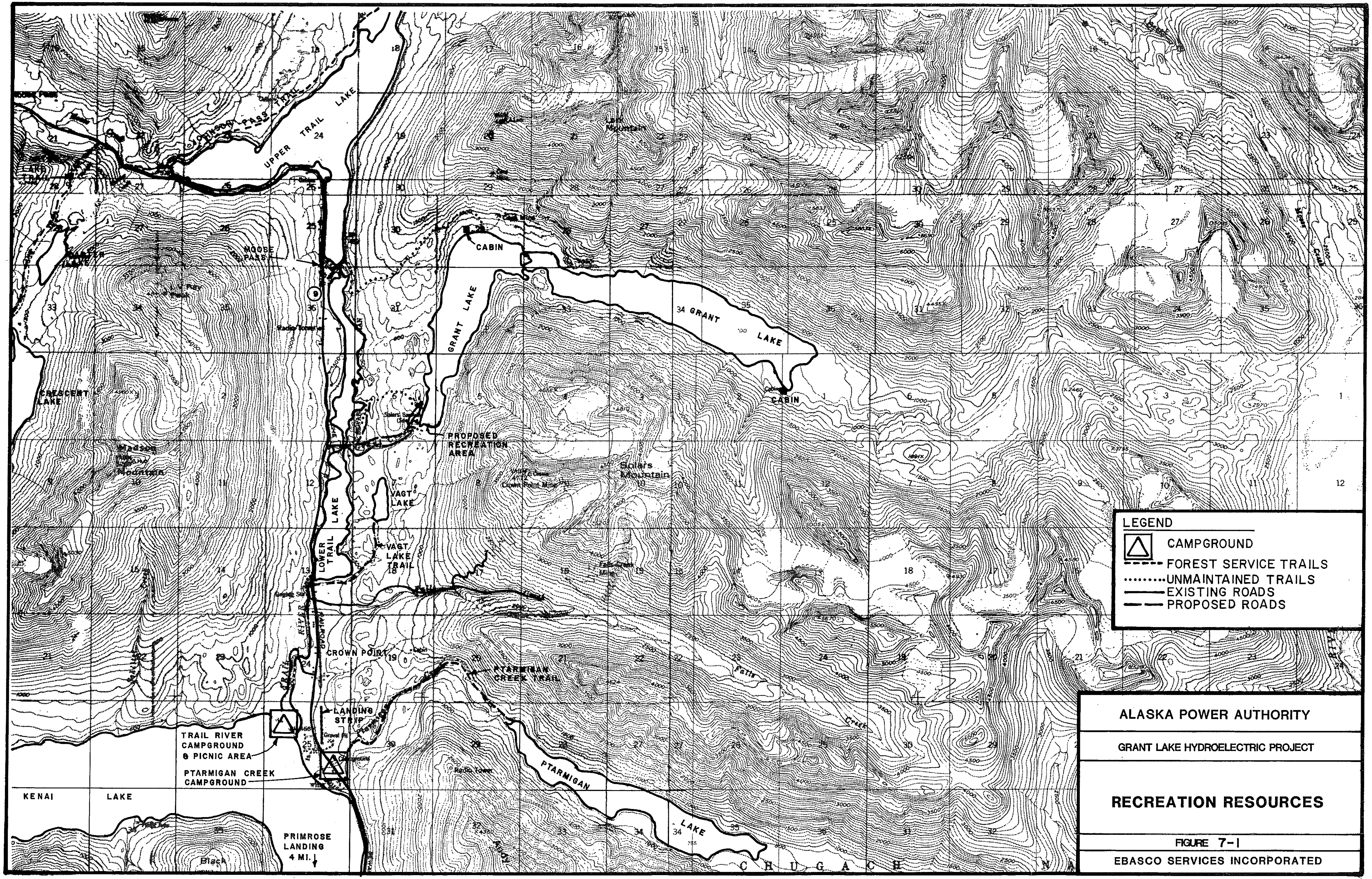
This report addresses existing recreation resources and use in the general and immediate vicinity of the proposed Project, planned recreational development associated with the Project, estimates of current and future recreational use of the Project vicinity, recreational land management considerations, and agency consultation and recommendations concerning the recreation aspects of the Project.

7.1 REGIONAL RECREATIONAL RESOURCES AND USE

Lands within the Project vicinity and the surrounding region are predominantly undeveloped public lands with high scenic and recreational values. The Kenai Peninsula attracts considerable recreation and tourism from residents of the region, the Anchorage area, other parts of the state, and outside of Alaska. While recreational activities that take place in the Kenai Peninsula are highly varied, freshwater and saltwater fishing appear to be the most popular activities, and largely drive many of the other types of use on the Kenai Peninsula. These activities and the recreation resources supporting them are described according to agency jurisdiction in more detail below. Recreation facilities and areas which are near the Moose Pass section of the highway corridor are shown in Figure 7-1.

7.1.1 Forest Service

The Forest Service, United States Department of Agriculture (USDA), administers the Chugach National Forest, which encompasses essentially the northeastern quadrant of the Kenai Peninsula as well as other lands abutting Prince William Sound and the Gulf of Alaska. The peninsula portion of the forest is divided between two ranger districts, headquartered at Anchorage (also the location of the Forest Supervisor's Office) and Seward. Major attractions of the Anchorage District include the visitor facility at the Portage Glacier, which is



ALASKA POWER AUTHORITY

GRANT LAKE HYDROELECTRIC PROJECT

RECREATION RESOURCES

FIGURE 7-1

EBASCO SERVICES INCORPORATED

the single most frequently visited recreation facility in Alaska (Hennig 1982), and two winter sports areas. The Anchorage District also maintains eight campgrounds, with a total of 142 units. The Seward District includes a number of large lakes, and during certain periods of the year receives heavy recreational use centered on the Kenai and Russian Rivers and Kenai Lake. Peak use periods on the district generally coincide with the timing of salmon runs.

Developed recreation facilities provided by the Seward Ranger District include eight campgrounds with a total of 240 units, two boat ramps, a picnic ground, and several recreation cabins, organization sites, and recreation residences. Five of the campgrounds (Russian River, Cooper Creek, Quartz Creek, Crescent Creek and Tern Lake) are located on or very near the Sterling Highway (Alaska Highway 1) in the western part of the district. The Russian River campground is the most popular facility, ranking third in the state in visitation after Portage Glacier and Denali National Park (Hennig 1982); the Cooper Creek and Quartz Creek campgrounds often function as overflow areas for Russian River during peak fishing activity. Use of the Trail River, Ptarmigan Creek, and Primrose campgrounds, which are located along the Seward-Anchorage Highway (Alaska Highway 9, locally known as the Seward Highway) south of Moose Pass, tends more toward transient use as opposed to destination use.

Total recreational use on the Seward District during fiscal year 1981 was estimated at 442,400 recreation visitor days (RVDs), representing approximately 40 percent of the nearly 1.1 million total RVDs for the Chugach National Forest (USDA, Forest Service 1982a). Developed use in the Seward District amounted to about 106,000 RVDs during FY 1981, or 24 percent of the total for the district. The eight campgrounds accounted for roughly 70,000 RVDs, with 33,200 RVDs for Russian River alone. Dispersed recreation typically accounts for the largest share of all use, primarily due to the time spent sightseeing, driving for pleasure, or otherwise using roads within the National Forest. Nonroaded, dispersed recreation during 1981 included 56,700 RVDs of trail use and nearly 41,000 days of recreation on lakes, rivers, and streams. Annual recreation data sufficient to identify trends do not exist, but use of the Chugach National Forest has increased at a moderate rate in recent years (Devore 1982).

The eastern side of the Seward District, primarily the area bordering the Seward Highway from Upper Trail Lake southward, does not receive the heavy use of the Kenai-Russian River area, but does contain several locations that are popular for backpacking, hunting, and other uses. Most of the developed recreation in this area is focused on Kenai Lake, as there are three campgrounds, a boat launch, and a picnic area on or near the lake. The two recreation cabins at Paradise Lakes are extremely popular, and must be reserved well in advance for summer use.

Visitor use data for a number of specific recreation facilities in this portion of the Seward District are presented in Table 7-1. Most of these facilities are mapped in Figure 7-1. The developed facilities in the area generally receive light to moderate use, although utilization rates at the campgrounds can be high on summer weekends. Trail River Campground is the largest of three campgrounds, with 43 units currently open for use (half of the original campground has been closed), and also receives the most use. Over the 104-day managed season, the 7,800 RVDs at Trail River represent an average occupancy level (people at one time, or PAOT) of 37 people, or about 17 percent of theoretical capacity. In comparison, average occupancy at the much larger Russian River Campground is about 160 people, which represents 18 percent of theoretical capacity (USDA, Forest Service 1982a).

In general, a utilization rate of between 20 and 40 percent of theoretical capacity is considered appropriate, because campground use levels cycle weekly and are unevenly distributed over time. In this case, however, the similar utilization rates for the two facilities reflect the very large capacity needed to handle Russian River activity peaks during salmon runs, and the closure of half of the Trail River

TABLE 7-1

RECREATION USE FOR SELECTED SITES IN THE SEWARD RANGER DISTRICT, FISCAL YEAR 1981[a/]

Facility	Estimated Visitor-Days (RVDs)
Ptarmigan Creek Campground	4,100
Primrose Campground	3,000
Trail River Campground	7,800
Trail River Picnic Loop	300
Primrose Landing Boat Launch	400
Subtotal, developed	15,600
Carter Lake Trail	800
Iditarod National Historic Trail	1,800
Johnson Pass Trail	6,600
Lost Lake Trail	2,800
Primrose Creek Trail	500
Ptarmigan Creek Trail	3,900
Grayling Lake Trail	500
Victor Creek Trail	200
Vagt Lake Trail	500
Subtotal, trail use	17,600
TOTAL DEVELOPED AND TRAIL USE	33,200

a/ USDA, Forest Service 1982a.

Campground. The estimated 1981 utilization rates for the Ptarmigan Creek and Primrose facilities were 15 percent and 29 percent, respectively (USDA, Forest Service 1982a).

Use of the nine trails listed in Table 7-1 was estimated at 17,600 RVDs in 1981, somewhat more than aggregate use at the developed facilities in the area. (The Forest Service data system is designed to segregate time actually spent on the trail from time spent at the destination, although use cannot be monitored closely enough to do this with precision.) The Johnson Pass Trail is a popular backpacking trail, especially for extended trips, and in 1981 was the third most frequently used trail among 17 on the Seward District. The Iditarod Trail is also somewhat unusual due to its historic significance and considerable interpretive use. The remaining seven trails listed in the table are generally similar in that they are comparatively short trails of mostly moderate grade leading to lakes or other specific destinations.

