FERC/DEIS-0038

SUSITNA HYDROELECTRIC PROJECT

FERC No. 7114

ALASKA

Draft Environmental Impact Statement

Volume 1: Main Text

OFFICE OF ELECTRIC POWER REGULATION
FEDERAL ENERGY REGULATORY COMMISSION

MAY 1984

FERC/DEIS-0038

FEDERAL ENERGY REGULATORY COMMISSION
OFFICE OF ELECTRIC POWER REGULATION

DRAFT ENVIRONMENTAL IMPACT STATEMENT

SUSITNA HYDROELECTRIC PROJECT
FERC NO. 7114 - ALASKA

Volume 1. Main Text

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

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

May 1984

COVER SHEET

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

b. Cooperating Agencies: United States Army Corps of Engineers (Corps) and the Rural Electrification Administration

c. Title: Susitna Hydroelectric Project, FERC Project No. 7114-Alaska

Application for FERC license to construct, operate, and maintain the proposed Susitna Hydroelectric Project

d. Contact: Mr. J. Mark Robinson
Federal Energy Regulatory Commission
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e. Draft Environmental Impact Statement

f. Abstract: Alaska Power Authority (Applicant) of Anchorage, Alaska, proposes to construct a hydroelectric project with an installed capacity of 1620 megawatts (MW) on the Susitna River approximately 140 miles north-northeast of Anchorage. The action proposed by the Applicant would require (1) an earth-fill dam (Watana), with a crest level of 2205 feet above mean sea level and a height above foundation of 885 feet, located at Susitna River Mile 184 (approximately 2.5 miles upstream of the confluence with Tsusena Creek); (2) a concrete arch dam (Devil Canyon), with a crest level of 1463 feet above mean sea level and a height above foundation of 646 feet, located at Susitna River Mile 152 (about 32 miles downstream of the proposed Watana dam), and an earth-fill saddle dam with a height 245 feet above its base on the south abutment of the Devil Canyon dam; (3) underground powerhouses at the proposed Watana and Devil Canyon dams; (4) approximately 370 miles of overhead and 4 miles of submarine transmission line; (5) 62 miles of access roads and 13 miles of railroad access; (6) a permanent town housing 130 operations workers at the Watana dam site; and (7) other appurtenant facilities. Construction would commence subsequent to issuance of a license.

g. Transmittal: This draft environmental impact statement, prepared by the Commission's Staff in connection with an application filed by the Alaska Power Authority for proposed Project No. 7114, is being transmitted for your information pursuant to the requirements of the National Environmental Policy Act of 1969 and Commission Order No. 415-C, issued December 18, 1972 (see Sec. 8, Attachment I).

h. Copies of the draft environmental impact statement are available for public review at the San Francisco Regional Office-FERC.

i. The draft environmental impact statement was sent to the Environmental Protection Agency and made available to the public on or about May 25, 1984.

FOREWORD

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

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

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

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* 16 U.S.C. § 791(a) - 825(r)

** Public Law 95-91, 91 Stat. 556

*** 16 U.S.C. Sec. 803(a)

† 16 U.S.C. Sec. 803(g)

†† 18 C.F.R. Sec. 1.6

PREFACE

The Draft Environmental Impact Statement (DEIS) for the Susitna Hydroelectric Project is composed of seven volumes. Volume 1 contains the main text of the DEIS, consisting of eight sections. Section 1 deals with the purpose and need for the action, including past, present, and future need for power, discussion of Applicant's and Staff's load growth forecasts, range of alternatives examined, economic analysis of alternatives, and Staff's development of various power generation scenarios that represent the range of available and feasible options for meeting the future electric energy demand in the Railbelt region of Alaska. Section 2 contains a detailed description of the proposed project and the various alternative power generation scenarios considered in the DEIS.

Section 3 contains descriptions of the regional and project-specific environments that could potentially be affected by development of the proposed project or any of the array of alternatives analyzed. This section covers land features and uses, climate and air quality, water resources and aquatic communities, plant and animal populations and associations, socioeconomic factors, recreational and visual resources, and archeological and historic sites.

Section 4 describes and discusses the probable environmental impacts that would be likely to occur in the environments described in Section 3 if the Susitna Hydroelectric Project or any of the various alternatives were constructed and operated as described in Section 2. In addition to discussion of environmental impacts of each proposed or alternative scenario, this section also covers impacts of the no-action alternative, a comparison of the projected impacts of the various alternatives, relationship of impacts to known resource plans and utilization, impacts that cannot be avoided or mitigated, resources that would be permanently lost, and short-term vs. long-term uses of the environment. A companion section to that detailing impacts is Section 5, which presents the Staff's conclusions regarding impacts of the proposed and alternative projects, the Staff's recommendations regarding the proposed project or alternatives, and any necessary mitigation or additional studies that the Staff believes are necessary to minimize impacts or clarify issues. Sections 6 and 7 contain a list of preparers and a list of primary recipients, respectively. Section 8 contains two standard attachments included in all FERC Environmental Impact Statements.