7.1.2 Other Public Agencies

Recreation areas managed by the National Park Service and Fish and Wildlife Service of the federal government, and the Division of Parks of the Alaska Department of Natural Resources are also important recreation attractions within the overall region, although none are located very close to the Project vicinity. The most significant of these areas is the Kenai National Wildlife Refuge (formerly the Kenai National Moose Range), which occupies nearly 2 million acres within the interior of the Kenai Peninsula and abuts the western edge of the Chugach National Forest. Much of the refuge is foothill or lowland area, providing easier access than the more rugged National Forest land. The rivers and streams of the refuge attract heavy fishing use for both salmon and resident freshwater fish, particularly in the Kenai River and Skilak Lake areas. The area is also popular for canoeing, boating, hunting, backpacking, and passive uses such as wildlife photography. The Fish and Wildlife Service operates 15 campgrounds with a total of 297 units, plus 15 hiking trails and 2 established canoe trails (U.S. Fish and Wildlife Service 1982). Annual recreational use of the refuge, exclusive of sightseeing and other incidental activities along the Sterling Highway, is estimated at about 250,000 visitors (Johnson 1982).

The National Park Service operates Kenai Fjords National Park, which extends west and southwest from Seward along the Gulf of Alaska. The Park is mostly undeveloped and attracts only light use, largely "flightseeing" trips to the Harding Icefield, Aialik Bay, and other attractions. Recent access improvements have provided for backcountry use in the Exit Glacier area, a few miles northwest of Seward.

The Alaska State Park System includes 36 existing and proposed units within its Kenai Subregion administrative area (Alaska Department of Natural Resources, Division of Parks 1982). To some extent these facilities may compete for recreationists with the Chugach National Forest, but the State-owned units provide different types of recreation opportunities because they are located in or near coastal areas. Most of these 36 units are small recreation areas or sites; the most significant units are Kachemak Bay State Park, east of Homer, and Captain Cook State Recreation Area, on the shore of Cook Inlet northeast of Kenai. While not located on the Kenai Peninsula, Chugach State Park is also a very significant recreational resource. This 495,000-acre state park, located just east of Anchorage, provides many of the same types of recreational opportunities as the Chugach National Forest and is located much closer to the major regional source of recreationists.

7.1.3 Private Entities

Privately owned recreation facilities and services in the Project vicinity are somewhat limited due to the predominance of public land ownership. Lodges are located one each at Crown Point and Moose Pass, while three lodge and resort facilities, some with campsites, are located in the Cooper Landing area near the west end of Kenai Lake (Alaska Department of Commerce and Economic Development, Division of Tourism 1982). The other significant local private entities are two flying services, operating out of Crown Point and Moose Pass which provide fly-in access to remote areas in this portion of the Kenai Peninsula. More distant from the Project vicinity, three private campgrounds, several lodging facilities, a flying service, and other outlets serving recreation and tourism are located in Seward.

7.2 EXISTING PROJECT VICINITY FACILITIES AND USE

The Project vicinity currently possesses no structural recreation facilities other than a series of established but unmaintained trails from both Upper and Lower Trail Lakes to Grant Lake, a primitive road to mining claims near upper Falls Creek, and a maintained trail to Vagt Lake. The Vagt Lake Trail is part of the Forest Service trail system, but the trails to Grant Lake and road along Falls Creek are not. The only other enhancement of recreation carried out in the Project vicinity has been the creation of a sport fishery in Vagt Lake. In 1973 the Alaska Department of Fish and Game (ADF&G) treated the lake witn rotenone to kill the resident, nongame species. In 1974 and again in 1980 the lake was stocked by the ADF&G with rainbow trout. Project vicinity fishery resources are described in greater detail in Chapter 3.

The Project vicinity receives limited recreational use for fishing, hunting, hiking, backpacking, and camping, mainly during the spring and summer. There is also some canoeing on Grant Lake, mostly by hunters. Snowmobilers have been observed heading up the trail from Moose Pass toward Grant Lake (Quilliam 1982) although most of the slopes around the lake are steep and subject to avalanche hazard. These basic activities can be expected to continue to be pursued after the proposed Project is constructed.

The principal recreation attractions within the Project vicinity are hunting, fishing, and general opportunities for backcountry experiences. Game animals residing in the area include mountain goat, black bear, brown bear, Dall sheep, and moose (see Chapter 3). Access to remote hunting territory, such as above the east end of Grant Lake, is currently limited to float plane and foot travel. Lower Grant Creek, Vagt Lake, and possibly lower Falls Creek provide fishing opportunities in the Project vicinity. Activity in Grant Creek is limited to fishing for rainbow trout and Dolly Varden in the lower 0.5 to 0.75 mile of the stream, as the creek is closed to salmon fishing and the upper reaches do not support fish. Grant Creek fishing is also limited by difficult access, because it can only be reached by boat via Trail Lakes or by hiking several miles from the highway. Vagt Lake has been stocked with rainbow trout, as indicated above, and there is some evidence of fishing activity at the mouth of Falls Creek.

Estimates of recreational use of the Project vicinity or specific sites within the area are limited to Forest Service data on use of the Vagt Lake Trail. As stated in Section 7.1, this trail received an estimated 500 RVDs of use during FY 1981 (see Table 7-1). The 500 RVDs amount to 6,000 hours of use. Allowing two hours for the round trip hike, this would correspond to 3,000 annual visits to Vagt Lake (unless the 500-RVD estimate includes some time spent at the lake, a statistical division which is difficult to identify). Time spent in fishing or other recreational activities at Vagt Lake would probably be at least equal to the 500 RVDs of trail use. Ptarmigan Lake and other locations outside of the immediate study area receive heavier use; still 3,000 visits is a substantial figure.

Backpackers have been observed camping at Grant Lake, primarily at the northern end of the lower part of the lake, but the observations have not been frequent enough for Forest Service recreation personnel to offer estimates of use. Assuming two parties hiked in to Grant Lake every month during a four month backpacking season, with an average party size of three people and length of stay of 36 hours, backcountry use of the lake would amount to 24 visits and 72 RVDs per year.

Most of the hunters using the area around Grant Lake undoubtedly use float plane access, given the difficulty of hiking around the lake or carrying a canoe to the lake from the highway. The proprietor of a local flying service estimates that an average of about five parties of three to four hunters each fly to Grant Lake every year (Pfleger 1982). In comparison Paradise Lakes and Upper Russian Lake receive approximately 200 and 100 annual visitors, respectively, for hunting, fishing, and camping (both areas have Forest Service cabins). Assuming 20 fly-in hunters spend an average of four days each near Grant Lake, annual hunting activity in the lake basin would amount to about 160 RVDs. Some additional hunting may occur in the lower portions of the study area closer to the highway, but it appears neither significant nor quantifiable.

Estimates or educated guesses as to the number of visits or time spent fishing Grant Creek and Falls Creek, and snowmobiling near Grant Lake, or other recreational activities in the area cannot be provided. Given the rough figures provided above, total recreational activity in the entire Project area may range from 800 to 1,300 RVDs per year, of which Vagt Lake would account for more than three quarters.

No new recreation facilities or activities are currently planned for the Project vicinity other than the recreation development proposed in this report. The periodic stocking of Vagt Lake with trout by the ADF&G and the maintenance of the Vagt Lake Trail by the Forest Service are the only active recreation programs in the area. The Draft Forest Plan for the Chugach National Forest (USDA, Forest Service 1982b) proposes that the remaining National Forest lands in the analysis areas encompassing Grant Lake be managed principally for dispersed recreation. The Draft Plan also proposes possible cooperative development, with the State of Alaska, of hiking and cross-country skiing trails along the right-of-way of the Alaska Railroad, if the railroad is transferred to State ownership. Such development could conceivably occur near Grant Lake, but more likely it would be much closer to Anchorage.

7.3 SPECIAL USE DESIGNATIONS

The Project vicinity is not directly affected by any special legislative or administrative land use designations, other than the route of the Iditarod Trail as a National Historic Trail. The Iditarod Trail, which generally follows the route of the Alaska Railroad, is discussed in Chapter 4. Much of the Project lies within a roadless area studied under the second Roadless Area Review and Evaluation (RARE II) process; this 216,000-acre roadless area (area number A005, A-E Kenai Mountains) was designated for further planning under RARE II, with eventual disposition to be determined through the Chugach Forest Plan (USDA, Forest Service 1982b, 1982c). The Grant Lake portion of this area was not proposed for wilderness designation in five out of six alternatives presented in the Draft Forest Plan, with the hydroelectric potential of Grant Lake specifically cited as the reason for not proposing the area around the lake for wilderness designation.

Extensive wilderness areas and lands with other special use designations are located elsewhere on the Kenai Peninsula relatively close to the Project. The Kenai National Wildlife Refuge contains about 1.3 million acres of wilderness land, some of which abuts the Chugach National Forest on its western border. The largely undeveloped Kenai Fjords National Park extends along the southwestern edge of the forest. Additionally, it appears likely that a wilderness designation will be given to the Nellie Juan area, which includes the Paradise Lakes country about 12 miles southeast of Grant Lake (USDA, Forest Service 1982b, 1982c).

None of the streams of the Kenai Peninsula have been designated as part of the National Wild and Scenic River System or are under study for inclusion in the system (U.S. National Park Service 1982). No national trail other than the Iditarod Trails are located near the Project.

7.4 SHORELINE BUFFER ZONE

The shoreline of Grant Lake will be included in the Project and will remain open to public access. The lands will continue to receive Forest Service overview for their scenic, recreational, cultural, and other environmental values. Lands along the western edge of the Project vicinity, including approximately one-half mile of Grant Lake shoreline near the lake outlet, are scheduled to be transferred from the federal government to the State of Alaska and then to the Kenai Peninsula Borough. This transfer is described in more detail in Chapter 9. While ownership and jurisdiction of these lands will ultimately be municipal, or possibly private, public access rights to this shoreline area and the proposed recreation area will be ensured through easements retained by the Forest Service and provisions of the FERC License issued for the Project.

7.5 RECREATION DEVELOPMENT PLAN

A small, day use recreation area near the outlet of Grant Lake is proposed as a component of the Project. A description of the development concept and proposed facilities are provided below, along with information on expected recreational use and development cost and schedule.

7.5.1 Recreation Plan Concept

Several recreation development concepts involving varying levels of use and development intensity were considered for the Project. The levels of development considered ranged from relatively intense development at Grant Lake, based on a campground and boat ramp, to primitive recreation, with only trail access to the lake. Tne recommended development concept consists of road access to the lake with a small picnic area and launch access for easily portable boats.

Intense recreational development at Grant Lake does not appear to be appropriate due to existing developed facilities in the general vicinity and the apparent difficulty and expense of constructing a boat ramp for trailered boats. The Forest Service currently operates four lake-oriented campgrounds (Trail River, Ptarmigan Creek, Primrose, and Tern Lake) within approximately 10 or 12 miles of Grant Lake. Low utilization rates at two of these campgrounds and the closure of half of Trail River Campground indicate that a car campground at Grant Lake would duplicate existing facilities and probably receive insufficient use.

At the lower end of the range of possible recreation development, primitive recreation based on a trail to a camping and day-use area at the south end of Grant Lake would be consistent with current recreational use of the area and would serve an identified demand for relatively quick, easy trail access to backcountry areas. However, the existing trail system provides a number of trail access opportunities in the area. Moreover, agency contacts and an assessment of existing recreational opportunities in the Project vicinity indicate that there is a greater demand for recreational access by road to places such as Grant Lake. Moreover, Project facility operation and maintenance will require permanent road access to the gate shaft intake area on Grant Lake. Closure of this road to public use would be inadvisable and contrary to Forest Service policy. These considerations support a middle level of development involving road access to a day-use area on the lake. The proposed facilities to be developed under this plan are described in more detail in the following section.

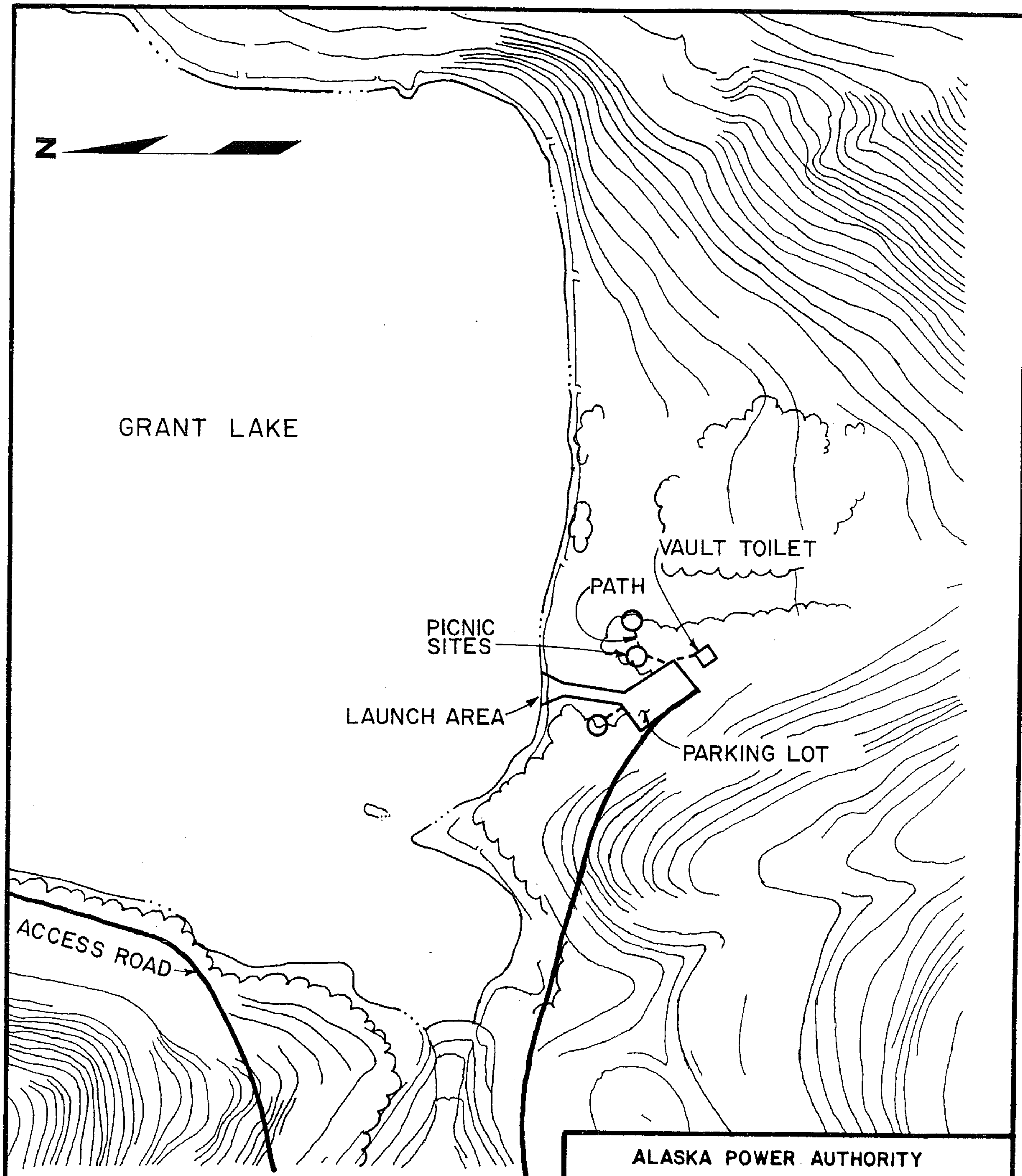
7.5.2 Proposed Recreation Facilities

Recreation development proposed for the Project will be concentrated at the south end of Grant Lake, approximately 500 ft east of the outlet. This is a relatively level area, lending itself to use by the handicapped, with scattered growths of evergreens and adjoining one of only a few parts of the Grant Lake shoreline possessing a gentle slope at and below the lake's present water line. The general layout of these facilities is indicated on Figure 7-2. Some signing would also be required at other locations. All facilities will be designed consistent with Forest Service standards.

The major facilities proposed for the recreation area are a parking lot, small picnic area, vault toilet, and launch ramp for boats. A graded and gravelled parking area of approximately 6,000 square ft, sufficient for 12 vehicles, would be located adjacent to the access road. A short, two-lane road extension approximately 100 ft in length would connect the parking lot with the lakeshore and boat launching area. The launch ramp would extend from the lake's normal maximum operating level (elevation 691 ft) to an elevation which will allow usage when the lake is not completely full.

A total of three picnic sites will be developed, one west of the lauch and the other two just east of the parking area. The site nearest the parking lot will be a double site for larger parties. All sites would be located just inside the edge of the existing trees in order to minimize clearing yet provide shade, and the two sites east of the parking area would be separated by 100 ft. Each site would consist of a picnic table (four total), and steel channel fireplace with flip grate. Short lengths of trail connecting the sites with the parking area would be constructed. The sealed vault toilet would be situated at the south end of the parking lot, as far inland as possible but still within the required 300 ft of all picnic sites.

Signing for the Project would primarily consist of directional and informational signs. Signs directing travellers to the recreation area would be posted on both sides of the access road intersection with the Seward Highway and at various points along the main access road. Several signs at the recreation area would direct users to the various



ALASKA POWER AUTHORITY

GRANT LAKE HYDROELECTRIC PROJECT

RECREATION DEVELOPMENT

FIGURE 7-2

EBASCO SERVICES INCORPORATED

facilities and post the area against overnight camping. The main Project sign, providing basic Project data and an area map, would be located near the powerhouse. An interpretive sign describing the Project's fish mitigation program would be installed at the Trail Lake Hatchery.

7.5.3 Facility Capacity and Use

The instantaneous capacity (people at one time or PAOT) of the proposed recreation area would be 48 people, based upon the parking capacity of 12 vehicles and an assumed occupancy rate of four persons per vehicle. The picnic area would have a rated capacity of 16 PAOT, given four persons per table, although parties of five or six persons can comfortably use a standard-size picnic table. The proposed picnic capacity is less than the total site capacity because some recreationists would use the area only for boating and some overnight parking would be provided for campers travelling to up-lake areas by boat. The theoretical season capacity of the picnic area over a 104-day managed season (the same as for Seward District campgrounds) would be 1,664 recreation visitor days (RVDs). Assuming an average length of stay of three hours, this would correspond to 6,654 maximum visits annually.

The actual use that the proposed recreation facility will receive is difficult to estimate due to insufficient data on existing use and a lack of comparable facilities. Given the size of the facility and visitation of minor Forest Service recreation attractions elsewhere on the Seward District, however, it is expected that typical annual use of the picnic area will initially be approximately 200 RVDs. This assumed use level corresponds to a visitation pattern of five parties per day on weekends and holidays (33 days of the 104-day season) and an average of 1.5 parties per day on weekdays, with three people per party and an average visit of three hours. A use level of 200 RVDs (800 visits) per year would represent a utilization rate of about 12 percent of theoretical season capacity. Given the assumed party size, 800 annual visits would require nearly 270 vehicle-trips to the site. This level of traffic flow represents roughly one out of every 500 cars travelling the Seward Highway during the area's recreation season, based on 1981 traffic counts at Moose Pass (Alaska Department of Transportation 1982).

Recreational use of the three existing boat ramps on the Seward and Anchorage Districts (Primrose Landing, Quartz Creek, and Tenderfoot) ranged from 100 to 400 RVDs during FY 1981 (USDA, Forest Service, Chugach National Forest 1982a). Because all three of these ramps are located adjacent to major highways and serve trailered boats as well as smaller craft, use of the launch area at Grant Lake can reasonably be expected to be lower than any of the existing ramps if the lake is not planted with a sport fish like rainbow trout. If it is, (see Appendix B, specifically Fish Mitigation Planning Document No. 3, for details) then usage will likely be higher. Because the level of sport fishery mitigation remains to be established, no mitigation is assumed and initial use of the launch at Grant Lake will be arbitrarily estimated at 50 RVDs per year. Some of this activity will likely consist of campers and hunters launching boats for access to other parts of the lake basin. Assuming 30 recreationists per year spent an average of 36 hours each elsewhere in the lake basin, this would result in an additional 90 RVDs per year.

Aggregate use associated with the proposed recreational development at the south end of Grant Lake, including overnight use of other parts of the lake basin and time spent at Project-related interpretive signs during visits to the powerhouse and Trail Lake Hatchery, will probably range from 250 to 400 RVDs per year. Recreational use of the area could be expected to increase somewhat with continued population growth in Anchorage and the Kenai Peninsula and with increased tourism. Greater public knowledge of recreational opportunities at Grant Lake also might lead to increased use over time, particularly because current use of Grant Lake appears to be primarily by local residents.

Use of the recreation area and surrounding lands during the initial hunting seasons will be monitored by ADF&G and Forest Service wildlife biologists to determine if road access to Grant Lake has an adverse impact upon the local wildlife. If it is determined that this access has resulted in unacceptable hunting pressure, hunting may be restricted through the mandatory use of permits or Project roads may be closed to public access during subsequent hunting seasons.