In an effort to reduce the length and improve the readability of the main DEIS text, Sections 1 through 5 of Volume 1 are presented more or less as summaries of the Staff's studies and project-related descriptions, analyses, and environmental impact discussions. These five sections contain relatively brief and concise supporting technical discussions, few reference citations, and comparatively few technical tables and figures. Summary descriptions, analyses, and discussions in Volume 1 are comprehensively discussed and supported, as appropriate, with substantial technical detail in a parallel set of appendices grouped by disciplines in Volumes 2 through 7. These appendix volumes are available for public inspection at various public locations throughout the Railbelt, or may be ordered individually from the FERC Public Information Office in Washington, D.C.

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SUMMARY

The action before the Federal Energy Regulatory Commission (FERC) is an application for a license to construct and operate the proposed Susitna Hydroelectric Project, FERC No. 7114. The Applicant, Alaska Power Authority, seeks authorization to construct and operate a hydroelectric generating system located on the Susitna River, approximately 140 miles (mi) [220 kilometers (km)] north-northeast of Anchorage, Alaska. The system would be comprised of two dams (Watana and Devil Canyon), reservoirs, and powerhouses with an installed capacity of approximately 1,620 megawatts (MW) producing an average of approximately 6,570 gigawatt hours (GWh) annually. The Applicant proposes to utilize the power and energy developed by the Susitna project to serve the needs of customers within the Railbelt region of Alaska. This region includes Anchorage and Fairbanks, the two largest cities in Alaska, as well as most of the population of the state. The Susitna Hydroelectric Project would utilize waters of the Susitna River for power production. The Susitna project would not involve a consumptive use of water, because all water would be returned to the river via the powerplant tailrace or spillways.

Watana dam would be located at River Mile (RM) 184 approximately 2.5 mi (4 km) upstream of the confluence with Tsusena Creek. This earth-rock fill dam would have a impervious central core protected by fine and coarse filters. The nominal crest elevation of the dam would be 2,205 feet (ft) [672 meters (m)] MSL, with a maximum height of 885 ft (270 m) above the foundation and a crest length of 4,100 ft (1,250 m). The total volume of the structure would be approximately 62 million yd^3 (47 million m^3) of fill. The Watana dam would create a reservoir approximately 48 mi (77 km) long, with a surface area of 38,000 acres [15,400 hectares (ha)], and a gross storage capacity of 9 million acre-feet (ac-ft) [1.2×10^{10} cubic meters (m^3)] with the water surface at elevation 2185 ft (666 m) MSL, the normal maximum operating level. The maximum water surface elevation of the reservoir would be 2201 ft (678 m) MSL, and the minimum operating level of the reservoir would be 2,065 ft (629 m) MSL, providing a live storage of 3 million ac-ft (4.6×10^9 m^3).

The Devil Canyon dam would be located at the upstream entrance of the Devil Canyon gorge at RM 152 approximately 32 mi (51 km) downstream from Watana dam. The Devil Canyon dam would be a thin arch concrete structure 646 ft (197 m) high with a crest length-to-height ratio of approximately two. The dam would have a crest elevation of 1,463 ft (446 m) MSL and be supported by mass concrete thrust blocks on each abutment. On the south abutment, the lower bedrock surface would require the construction of a large thrust block and adjacent to this thrust block, a 245-ft (75-m) high earth and rockfill saddle dam to provide closure to the south bank. The saddle dam would be a central core type similar in cross section to the Watana dam. The Devil Canyon dam would form a reservoir approximately 26 mi (42 km) long with a water surface area of 7,800 acres (3,200 ha) and a gross storage capacity of 1 million ac-ft (1.4×10^9 m^3) at elevation 1,455 ft (443 m) MSL, the normal maximum operating level. The maximum water surface elevation of the reservoir would be 1,466 ft (447 m) MSL, and the minimum operating level would be 1,405 ft (428 m) MSL, providing a live storage of 0.35 million ac-ft (4.3×10^8 m^3).

The construction and operation of the Susitna development would require facilities to support the construction activities throughout the entire construction period. The most significant facility would be a combination temporary camp and village constructed and maintained at the Watana project site. The camp/village would be a largely self-sufficient community housing up to 3,300 people during construction of the project. Upon completion of construction, most of this facility would be dismantled and the area rehabilitated. The dismantled buildings and other items from the camp would be used, to the extent possible, during construction of the Devil Canyon development. The Devil Canyon camp/village would provide housing and living facilities for 1,800 people during construction. The Devil Canyon camp/village would be completely dismantled and the site rehabilitated after construction. Other temporary site facilities would include contractors' work areas and roads and onsite facilities to provide power, services, and communications. Permanent facilities would include a town or small community for approximately 130 staff members and their families located at the Watana site. Other permanent facilities would include a maintenance building and airstrip for use during operation of the power plant.

Transmission and substation additions would be constructed in stages keyed to the differing dates for Watana and Devil Canyon generation. Transmission facilities to be constructed for Watana would include: (1) two 37-mi (59-km), single-circuit, 345-kV (kilovolt) outlet transmission lines to connect the powerhouse substation with a new substation located at Gold Creek on the existing Healy-to-Willow line (which would then be upgraded to 345 kV), (2) a second 345-kV line, 170 mi (270 km) long, from Healy to Willow paralleling the existing line, (3) a pair of single-circuit, 345-kV lines, 63 mi (101 km) long, extending from Willow to the new Knik Arm and University substations in the Anchorage area, and (4) a pair of single-circuit 345-kV lines, 100 mi (160 km) long, extending from Healy to the new Ester substation west of Fairbanks.

Transmission facilities to be constructed for Devil Canyon would include: (1) 8 mi (13 km) of 345-kV, double-circuit outlet transmission from the powerhouse substation to the Gold Creek substation, and (2) an additional 345-kV circuit, 123 mi (197 km) long, from Gold Creek to Knik Arm, paralleling the previously constructed two single-circuit lines.

The Applicant's proposed access plan would provide for rail and road transport of the necessary materials, equipment, and personnel to the Watana-Devil Canyon construction sites. A railhead and storage facility covering approximately 40 acres (16 ha) would be constructed at Cantwell along the existing Alaska Railroad. From this facility, access to the Watana site would be along an existing road, 2 mi (3 km) to the intersection of the George Parks and Denali Highways, then easterly along the Denali Highway for 21.3 mi (34.1 km) to a new road. The new road would be constructed to the Watana camp site approximately 42 mi (67 km) due south from the Denali Highway. Access to the Devil Canyon site would be along a new road, approximately 20 mi (30 km) in length, constructed from the Watana access road. A high-level suspension bridge would be required where the access road would cross the Susitna River downstream of the Devil Canyon dam. Rail access to the Devil Canyon site would require construction of a spur between the existing Alaska Railroad at Gold Creek and the camp site.

The Applicant's proposed construction schedule spans a period from April 1985, beginning with access road construction at Watana, to October 2002, when commercial operation of Devil Canyon units would begin. This schedule is predicated on the awarding of a FERC license by December 31, 1984. Two constraints were considered in the development of this schedule: the issuance date of the FERC license and the need to have four units on line by January 1994 in order to meet Railbelt load growth as projected by the Applicant.

The critical path of activities to meet these constraints would be through site access, site facilities, diversion, and main dam construction. The proposed schedule would require that extensive planning, bid selection, and commitments be made before the end of 1984 to permit work to progress on schedule during 1985 and 1986. Year-round road access to the site would be required by October 1, 1985; equipment would be transported overland via winter trail during the winter of 1984 in order for an airfield to be constructed by July 1985. This would allow site facilities to be developed in a very short time to support the main construction activities. A camp to house approximately 1,000 people would be constructed during the first 18 months. Onsite power generating equipment would have to be installed in 1985 to supply power for camp and construction activities, and an aggregate processing plant and concrete batching plant would have to be operational to start diversion tunnel concrete work by April 1986. Excavation of the access tunnel into the powerhouse complex would start in late 1987. Stage I concrete would begin in 1989, and installation of major mechanical and electrical work would start in 1991. Construction of the transmission lines and switchyards has been scheduled to begin in 1989 and to be completed before commissioning of the first unit. The first four units are scheduled to be on line by the beginning of 1994 and the remaining two units in early 1994.

The schedule for Devil Canyon was developed to meet the on-line power requirement of all four units in 2002. The critical path of activities was determined to follow through site facilities, diversion, and main dam construction. The development of site facilities at Devil Canyon would begin slowly in 1994, with a rapid acceleration in 1995 through 1997. It has been assumed that site access built to Watana would exist at the start of construction. A road would be constructed connecting the Devil Canyon site to the Watana access road, including a high-level bridge over the Susitna River downstream of the Devil Canyon Dam. At the same time, a railroad spur would be constructed to permit rail access to the southern bank of the Susitna near Devil Canyon. These activities would be completed by mid-1994. Within a short period of time thereafter, construction would begin on most major structures.