The proposed development could easily be expanded if activity levels warrant. Adequate space exists at the south end of Grant Lake for development of additional picnic sites adjacent to the proposed sites, particularly those east of the parking area. If necessary, additional parking could be provided south of the proposed facilities adjacent to the access road. If there appears to be sufficient demand for overnight camping facilities, the logical approach would be to develop several hardened campsites along the lakeshore for boat access. Responsibilities for financing and implementing potential future expansion of the recreational facilities will be addressed in the cooperative agreement concerning the Project between the Power Authority and the Forest Service.

7.5.4 Development Schedule and Costs

Preliminary, planning-level cost estimates for the proposed recreation facilities are presented in Table 7-2. They are primarily based on recreation facility cost figures from recent Forest Service experience (Hennig 1982), supported by escalated 1981 standard facility cost figures prepared by the Alaska Division of Parks (Alaska Department of Natural Resources 1981). The estimated total cost of the proposed facilties, is $45,000. These capital costs will be borne by the Power Authority as part of the overall cost of the Project. Operation and maintenance requirements of the proposed recreational facilities will be low, although establishment of the actual maintenance program will be the responsibility of the administering agency. Estimated costs of operation of these facilities are included in the Project cost estimates.

TABLE 7-2

GRANT LAKE HYDROELECTRIC PROJECT RECREATION PLAN
CONCEPTUAL COST ESTIMATE

Item	Unit	Quantity	Unit Cost	Total Cost
Clearing	LS		$	$ 5,000
Park area - gravel surfacing	SF	6,000	2.00	12,000
Launch access road - gravel surfacing	LF	100	20.00	2,000
Boat launch area - gravel surfacing	SF	600	2.00	1,200
Picnic tables	EA	4	400.00	1,600
Fireplace	EA	4	1,500.00	6,000
Picnic area trails	LF	250	10.00	2,500
Contained vault toilet	EA	1	3,000.00	3,000
Project sign (at powerhouse)	EA	1	1,000.00	1,000
Fishery interpretive sign (at hatchery)	EA	1	1,000.00	1,000
Miscellaneous signing for recreation area	LS		3,000.00	3,000
Miscellaneous	LS			6,700
Total				45,000

7.6 SUMMARY OF AGENCY CONTACTS

Definitive, formal recommendations or policies concerning recreation development at the Project have not been offered by any of the resource agencies involved. However, there have been clear indications of various agency concerns and interests, particularly from Forest Service personnel of the Seward Ranger District and the Alaska Department of Fish and Game. Briefly, the Seward District recognizes a need for more off-highway recreation opportunities in the area, and recommends keeping the Project access road open to the public and providing parking and boat launching facilities at Grant Lake (Wilson 1982). It is uniform Forest Service policy to leave roads on National Forest lands open to multiple use if possible. As mitigation for the lost sport fishing opportunity that would result with dewatering of Grant Creek, the ADF&G advocates planting Grant Lake with rainbow trout or similar species. For access to this fishery, they advocate a boat launching ramp on Grant Lake.

Other Forest Service employees and personnel from the Alaska Division of Parks, the Alaska Department of Fish and Game, and the City of Seward have also offered views on Project recreation, although these views were offered informally and do not necessarily represent official agency positions. Other Forest Service contacts (Albrecht 1982; DeVore 1982; Hennig 1982; Quilliam 1982; Tallerico 1982) also noted the shortage of accessible recreation spots away from the Seward Highway, and the advisability of leaving roads open and providing a vault toilet and possibly a launch and other facilities. There was some indication that the Forest Service would consider maintaining recreation facilities, other than roads, built for the Project. Information was also provided on Forest Service guidelines concerning the types of facilities provided for the various levels of development on the recreation opportunity spectrum, as was the observation that about 10 camp units would be required if overnight camping were to be encouraged at Grant Lake. There was some feeling that the Forest Service would favor a day-use facility, that camping at such a facility should be discouraged, and that some reviewers would express concern that road access to Grant Lake would change the character of recreation in the area.

Opinions of other agency personnel are generally divided over the advisability of providing road access to the lake. A representative of the Alaska Division of Parks thought that primitive recreation would be appropriate for Grant Lake and suggested minimal development consisting of trail access to the lake and a pit toilet (Wiles 1982). ADF&G staff initially expressed concern that road access would lead to increased pressure on wildlife, particularly moose, although they later indicated that temporary road closures or area restrictions could minimize wildlife impacts if problems arose (Schwartz 1982; Spraker 1982). A City of Seward official reflected the prevailing Forest Service opinion that Project access roads should be left open because of the significant demand for getting off the highway (Schaefermyer 1982).

The recreation development plan proposed above is intended to meet agency recreation planning objectives and be responsive to views of agency staff.

The following summarizes pertinent Agency contacts made in support of this report. Correspondence between the Alaska Power Authority and various agencies is included in the Technical Appendix, Part VIII.

Alaska Department of Fish and Game

1) <u>Date:</u> January 5, 1982
   <u>Agency Representative:</u> Ted McHenry, Seward
   <u>Location:</u> (Telephone conversation)
   <u>Subject:</u> Availability of information on recreation in Grant Lake vicinity

2) Date: June 2, 1982

Agency Representative: Dave Daisy and Bill Gaylor (Anchorage)

Location: (Telephone conversation)

Subject: Construction work force management for Upper Trail Lake fish hatchery; source of work force; policies on housing work force.

3) Date: June 7, 1982

Agency Representative: Ted Spraker (Soldotna)

Location: (Telephone conversation)

Subject: Agency policies toward recreational access to Grant Lake area

4) Date: June 18, 1982

Agency Representative: Chuck Schwartz (Soldotna)

Location: Soldotna, Alaska

Subject: Agency policies toward recreational access to Grant Lake area and game management alternatives to protect local moose herd

5) Date: July 13, 1982

Agency Representative: Ted Spraker (Soldotna)

Location: (Telephone conversation)

Subject: Plans for managing recreational access to Grant Lake area

Alaska Department of Natural Resources, Division of Parks

1) Date: June 22, 1982

Agency Representative: Jack Wiles (Anchorage)

Location: Anchorage

Subject: Recreation planning concepts for the Project; need for vehicular access to Project vicinity

2) Date: August 18, 1982

Agency Representative: Jack Wiles

Location: (Telephone conversation)

Subject: Iditarod Trail, state park visitation, recreation facility costs

U.S. Department of Agriculture, Forest Service

1) Date: January 19, 1982

Agency Representative: Ron Quilliam (Seward)

Location: (Telephone conversation)

Subject: Availability of recreation and other uses of Grant Lake area

2) Date: June 17, 1982

Agency Representative: Ron Quilliam (Seward)

Location: Seward, Alaska

Subject: Acquisition of data on recreation and other land uses in Project vicinity

3) Date: June 21, 1982

Agency Representative: Jim Tallerico

Location: Anchorage, Alaska

Subject: Acquisition of data on recreational uses of Project vicinity

4) Date: August 18, 1982

Agency Representative: Steve Hennig (Anchorage)

Location: (Telephone conversation)

Subject: Recreation use on Seward District, probable recreational uses in vicinity of Grant Lake

5) Date: August 20, 1982

Agency Representative: Ron Quilliam, Bob Walker, Chad Devore (Seward)

Location: (Telephone conversation)

Subject: Recreation use on Seward District, recreational development of alternatives; agency policies on recreational access

6) Date: September 3, 1982

Agency Representative: Steve Hennig (Anchorage)

Location: (Telephone conversation)

Subject: Recreation facility costs, appropriate level and type of development at Grant Lake

U.S. Fish and Wildlife Service

1) Date: August 16, 1982

Agency Representative: Rick Johnson (Soldotna)

Location: (Telephone conversation)

Subject: Recreation use on Kenai National Wildlife Refuge

8.0 REPORT ON AESTHETIC RESOURCES

The principal aesthetic attraction of the Grant Lake Hydroelectric Project vicinity and adjacent lands is the visual resource. Accordingly, the following sections identify the visual characteristics of the Project vicinity, anticipated potential Project impacts on visual resources, and protective measures necessary to avoid or reduce such impacts. Much of the information presented in this chapter is based directly on materials provided by the Forest Service and on consultation with Forest Service personnel.

8.1 VISUAL CHARACTER OF LANDS AND WATERS AFFECTED BY THE PROJECT

A visual resource assessment of the Project vicinity was conducted to identify the visual character of the area's landscapes. The visual analysis process included identifying the visually dominant physical components of the landscapes (i.e., land forms, rock formations, vegetation patterns, water forms) as well as conducting a subjective evaluation of viewer sensitivity to the visual resources. This methodology permits classification of landscapes according to their scenic resource values, facilitating sound resource management.

8.1.1 Physical Visual Characteristics

The Project is situated in an environmental setting of distinctive and varied landscapes, typical of Alaska's southcentral region. Rounded foothills with moderate slopes contrast with steep mountain peaks characterized by sharply defined ridges, angular steep-sided crests, and conspicuous boulder outcrops. The Project vicinity is visually dominated by snow-capped mountain peaks. Three prominent peaks rising to 4,810 ft, 5,180 ft and 5,269 ft elevations surround the Project site. Snow-icefields cover approximately 25 percent of the southcentral region (USDA, Forest Service 1979), dominating higher elevations year-round. The presence of glacial activity contributes significantly to the contrast and variety of the visual experience of southcentral Alaska.

Steep slopes, elevation, and climatic conditions influence the variety of vegetation characterizing the Project vicinity. Slopes above 4,000 ft elevations typically display barren rock and talus surfaces. Timberline varies between 1,000-1,500 ft elevations. Alpine vegetation and subalpine herbaceous meadows dominate slopes above treeline while mixed conifer and deciduous species comprise most of the densely forested areas below. The area's vegetation is described in detail in Chapter 3.

Landscapes viewed throughout the Project vicinity are frequently confined to foreground and middleground distance zones. Extreme peak elevations, steep mountain slopes, and dense forest vegetation at lower elevations spatially enclose and restrict the viewshed, the areal extent of terrain visible from a given point of the viewer.

Man-made elements that have been introduced into the visual environment, shown on Figure 1-2, include the Anchorage-Seward Highway, the Alaska Railroad, the Moose Pass community and its associated buildings, a 24 kV transmission line paralleling the Anchorage-Seward Highway, and a number of Forest Service campgrounds and trails.