Excavation and concreting of the single diversion tunnel would begin in 1995. River closure and cofferdam construction would take place to permit start of dam construction in 1996. The construction of the arch dam would be the most critical construction activity from start of excavation in 1996 until topping out in 2001. Excavation of access into the powerhouse cavern would begin in 1996. Stage I concrete would begin in 1998, and installation of major mechanical and electrical work would start in 2000. The spillway and intake would be scheduled for completion by the end of 2000 to permit reservoir filling the next year. The additional transmission facilities needed for Devil Canyon would be scheduled for completion by the time the final unit was ready for commissioning in late 2001.

Workforce requirements for construction of the Watana development would vary from approximately 1,100 people at the start of access road construction in 1985 to a peak of about 3,500 in 1990. A rapid drop in workforce needs would occur between 1990 and 1995 when construction would be complete and the operation staff of 105 would occupy the permanent town. Workforce requirements for construction of the Devil Canyon development would vary from about 100 in 1994 to a peak of 1,700 in 1998, reducing to a permanent staff of approximately 25 in 2002.

The Staff analyzed the potential environmental consequences of the proposed project in relation to several alternatives. Alternative development along the middle Susitna River included alternative dam designs and configurations, flow regimes, access routes, and transmission line routes. In addition, Staff considered alternative power generation scenarios that would not involve development along the Susitna River. These scenarios included: natural-gas generation of power at sites around Cook Inlet; generation of power at Nenana and Willow using coal from the Nenana coal field; and a combined hydropower-thermal generation of power at several sites in South-central and Interior Alaska. Each alternative scenario that was addressed was considered capable of meeting load growth needs in Alaska's Railbelt region and of providing equivalent energy generation. The array of alternative scenarios was chosen to be representative of the feasible extremes of development that would meet projected load growth.

The Staff considered three alternative development schemes within the Susitna River Basin: Watana I with Devil Canyon; Watana I with Modified High Devil Canyon, and Watana I with a reregulating dam.

Watana I-Devil Canyon development would be identical to the proposed project, with the exception that Watana dam would be scaled down to have a crest elevation of 2,125 ft (646 m) MSL and a normal reservoir level of 2,100 ft (637 m) MSL [versus 2,210 ft (671 m) and 2,185 ft (663 m) MSL, respectively, for the proposed dam]. This project would operate in the same manner as the proposed project, i.e., Watana I would operate as a baseload plant until completion of Devil Canyon. After completion of Devil Canyon, Watana I would operate as a peaking plant and Devil Canyon would be operated to regulate Watana I discharges to meet downstream fishery requirements.

Watana I-Modified High Devil Canyon development would be as described above except a modified High Devil Canyon development would be located at approximately RM 157, or about 5 mi (8 km) upstream from the proposed Devil Canyon site. The dam would be of earth and rockfill construction with an impervious core; it would have a crest elevation of 1,495 ft (454 m) MSL. It would have a normal maximum water surface elevation of 1,470 ft (447 m) MSL and a maximum height of approximately 595 ft (181 m). This development would be operated in the same manner as the Watana I-Devil Canyon project.

Watana I-Reregulating dam development would utilize a reregulating dam located approximately 16 mi (25 km) downstream of Watana I. The reregulating dam would be of earth and rockfill construction, with a crest elevation of 1,500 ft (456 m) MSL and a maximum height of approximately 250 ft (76 m). A spillway would be located on the northern abutment, and a 200-MW powerhouse would be downstream of the dam on the southern bank. A tunnel and a powerhouse at Devil Canyon could be added in the future. However, if further study indicates that the tunnel is an economically feasible alternative, the Reregulating dam powerhouse construction could be staged to avoid installing capacity that could not be used if water was diverted to the tunnel powerhouse. The project would be operated in the same manner as the two previously discussed developments.

The gas-fired generation scenario analyzed by the Staff assumed the phased installation of eight 200-MW, gas-fired, baseload, combined-cycle units and two 70-MW gas-fired combustion-turbine peaking units. The combined-cycle units each would include two combustion-turbine generator units, a heat recovery boiler using the exhaust gases of the combustion turbines to produce superheated steam, and a steam turbine generator. The combined cycle substantially improves power generation efficiency. A plant with two combustion turbines can be operated at partial load with one of the gas turbines out of service.

In its analysis, the Staff assumed that the combined-cycle and combustion-turbine units would be sited in proximity to natural-gas distribution pipelines. Because of the greater volume of gas required by the combined-cycle units, it is expected that they would be concentrated in the western Cook Inlet area and on the Kenai Peninsula. Specific sites considered were along the Chuitna and Beluga rivers, near Kenai, and near Anchorage.

For its coal-fired generation scenario, the Staff assumed the phased installation of five 200-MW, coal-fired, baseload units and ten 70-MW combustion-turbine peaking units to meet the projected Railbelt power requirements. The coal units were assumed to be of conventional design and to use dry flue gas desulfurization scrubbers for the removal of sulfur oxides, baghouse particulate removal, wet/dry mechanical draft cooling towers for heat rejection, and pulverized coal for combustion. The assumed capital cost was deemed to reflect the state-of-the-art with regard to environmental safeguards and an ability to meet established performance standards. The combustion-turbine peaking units were assumed to be simple-cycle machines using natural-gas fuel.

In the coal scenario, the Staff assumed that three 200-MW coal generation units would be located in the Nenana area and two 200-MW units in the Willow area. Combustion-turbine facilities would be dispersed throughout Cook Inlet area. Coal delivery to the Nenana and Willow stations was assumed to be by unit train from the vicinity of the Usibelli Mine in the Nenana coal field. Fuel for the combustion-turbine installations was assumed to be available from gas distribution pipelines.

The final scenario considered by the staff was a combined hydro-thermal generating scenario consisting of hydropower facilities at sites outside the Susitna Basin plus various thermal (coal- and gas-fired) units. The hydroelectric sites considered in this scenario were Browne, Chakachamna, Johnson, Keetna, and Snow.

The Browne site is located on the Nenana River near Healy, approximately 75 mi (120 km) southwest of Fairbanks. The Browne dam would be either a concrete gravity or a concrete-faced rockfill structure. It would have a crest elevation of 995 ft (302 m) MSL and a maximum height of approximately 235 ft (71 m). A diversion tunnel and flip-bucket spillway would be constructed on the northern abutment and a power tunnel and surface powerhouse on the southern abutment.

Chakachamna Lake is located in the Alaska range approximately 80 mi (130 km) west of Anchorage. The lake discharges into the Chakachatna River, which runs southeasterly out of the lake and eventually discharges into Cook Inlet. The alternative development here would be a lake tap of Chakachamna Lake, with a diversion tunnel [approximately 23 ft (7 m) in diameter] to the MacArthur River Basin. An underground powerhouse would be located on the MacArthur River near the base of the Blockade Glacier.

The Johnson site is located on the Tanana River, approximately 120 mi (190 km) southeast of Fairbanks, and has a drainage area of 10,450 square miles (mi^2) [27,060 square kilometers (km^2)]. The Johnson dam would be a concrete gravity structure with earthen dikes, and would have a maximum height of about 140 ft (40 m). The reservoir would have a maximum water surface elevation of 1470 ft (447 m) MSL and would have an active storage of about 5 million ac-ft (6.5×10^9 m^3).

The Keetna site is located on the Talkeetna River, approximately 70 mi (110 km) north of Anchorage. The Talkeetna River, with headwaters in the Talkeetna Mountains, flows southwesterly to its confluence with the Susitna River. The damsite has a drainage area of 1,260 mi^2 (3,260 km^2). Streamflow records indicate the yearly average discharge at the site to be 1 million ac-ft (2.09×10^9 m^3). Power development would include a dam with a diversion tunnel. The dam would be of earth and rockfill construction and would have a crest elevation of 965 ft (293 m) MSL, with a maximum height of approximately 365 ft (111 m). The spillway and power facilities would be located south of the dam.

The Snow site is located on the Snow River in the Kenai Peninsula. Power development would include a dam with diversion through a tunnel approximately 7,500 to 10,000 ft (2,300 to 3,600 m) long. An earth and rockfill dam with a crest elevation of 1,210 ft (367 m) MSL and a maximum height of approximately 310 ft (90 m) would be constructed. The diversion and power tunnel would be located on the southern abutment, and a spillway would be constructed at the southern end of the reservoir approximately 1 mi (2 km) from the dam.

The average annual streamflow at the dam site is estimated at 510,000 to 535,000 ac-ft (6.3×10^8 to 6.6×10^8 m^3). The dam site would be fed by 105 mi^2 (272 km^2) of the river's 166-mi^2 (430-km^2) drainage area.

The thermal portion of a combined hydro-thermal scenario would consist of the same types of thermal generating units considered in the coal and gas scenarios discussed previously. These would include one 200-MW conventional coal-fired unit of the type discussed in the coal scenario, three or four 200-MW combined-cycle gas units as discussed in the gas scenario, and three 70-MW gas-fired combustion-turbine units as discussed in both of the thermal scenarios. Use of the lower-cost hydropower resources in the combined scenario would reduce the number of thermal units needed to meet power requirements through the 30 years of operation, as compared to the two all-thermal scenarios.