8.1.2 Scenic Resource Values

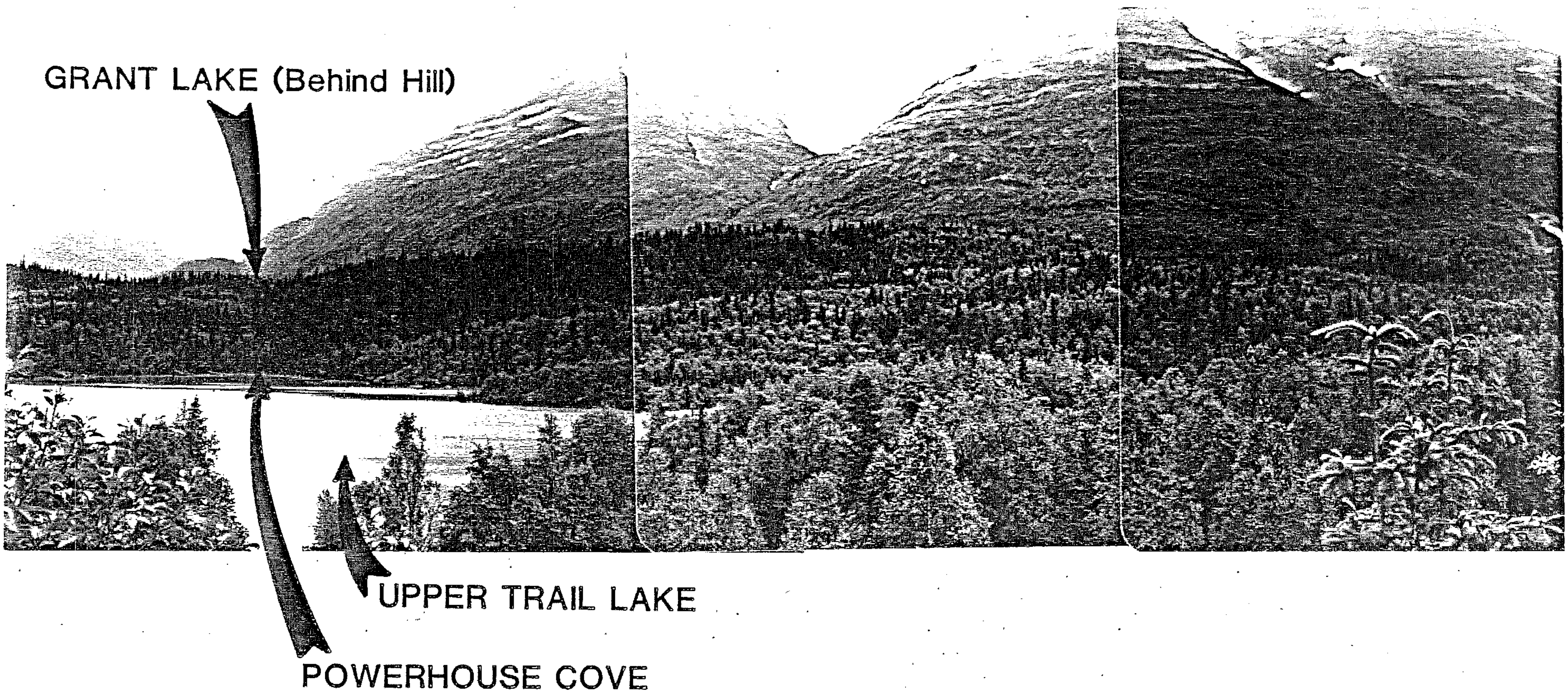
The scenic resource values of an area reflect the viewer's sensitivity to the landscape's aesthetic qualities. This sensitivity level is based on the number and frequency of viewers, the duration of the viewing period, and the location of viewing points. The viewer's perception of aesthetic quality is based primarily upon the diversity of the landscape elements and their visibility.

The Anchorage-Seward Highway, a north-south route, parallels the west shore of Upper and Lower Trail Lakes, from the westward extension of Upper Trail Lake to the south end of Lower Trail Lake. At this location the highway crosses over the Lower Trail Lakes' outlet, the Trail River, and continues south to Seward. Approximately one-quarter of a mile south of the Trail River crossing the highway crosses Falls Creek.

Views from viewpoints along the highway are frequently enclosed. Madson Mountain rising to 5,269 ft elevation along the west shore of the Upper and Lower Trail Lakes system, as well as the lakes' densely forested shoreline effectively restrict the potential viewshed to immediate foreground distance zones. Consequently, views from the Anchorage-Seward Highway in the Project vicinity typically consist of the higher elevations of mountain peaks, dense forest vegetation, the highway and portions of the Alaska Railroad tracks, and occasional Moose Pass community structures along the highway.

From a few locations along the highway, views of the Trail Lakes system, its east shoreline, and a backdrop of snow-capped mountains can be seen. Views are less restricted during the fall and winter as the majority of the shoreline vegetation is deciduous. Photographs from locations where there is an opportunity to view these landscapes are shown as Figures 8-1 and 8-2.

Neither Grant Lake nor Vagt Lake at their respective 696 ft and 554 ft elevations are visible to viewers traveling the Anchorage-Seward Highway. The highway, for most of its route along the west shore of the Trail Lakes system, is generally at about 500 ft elevation. Ridges reach elevations ranging from 639 ft along the west shore of Vagt Lake to 892 ft along the west shore of Grant Lake (see Figures 8-1 and 8-2).



View of Powerhouse Cove Location at East Shoreline of Upper Trail Lake. View Taken From Viewpoint on the Anchorage-Seward Highway.

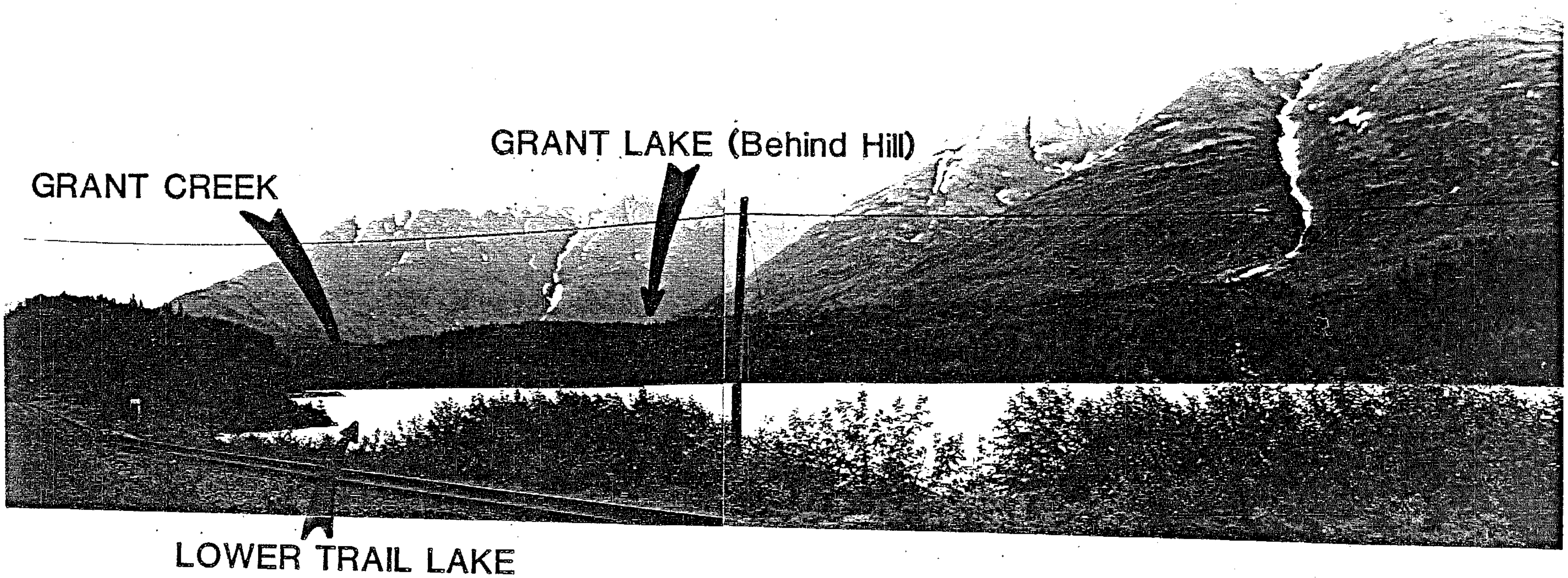
ALASKA POWER AUTHORITY

GRANT LAKE HYDROELECTRIC PROJECT

POWERHOUSE COVE

FIGURE 8-1

EBASCO SERVICES INCORPORATED



View of East Shoreline of Lower Trail Lake with Solars Mountain as a Backdrop. View Taken From Viewpoint on the Anchorage-Seward Highway.

ALASKA POWER AUTHORITY
GRANT LAKE HYDROELECTRIC PROJECT
LOWER TRAIL LAKE
FIGURE 8-2
EBASCO SERVICES INCORPORATED

The Anchorage-Seward Highway is one of the two major traffic routes on the Kenai Peninsula and the principal traffic route in the vicinity of the Project. It branches from the Old Sterling Highway, the only Anchorage-Kenai road access, and continues south as the only road providing access to the City of Seward and intermediate points. Traffic data (Alaska Department of Transportation 1982) summarizing monthly average daily traffic (MADT) totals and annual average daily traffic (AADT) totals recorded at the Moose Pass Maintenance Station (Route Mile 29.24) indicate peak MADT totals occurred during July and August for both 1980 and 1981. The MADT totals for traffic during late fall through early spring (October - April) averaged less than one-half of the peak MADT totals for July and August. The significant increase in traffic levels during summer corresponds with peak recreation (see Chapter 7).

A number of Forest Service trailheads and campground sites are accessible from the highway. However, most of the established recreational facilities are concentrated south of the Project vicinity and nearer Kenai Lake. The nearest campground site, Trail River Campground, is approximately one mile south of the Grant Creek- Trail Lakes junction. Recreation visitor use information provided by the Forest Service, characterizing activity at recreation facilities in the Project vicinity is detailed in Section 7.0.

The Alaska Railroad parallels the northeast shore of Upper Trail Lake before crossing to the west shore of the lake at Moose Pass. From this location the railroad continues south paralleling the west shore of the remainder of the Upper and Lower Trail Lakes system. The railroad crosses Falls Creek at the same location as the highway crossing. Currently, this segment of the Alaska Railroad transports only freight and does not provide passenger service. The railroad corridor is therefore not a significant scenic resource factor at present.

8.1.3 Forest Service Visual Management System

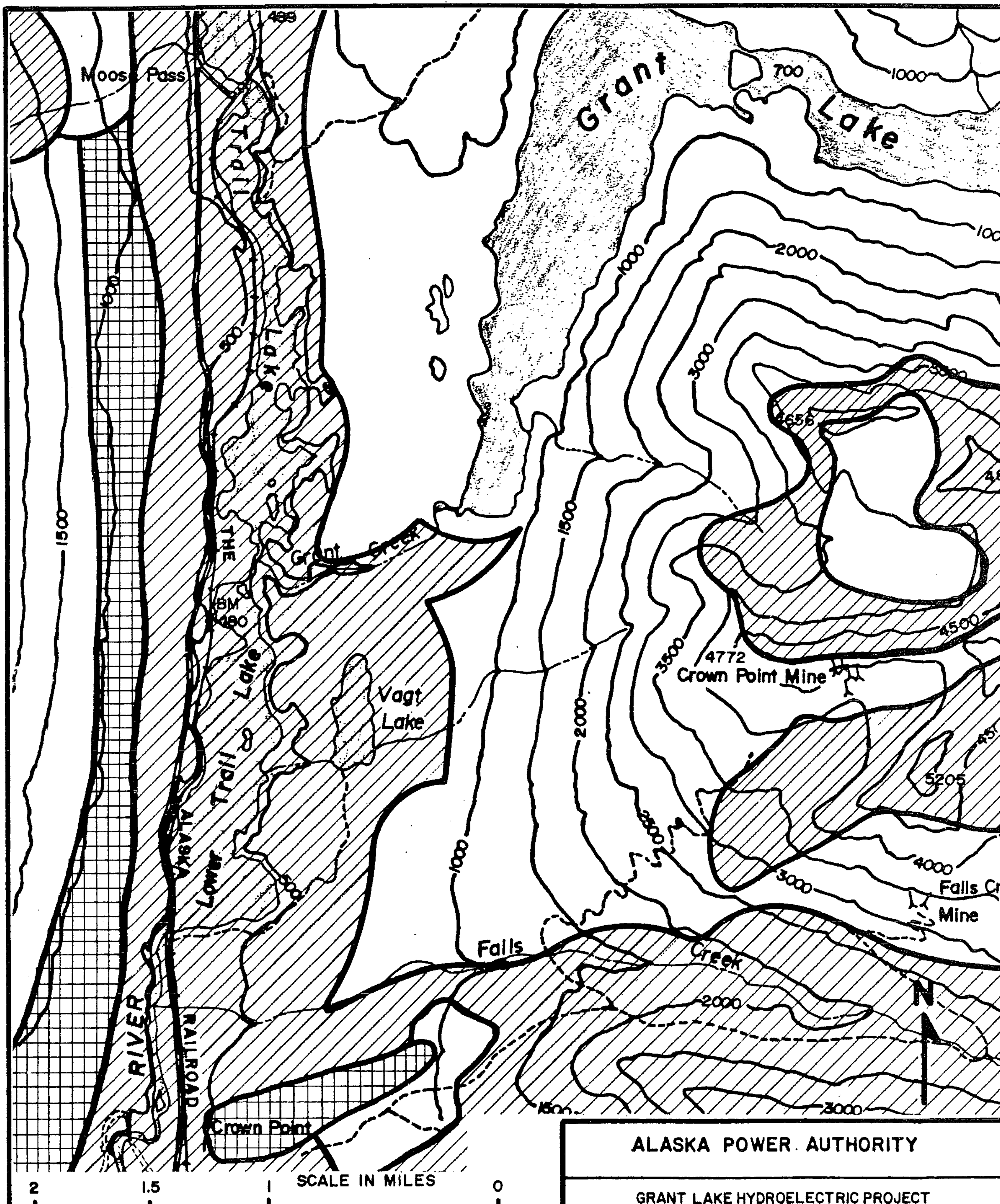
Visual management system objectives applicable to Forest Service lands affected by the Project include the following (USDA, Forest Service 1978):

1) Retention: This visual quality objective provides for management activities which are not visually evident. Retention classifications dictate that activities may only repeat form, line, color, and texture which are frequently found in the characteristic landscape.

2) Partial Retention: Management activities should remain visually subordinate to the characteristic landscape. Activities may repeat form, line, color, or texture common to the characteristic landscape. Activities may also introduce form, line, color, or texture which are found infrequently or not at all in the characteristic landscape, but they should remain subordinate to the visual strength of the characteristic landscape.

3) Modification: Visual quality objective management activities may visually dominate the original characteristic landscape. However, activities of vegetative and land form alteration must borrow from naturally established form, line, color, or texture so its visual characteristics are those of natural occurrences within the surrounding area or character type.

The visual resource management objectives assigned by the Forest Service to landscapes in the Project vicinity are shown in Figure 8-3. Landscapes whose variety and sensitivity level classifications result in the same visual resource management objective are combined to provide concise representation of the VMS data. As the figure shows, the Forest Service has assigned partial retention visual resource management objectives to most of the landscapes in the Project vicinity (USDA, Forest Service 1978). These landscapes are designated as such due to two factors:



LEGEND

- RETENTION
- PARTIAL RETENTION
- MODIFICATION

ALASKA POWER AUTHORITY

GRANT LAKE HYDROELECTRIC PROJECT

VISUAL QUALITY MANAGEMENT OBJECTIVES

FIGURE 8-3

EBASCO SERVICES INCORPORATED

1) their viewability at middleground distance zones from primary access routes (e.g., the Anchorage-Seward Highway, or the Vagt Lake Trail), or

2) numbers of recreational visitors viewing these landscapes are likely to be few; their locations are generally removed from primary access routes (e.g., the Grant Lake shoreline).

The Forest Service has rated highly the viewing significance of the entire shoreline of the Upper and Lower Trail Lakes system, along all primary access routes and recreation trails. Sensitivity level classifications are higher at these locations due to the higher viewing activities by recreationists traveling the Anchorage-Seward highway, boaters, fishermen, and hikers. These areas have been assigned the retention visual resource management objective.

8.2 POTENTIAL IMPACTS

8.2.1 Construction Activities

Project construction activities will overlap with peak recreational activity during summer months. Recreational opportunities, as discussed previously in this chapter and in Chapter 7, attract visitor and local resident recreationists from mid-June through September. Peak recreation activity typically occurs from mid-June through mid-August, months usually having mild weather. Peak construction activity is anticipated to occur between April and November of the first year of construction. Construction activity will taper off after this period, but construction of the powerhouse and tailrace structures will continue until completion around May of the second year of construction.

During the construction period structures and construction equipment will be introduced into the natural landscape. Construction activity will simultaneously be underway at several locations: the gateshaft, intake, penstock, and the powerhouse and tailrace.

The natural character of the Project vicinity will be disturbed temporarily during the construction period. Adverse aesthetic impacts associated with construction activity will result from increases in vehicular traffic, equipment noise, and emissions of smoke and dust. Aesthetic impacts will affect recreationists viewing the area, particularly those interested in viewing wildlife, some of which may temporarily avoid the area. A more permanent disturbance of the natural landscape will result from the removal of forest vegetation to accommodate the construction of permanent access roads required to maintain the Project. Local residents of the Moose Pass community will be most affected by the temporary increase in vehicular traffic and noise.

Disposal of tunnel debris may introduce a visual impact. Approximately 7,000 cubic yards of tunnel debris will be displaced during tunnel construction. This activity will occur during the winter months. This volume of material, when piled 20 ft high, would cover approximately one-half acre of surface terrain. The nature of the material will determine its suitability for potential use as riprap for the tailrace channel or other construction purposes. Tunnel debris not suitable for this or other uses during Project development will require disposal. The economic feasibility of transporting the material as well as the potential visual impacts associated with its disposal will be factors determining the selection of a suitable disposal site.

8.2.2 Project Structures

Principal structural facilities of the Project are the access roads, intake structure, gate shaft, recreation facilities, powerhouse and tailrace, power tunnel and penstock, fish mitigation facilities, and transmission line. The visual impacts of these structural features are discussed in the following paragraphs.

8.2.2.1 Access Roads

A permanent access road will be constructed to the powerhouse and gate shaft locations. With a width of approximately 20 ft but allowing a 100 ft-wide corridor for necessary cuts and fills, it will branch from the Anchorage-Seward Highway approximately three miles south of Moose Pass. The construction of a bridge across the Trail Lakes narrows will provide access to the east shoreline. The access road will be routed east and then north around a ridge which rises to approximately 671 ft elevation, and continue to the powerhouse site. To reach the gate shaft-intake area, the access road will follow the north bank of Grant Creek to within about 200 yards of Grant Lake where it will be routed northeasterly toward the gate shaft. An access road will also be constructed across Grant Creek to the south shore of Grant Lake to allow access to Project recreational facilities.

The elevation of the ridge and topographic configuration of the shoreline at the narrows will effectively restrict visibility of the powerhouse and gate shaft access roads and bridge from the principal view points along the Anchorage-Seward Highway.

Roads that provide recreational access to points of interest throughout the Project vicinity will increase the recreational viewing potential of landscapes previously viewed from only middleground and background distance zones. These new access roads will be classified by the Forest Service as secondary access routes, routes leading to secondary areas of interest and recreation sites where between one-fourth and three-fourths of the forest visitors have a major concern for scenic qualities (USDA, Forest Service 1974). Landscapes viewed adjacent to and at middleground distance zones from these routes will receive different VMS classification categories from those currently assigned by the Forest Service. Under the Visual Management System, these landscapes will require higher visual significance ratings due to the higher incidences of viewing made possible by the access roads.

8.2.2.2 Intake Structure, Gate Shaft, and Recreation Facilities

The Grant Lake intake and gate shaft structures and recreation facilities will not be visually evident to travelers along the Anchorage-Seward Highway or from locations within the Project vicinity. These Project structures will be visually evident only to visitors in the immediate vicinity of each structure.

8.2.2.3 Powerhouse and Tailrace Structures

The powerhouse will be located approximately 400 ft from the east shore of Upper Trail Lake. Its location will be sufficiently distant from the shoreline to minimize its visibility to travelers along the Anchorage-Seward Highway. An exterior design will be selected so that the powerhouse will harmonize with the surrounding natural landscape.

The tailrace will be constructed of riprap. Although the construction of the tailrace will introduce a linear feature into the natural landscape, the features of a tailrace designed of rock will harmonize with the visual image of the surrounding landscapes.

8.2.2.4 Transmission Line

A 69 kV transmission line will be required to transmit electricity generated by the powerplant to consumers at Seward, Alaska. The transmission line will parallel the powerhouse access road to the Anchorage-Seward Highway where it will tie into an existing transmission line.