The single coal-fired unit in the combined hydro-thermal scenario was again assumed to be in the Nenana area of the Railbelt, taking advantage of the expansion capability of the Usibelli Mine. Gas-fired combined-cycle units were again located in the Kenai Peninsula and on the western side of the Cook Inlet (the Beluga area) close to natural-gas fuel supplies. Required gas-fired combustion-turbine units for peaking were again assumed to be located near natural-gas distribution pipelines.

The Staff has completed a detailed analysis of the environmental consequences of implementing the proposed Susitna hydropower development or any of the alternatives that were considered.

The Staff has found that significant environmental impacts would occur as a consequence of the proposed action:

1. Geology and Soils

   - Accelerated slope erosion and failure along the shorelines of the reservoirs;
   - Accelerated soil erosion and permafrost thaw as a result of vegetation clearing for reservoirs, construction facilities, and rights-of-way.

2. Land Use and Ownership

   - Conversion of the remote, poorly accessible upper and middle Susitna River Basin into an area of greater human activity and development.

3. Water Quality and Quantity

   - Nitrogen supersaturation due to release of excess flows between July and September in almost every year of operation;
   - Reduced mean summer flows and increased mean winter flows;
   - 60% reduction in mean annual flood; stabilization and narrowing of river channel above Talkeetna;
   - Decreased summer turbidity and increased winter turbidity.

4. Fisheries

   - Restricted access to spawning sloughs used by chum and sockeye salmon;
   - 50% reduction in annual juvenile growth for salmon; growth reduction by 60% to 70% for early emigrating chum and pink salmon;
   - Increased fishing pressure on species throughout the middle and upper Susitna Basin due to improved access.

5. Terrestrial Communities

   - Inundation and complete or selective clearing of more than 56,000 acres (22,700 ha) of vegetation;
   - Reduction in the moose population in the upper and middle Susitna Basin as a consequence of losing about 60 mi^2 (150 km^2) of overwintering and calving habitat;
   - Reduction in the black bear population in the basin as a consequence of inundation of already limited habitat and of 50% of the available denning sites;
   - Doubling of the hunting pressure on big game in the basin and consequent increases in wildlife mortality;
   - Loss or disturbance of 4 bald eagle and 16 to 18 golden eagle nesting locations.

6. Recreation Resources

   - Disruption of wilderness-type recreation experiences in the upper and middle Susitna Basin, including hunting and fishing;
   - Increased competition for use of recreation resources and the potential for degradation of recreation resource areas, particularly during peak construction periods;
   - Inundation of the Vee Canyon and Devil Canyon rapids, which are noteable white-water recreation resources;

7. Socioeconomic Factors

   - Large population increases followed by decreases ("boom-and-bust" conditions) in Trapper Creek, Talkeetna, Cantwell, and other communities in the project area;
   - Shortages in housing and community services;
   - Potential cultural conflicts between inmigrants and current residents;
   - Alteration in patterns of human use of fish and wildlife in the upper and middle Susitna Basin;
   - Need to alter current fish and wildlife management goals and practices in response to changes in resource use patterns in the basin.

8. Visual Resources

- Significant visual contrast between the project features and the natural setting of the Susitna River Valley landscapes;
- Exposure of mudflats during spring and summer along the shores of the Watana reservoir;
- Vegetation clearing and transmission line structures visible at a number of points along the Parks Highway, Alaska Railroad, and Denali Highway; from various locations in Railbelt communities, Denali National Park and Preserve, and Denali State Park; and from the air.

The Staff also identified a number of other significant impacts of implementing alternatives to the proposed projects, including:

- Significant consumptive use of regional coal and gas reserves for thermal alternatives to the proposed project;
- Inundation of portions of the Parks and Alaska highways with filling of the reservoirs that would be associated with the Browne and Johnson hydropower alternatives;
- Potential for impaired visibility in the Class I area at Denali National Park as a result of emissions from three to five 200-MW coal-fired units at Nenana (one or two units should not result in significant impairment of visibility);
- Potential violation of PSD Class II increment for SO_2 (24-hr average) at elevated terrain northeast of Nenana due to three to five 200-MW coal-fired units at Nenana (one or two units would not result in violations);
- Potential violation of PSD Class I increment for SO_2 (24-hr average) at Denali National Park due to four or five 200-MW coal-fired units at Nenana (one to three units would not result in violations);
- Potential loss of major sockeye salmon population at Lake Chakachamna due to river rerouting;
- Potential loss of salmon habitat at the Keetna hydropower site;
- Potential loss of salmon habitat at the Johnson hydropower site;
- Increased pressure on fisheries due to improved access for all hydropower and thermal alternatives;
- Dedication of more than 115,000 acres (46,000 ha) of land and vegetation to project use in the combined hydro-thermal alternative;
- Disruption of a major river touring route along the Nenana River as a result of the Browne hydropower alternative;
- Alternating increases and decreases in populations of communities near alternative sites resulting in the boomtown syndrome;
- Alteration of aesthetic quality in area of alternative developments.

In reviewing the various alternative power generation scenarios (including the proposed project), the Staff concluded that, from an environmental standpoint only, the thermal alternatives (natural-gas and coal-fired generating facilities) would have the least severe consequences. Additionally, based on considerations of engineering feasibility, economic characteristics, and environmental impacts, the Staff concluded that a mixed thermal-based generation scenario, with selected non-Susitna hydropower projects added as needed, appears to be the most effective approach to meeting the projected generation requirements of the Railbelt area. The Staff further recommended that if any hydropower development is authorized for the Susitna Basin, it should be licensed and constructed in stages, with the first stage being Watana I.

The Staff concluded that the proposed project access route from Denali Highway to the Watana dam site would result in substantial adverse impacts to fish and wildlife populations, and therefore recommended that access to the Devil Canyon and Watana project areas be restricted by development and use of only the proposed Gold Creek-to-Devil Canyon and Devil Canyon-to-Watana access routes.

The Staff recommended that if the proposed project is authorized, the minimum releases from project dams proposed by the Applicant [12,000 cubic feet per second (cfs) or 340 cubic meters per second (m^3/s)] be augmented with periodic spiking flows up to a combined total release of 20,000 cfs (566 m^3/s) during the salmon spawning season (August 1 to September 15). These spike releases should occur for at least three continuous days, and should occur during at least three different periods during the indicated spawning season.

1. PURPOSE OF AND NEED FOR ACTION

1.1 PURPOSE OF ACTION

The proposed action before the Federal Energy Regulatory Commission (FERC) involves an application for license for the Susitna Hydroelectric Project, FERC No. 7114, by the Alaska Power Authority (APA)* seeking authorization to construct power facilities with a total installed capacity of approximately 1,620 megawatts (MW) producing an average of approximately 6,574 gigawatt-hours (GWh) of electricity annually. The Applicant proposes to use the power and energy developed by the Susitna project to serve the needs of customers within the "Railbelt" region of Alaska. This region includes the two largest cities in Alaska--Anchorage and Fairbanks--as well as most of the population of the state. The Susitna Hydroelectric Project would utilize waters of the Susitna River for power production. The Susitna project would not involve a consumptive use of water, since all water would be returned to the river through the powerplant tailrace or spillways.

1.2 NEED FOR POWER

1.2.1 Historical Energy Requirements

1.2.1.1 Perspective on Geography and Economy of the Region

The Alaskan Railbelt encompasses more than 150,000 square miles (mi^2) [385,000 square kilometers (km^2)] of territory, stretching from the Kenai Peninsula on the Gulf of Alaska and Cook Inlet in the south to Fairbanks and the surrounding military installations in the north. The so-called Southcentral portion of the Railbelt runs from the Matanuska and Susitna valleys north of Anchorage to the southern terminus of the Alaska Railroad at Seward on the Kenai Peninsula (see Fig. 1-1).

Alaska's agricultural production, a minor factor in the state economy, historically has been developed most thoroughly in the Mantanuska and Susitna valleys. The growing season is 120 days long with up to 19 hours of sunlight daily. The annual precipitation of approximately 17 inches (in) [43 centimeters (cm)] often is barely adequate for cultivation, and supplemental irrigation is common. The Tanana Valley section, 100 miles (mi) [160 kilometers (km)] east of Fairbanks, is the expanding agricultural area of the state, with medium-scale grain farming.

Anchorage is the primary business center of the state and is a major port and rail station. Fairbanks is the transportation and business center of the interior section of the Railbelt and the takeoff and supply point for the Arctic and the Trans-Alaska Pipeline maintenance activity. Coal is mined at Healy for the local generation of electric power, as well as for export to Korea.

Alaskan economic development during the 20th Century, including that of the Railbelt area, can be characterized as a sequence of boom periods and stagnations. Since the paucity of region-specific data prevents exclusive treatment of the Railbelt, it is necessary to discuss the economy of the state as a whole, rather than confine the description to just the Railbelt. However, the dominance of the state's economy by the Railbelt region means that the data available at the state level are, in large part, indicative of the developments within the Railbelt. Ever since Alaska achieved statehood in 1959, the primary factors shaping the economy have been the government and petroleum. Indeed, prior to the pipeline boom of the mid-1970s, the major economic force operating within the state appears to have been government payrolls.