Visual impacts associated with the transmission line junction will result from clearing the construction access road and adjacent transmission line structures. The clearing will require an opening in an area where dense vegetation currently exists. Portions of this opening will be visible from the highway. The bridge access and transmission line poles will be visible to boaters navigating the narrows joining Upper and Lower Trail Lakes.

8.2.3 Project Operation

Visual impacts associated with the operation of the Project will relate primarily to reduced flow releases downstream of the Grant Creek outlet at the Trail Lakes narrows, and increased flows into Upper Trail Lake from the powerhouse tailrace. Grant Creek flow will be reduced from an average annual flow of 196 cfs to an average annual spill of 10 cfs. In comparison to its existing natural flows, Grant Creek will essentially be dewatered.

The topographic configuration of the landscapes bordering Grant Creek and its outlet at the narrows between Upper and Lower Trail Lakes effectively screens views of Grant Creek from viewers traveling the Anchorage-Seward Highway. Visual impacts associated with the dewatering of Grant Creek will be evident to travelers along the new access bridge, boaters in the Trail Lakes narrows, and to anglers who fished Grant Creek before the Project.

Operation of the Project will reduce Grant Lake's current average annual lake elevation of 696 ft and result in fluctuating lake levels. The annual maximum regulated lake level of 691 ft will occur during late fall and early winter, August through October. The annual minimum regulated lake elevation of 660 ft will occur during the early spring, March through May. Maximum shoreline exposures will occur during March through May. Terrestrial surveys conducted in the Project vicinity indicate that an ice-covering persists over most area lakes and ponds as late as the end of April (AEIDC 1982). Recreationists are unlikely to be attracted to the Grant Lake recreation facility until it is free of ice, when the elevation of the lake will be approaching a level of 696 feet. Fluctuating lake levels will not have a great visual impact on recreation users of the Project vicinity.

8.3 MITIGATION OF IMPACTS

Several mitigative measures will be implemented by the Alaska Power Authority to reduce adverse visual impacts associated with Project construction and operation. Vegetation clearing required for the construction of access roads and transmission line corridors, powerhouse, and tailrace structures will be minimized. The transmission line will tie into an existing transmission line along the Anchorage-Seward Highway, avoiding the visual impact of the construction of a second transmission line along this same route.

Access roads will be routed, to the extent feasible, to prevent the introduction of conspicuous surface patterns into the natural environment, thereby minimizing their visual impacts. The permanent access road to the powerhouse facility and the transmission line will be routed behind a ridge away from the shoreline of Upper Trail Lake to minimize their visibility from travelers along the Anchorage-Seward Highway. The permanent access road to the gate shaft-intake area and the recreation area will be routed through natural depressions, avoiding unnecessary switchbacks. The topography and density of forest vegetation will minimize visibility of the permanent access road from the Anchorage-Seward Highway.

The power tunnel and penstock leading from the Grant Lake intake to the powerhouse at Upper Trail Lake will be an underground tunnel and will not be a visible Project feature.

The powerhouse will be constructed approximately 400 ft east of the Upper Trail Lake shoreline. It is set back from the shoreline and the presence of scattered shoreline vegetation will partially screen views of the powerhouse from view points along the highway. Additionally, the powerhouse exterior will be designed to be compatible with natural surroundings. The rock used to construct the tailrace will be visually compatible with the natural surroundings.

8.4 SUMMARY OF AGENCY CONTACTS

The following is a summary of pertinent Agency contacts made in support of this report. Correspondence between the Alaska Power Authority and various agencies is included in the Technical Appendix, Part VIII.

Alaska Department of Transportation

1) Date: July 8, 1982

Agency Representative: Bill Humphrey

Location: Anchorage

Subject: Traffic count data for the Moose Pass Maintenance Station

U.S. Department of Agriculture, Forest Service

1) Date: July 7, 1982

Agency Representative: Steve Hennig, Landscape Architect

Location: Anchorage

Subject: Visual Management System (VMS) classifications for the Project vicinity, receipt of maps delineating VMS classifications

9.0 LAND USE

This section describes current land ownership, use, and management characteristics in the Project vicinity, and proposed new land uses that would result from Project construction.

The study area for land use is defined as the land and water area directly or indirectly affected by construction and operation of the proposed Project, and is shown with surrounding lands in Figure 9-1. The study area extends from Trail River and Trail Lakes eastward to the headwaters of Grant Lake. This area includes the entire drainages of Grant Lake and Grant Creek, Falls Creek, Vagt Lake, and a small amount of direct drainage to Upper and Lower Trail Lakes. The area totals approximately 60 square miles. As Table 9-1 indicates, nearly three-fourths of the area lies within the Grant Lake and Grant Creek drainages.

TABLE 9-1

STUDY AREA BY DRAINAGE

Drainage	Approximate Area (Square Miles)
Grant Creek and Lake	44
Falls Creek	12
Vagt Lake and Creek	2
Upper and Lower Trail Lakes[a/]	2
TOTAL	60

a/ At gaging station just above Falls Creek.

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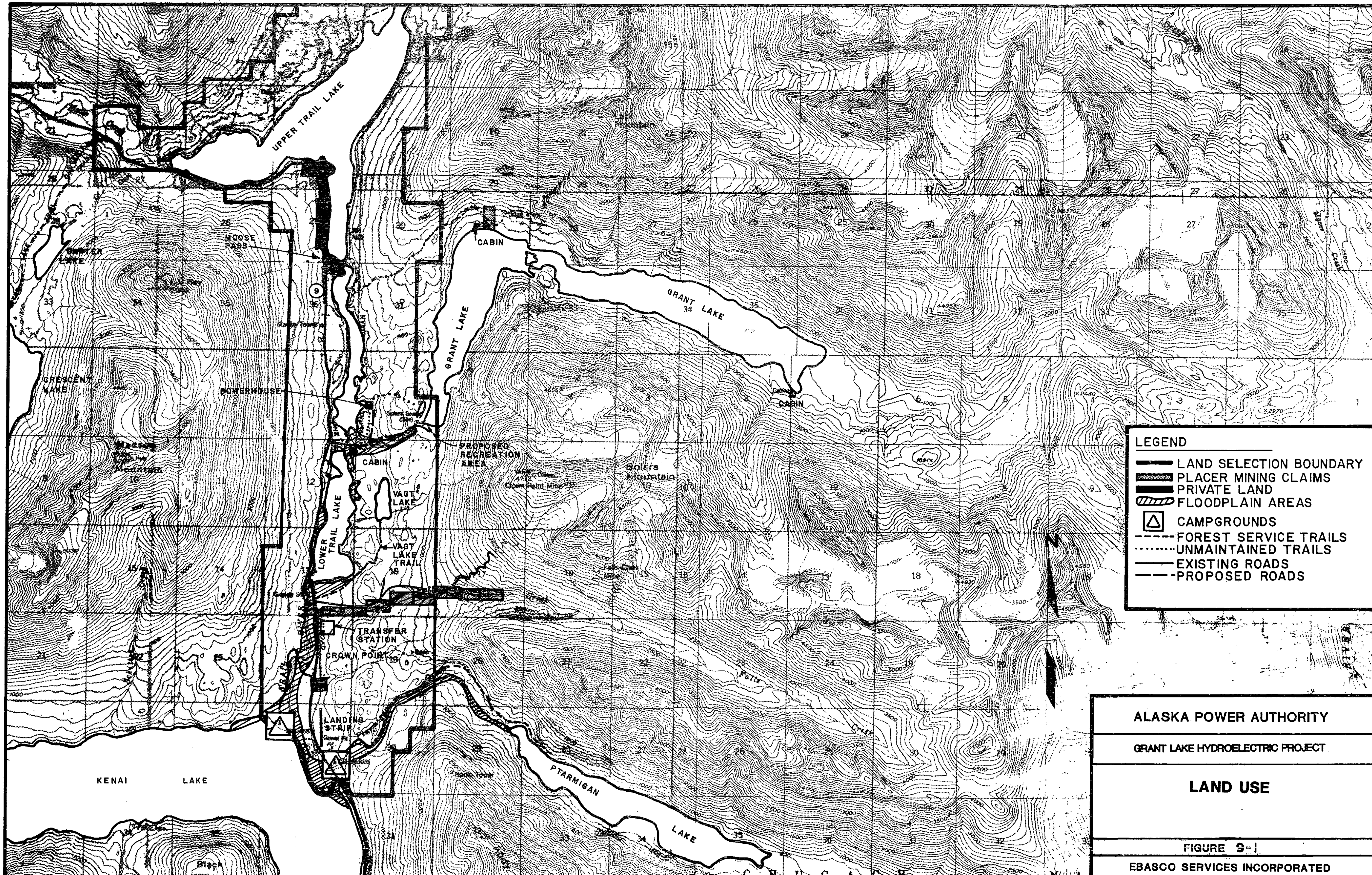
UPPER TRAIL LAKE
MOOSE PASS
CARTER LAKE
CRESCENT LAKE
POWERHOUSE
CABIN
GRANT LAKE
PROPOSED RECREATION AREA
Solars Mountain
VAGT LAKE
VAGT LAKE TRAIL
LOWER TRAIL LAKE
TRANSFER STATION
CROWN POINT
LANDING STRIP
KENAI LAKE
PTARMIGAN LAKE
LEGEND
LAND SELECTION BOUNDARY
PLACER MINING CLAIMS
PRIVATE LAND
FLOODPLAIN AREAS
CAMPGROUNDS
FOREST SERVICE TRAILS
UNMAINTAINED TRAILS
EXISTING ROADS
PROPOSED ROADS
ALASKA POWER AUTHORITY
GRANT LAKE HYDROELECTRIC PROJECT
LAND USE
EBASCO SERVICES INCORPORATED
FIGURE 9-1

As indicated in Chapter 3, lower lying lands in the Project vicinity are generally mixed forest, changing progressively at higher elevations to coniferous forest, shrub, and alpine vegetation. Glaciers occur at the highest elevations. Fragile areas within the area include those with shallow soils and areas of alpine vegetation. Of the approximately 60 square miles of the study area, about 3 square miles are in surface water, 2.5 square miles of which is Grant Lake.

9.1 LAND OWNERSHIP AND STATUS

The entire study area, with the exception of one private five-acre parcel, currently is federally owned land within the Chugach National Forest. The privately owned land is situated on the south side of the mouth of Grant Creek. Under terms of the Alaska Statehood Act and Alaska State legislation, ownership of a portion of the study area is to be conveyed to the State of Alaska and subsequently to the Kenai Peninsula Borough. Under the terms of the legislation, the land is to be used for expansion of existing communities, establishment of new communities, or recreation. The land to which the Borough is seeking title, amounting to slightly less than 11,000 acres, is shown in Figure 9-1. This land is scheduled to be conveyed to the Borough following negotiation and establishment of Forest Service easements for campgrounds, trails, and other facilities within the selection boundary.

Additional land status factors relevant to the Project involve land withdrawals and private claims on National Forest lands. The Federal Power Commission, predecessor agency to the Federal Energy Regulatory Commission, filed a power site withdrawal on behalf of the Chugach Electric Association for the Grant Lake-Falls Creek area with the Bureau of Land Management and Forest Service in 1960. According to the Federal Power Act (16 USC 818), this withdrawal does not preclude all other uses of the area, but does reserve the right to development of the hydroelectric site and limits other uses that would physically interfere with this right.

Numerous mining claims filed under the Mining Law of 1872 (30 USC 21 et seq.) also exist within the study area. Rights associated with valid mining claims allow the claimant sole authority to discover and remove minerals, and permit occupancy and the removal of timber to the extent necessary to support mining activities. Nine placer mining claims extend eastward from Trail River along lower Falls Creek, as shown in Figure 9-1 (USDA, Forest Service 1982a). The earliest placer mine claim was filed in 1969, nine years after the power site withdrawal was executed. Other mining claims, most of which are lode claims, are located on the northern, western, and southern slopes of Solars Mountain; at the northern end of Grant Lake, near the bend in the lake; and at various places south of Falls Creek.

9.2 LAND USE AND MANAGEMENT

9.2.1 Study Area

The study area (defined above) is predominantly undeveloped. Development has been limited to exploration and mining on the claims described above. Much of this mining activity has been situated in the upper Falls Creek drainage and to the north of the lower basin of Grant Lake, above the Project's high water level. The other significant use of lands in the area is for recreation, principally hiking, hunting, and fishing. These activities are described in Chapter 7. A miner's cabin is located at the north end of the lower basin of Grant Lake. A cabin formerly under special use permit to a local trapper is also located at the east end of Grant Lake; use of this cabin apparently is no longer authorized (Quilliam 1982). Forest Service management activities within the study area are not intensive, and consist primarily of maintenance, such as on the Vagt Lake Trail, and wildlife management.

9.2.2 Adjacent Lands

Lands abutting the study area on three sides are also primarily undeveloped National Forest lands. To the north of the Project, the Chugach National Forest extends for more than 25 miles and covers virtually all of this part of the Kenai Peninsula. Similarly, the National Forest extends eastward from the Project all the way to Prince William Sound. The southern border of the forest in this region is approximately 20 miles south of Falls Creek. While undeveloped, this area includes the popular recreation attractions of Paradise Lakes and Ptarmigan Lake.

To the west of the study area lie portions of Upper and Lower Trail Lakes and the major transportation corridor between Anchorage and Seward, which contains the Seward-Anchorage Highway and the Alaska Railroad. State Highway 9 becomes Highway 1 approximately 11 miles northwest of the Project. The unincorporated town of Moose Pass is located to the west of the study area on the west side of Upper Trail Lake. Private land on which Moose Pass is situated currently amounts to roughly 450 to 500 acres, although this figure may change after the land selection process is implemented. An unmaintained trail that is not part of the Forest Service system leads from Moose Pass to the northern end of the lower basin of Grant Lake.

Other developed land uses within the highway corridor include an Alaska Department of Fish and Game hatchery at the western end of Upper Trail Lake; a lodge, landing strip, and solid waste transfer station near Crown Point, which is just below the confluence of Falls Creek and Trail River; Forest Service campgrounds on Kenai Lake (Trail River) and Ptarmigan Creek; and a Forest Service guard station and a few scattered residences at Lawing on Kenai Lake. This pattern of highly-dispersed development along the highway generally continues from this area southward to Seward.

Undeveloped national forest lands again predominate to the west of the study area beyond the highway corridor. This sector of the Chugach National Forest contains several recreational facilities and is a popular recreation destination, particularly along Kenai Lake and the Kenai and Russian Rivers.

9.2.3 Special Land Use Considerations

Small wetlands occur in numerous locations within the study area. These wetlands primarily consist of areas of riparian vegetation along local streams and lakes and wet-meadow bogs in low-lying areas between Trail Lakes and Solars Mountain. The distribution and composition of these wetlands, and the effects of the Project on wetlands, are described in Chapter 3 of this report.

Floodplains are present within the study area, but are not extensive. Flood hazard studies have identified 100-year floodplains along Grant Creek, Falls Creek, Trail Lakes, and Trail River (Federal Emergency Management Agency 1981). The maximum width of these floodplains along Grant and Falls Creeks is about 650 ft, while the floodplain along the southern shore of Lower Trail Lake and the adjoining reach of Trail River extends inland for up to 750 ft. The remaining floodplain limits along Trail Lakes generally correspond to the normal lake shoreline, with the exception of a few low-lying promontories. The powerhouse will be located outside the 100-year floodplain of Upper Trail Lake. The main access road will cross a floodplain area at the confluence of Grant Creek and the channel between Upper and Lower Trail Lakes, and will be built to withstand flooding.

There are no prime farmlands within the study area (Moore 1982). The study area is not within the interim coastal zone boundaries established for the Alaska Coastal Management Program (Wolf 1982).

9.3 PROPOSED LAND USES

The proposed Project will produce three principal types of land use changes: addition of Project facilities and construction and operation activities on currently undeveloped lands and water, changes in surface water regulation, and changes in recreational use of the area. Some of these induced changes will be temporary or seasonal, but the Project will have a minor permanent impact on land use patterns in the study area.

9.3.1 New Land Uses

Proposed Project facilities, shown in Figure 1-3, include a lake tap, gate shaft, power tunnel, penstock, powerhouse, transmission line, access roads, and recreational facilities. The power tunnel will be an underground facility, and will not occupy or disturb any surface area. With the exception of access roads, Project facilities will occupy a relatively small amount of the total study area. Access roads, which will support both Project construction and operation and also recreational access, will occupy land that is currently mostly forested. The transmission line will be located within the corridor of the access road to the powerhouse and will not require additional clearing.

The land areas that will be required for permanent Project facilities are presented in Table 9-2. Of the 10.9 acres required for all Project facilities, road access to the powerhouse, gate shaft/intake, and recreation area accounts for 9.4 acres or 86 percent. In addition to the area that will be permanently occupied, construction and staging areas will require temporary disturbance and occupancy on 4 to 5 acres. These areas will be located near the powerhouse, the gate shaft, and the access road crossing of the narrows between Upper and Lower Trail Lakes.

TABLE 9-2

AREAS REQUIRED FOR PROJECT FACILITIES

Facility	Area (acres)
Gate shaft	--
Penstock	0.1
Powerhouse	0.3
Access roads and transmission line	9.4
Recreation area	1.1
All Facilities	10.9

Project construction and operation will produce fluctuations in the water level of Grant Lake of up to 40 ft during an average year, compared to approximately 8 ft per year under natural conditions. Project design involves lowering the lake's maximum average level from elevation 696 to 691 ft, producing fluctuations between elevations 660 and 691 feet. Project construction and operation would also effectively dewater Grant Creek.

9.3.2 New Recreational Uses

Construction of the Project will introduce roaded recreation to formerly roadless areas between the south end of Grant Lake and the Seward Highway. In addition to some new recreation uses that do not currently exist within the study area, increased access is also likely to result in higher use levels for dispersed recreational activities, which currently take place at and near Grant Lake. These changes in recreational use are described more fully in Chapter 7.

9.3.3 Compatibility with Existing and Planned Uses

The Project is compatible with existing and expected land uses and planning guidelines for the area. The Chugach National Forest land within the study area is currently managed for multiple uses forest, although lack of road access effectively limits the type of management activities that can be undertaken. Adoption and implementation of a new Chugach Forest Plan is not expected to change the character of Forest Service management, given the content of the Draft Forest Plan (USDA, Forest Service 1982b). Following completion of the land selection and conveyance process, the remaining National Forest lands immediately around Grant Lake and some lands in the Falls Creek drainage would be within Analysis Area 4 (Timbered Sideslopes, East Side, Kenai Peninsula); management prescriptions within the Draft Forest Plan for this area emphasize increased dispersed recreation opportunities and improved fish and wildlife habitat. Prescriptions for Analysis Area 1 (Alpine, Kenai Peninsula), which include Solars Mountain, also emphasize dispersed recreation, fish and wildlife habitat, and maintenance of landscape character.

Much of the study area, including lands around the outlet of Grant Lake and westward to Trail Lakes, will be under the jurisdiction of the Kenai Peninsula Borough and probably the community of Moose Pass in the relatively near future. The Moose Pass Advisory Planning Commission is currently developing a land use plan for the entire community land grant, but no plans or guidelines have been adopted.

9.4 SUMMARY OF AGENCY CONTACTS

The following is a summary of pertinent Agency contacts made in support of this report. Correspondence between the Alaska Power Authority and various agencies is included in the Technical Appendix, Part VIII.

Alaska Office of the Governor, State Clearinghouse

1) Date: October 14, 1982

Agency Representative: Wendy Wolf (Juneau)

Location: (Telephone conversation)

Subject: Coastal zone boundary and planning applicability to the Project

Kenai Peninsula Borough

1) Date: January 18, 1982

Agency Representative: Carolyn Thompson and Frank McIlhargey (Soldotna)

Location: (Telephone conversation)

Subject: Land use and development policies and objectives in Project vicinity and socioeconomic characteristics

2) Date: June 18, 1982

Agency Representative: Frank McIlhargey

Location: Soldotna, Alaska

Subject: Economic outlook and data for Borough and Project vicinity

3) Date: August 17, 1982

Agency Representative: Dawn Lahnum

Location: (Telephone conversation)

Subject: Local taxes applicable to the Project

U.S. Department of Agriculture, Forest Service

1) Date: January 14, 1982

Agency Representative: Bob Dunblazier and Ann Albrecht, Anchorage

Location: (Telephone conversation)

Subject: Forest Service Land use planning activity and management objectives in Grant Lake vicinity

2) Date: June 21, 1982

Agency Representative: Beulah Bowers

Location: Anchorage, Alaska

Subject: Locations and conditions of mining claims in Chugach National Forest

3) Date: August 25, 1982

Agency Representative: Beulah Bowers (Anchorage)

Location: (Telephone conversation)

Subject: Power site withdrawal regulations, particularly in regard to mining claims

U.S. Soil Conservation Service

1) Date: October 14, 1982

Agency Representative: Joe Moore (Anchorage)

Location: (Telephone conversation)

Subject: Location of prime farmlands in vicinity of Grant Lake

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