The military was responsible for the major buildup of Federal government workers. Subsequent to World War II and the Korean War, during which Alaska experienced a massive infusion of military-related investment, the Defense Department continued to build a presence in Alaska due to the state's strategic location as part of the nation's early warning system. Federal government

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*Throughout this document, the Alaska Power Authority is also referred to as APA and the Applicant.

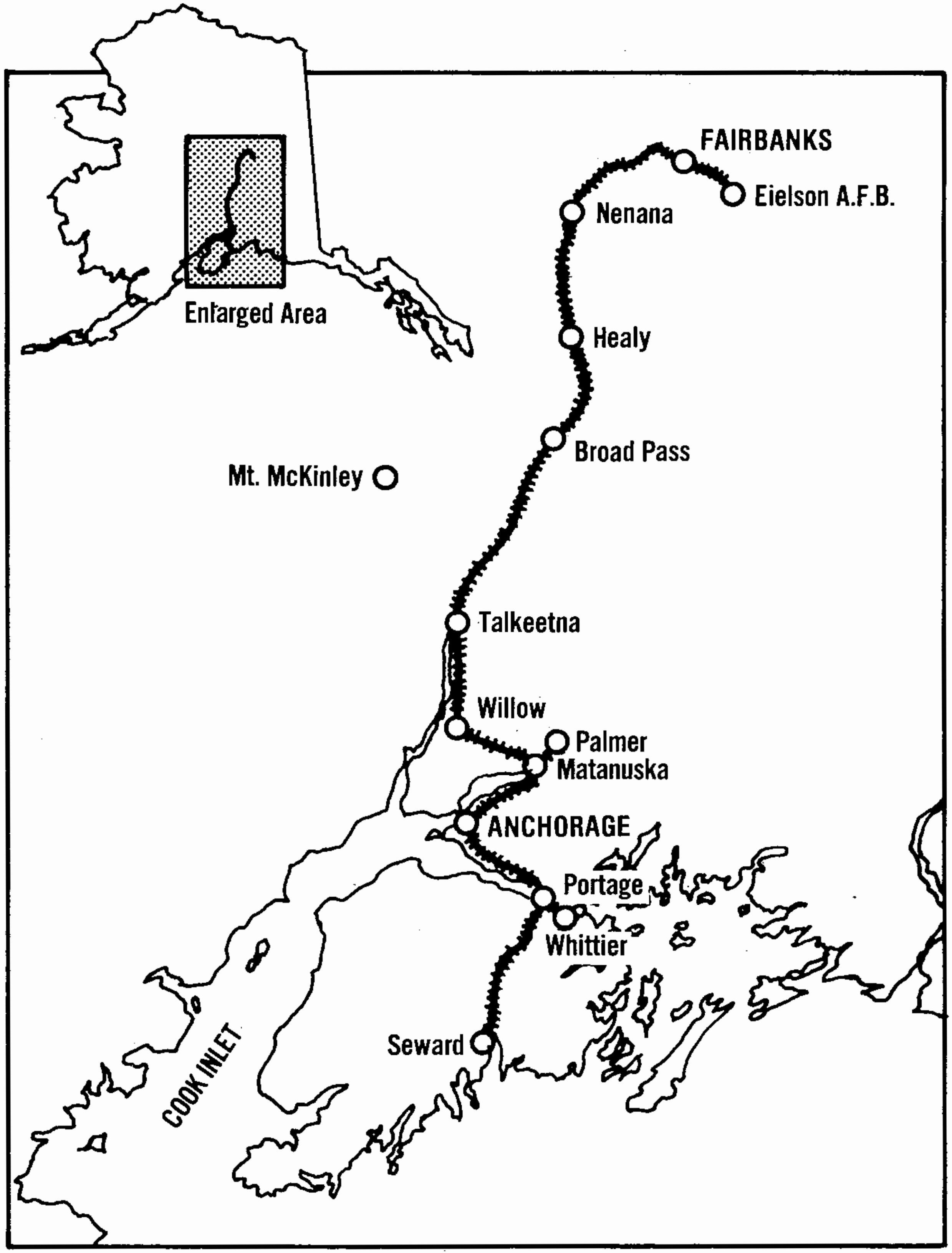

Figure 1-1. The Alaska Railway from Seward to Eielson Air Force Base. [Source: Transportation and Market Analysis of Alaska Coal - Department of Energy Study - 1980]

employment reached a peak of 51,000 in 1967 and declined to 36,000 in 1981. Most of the fluctuations in Federal employment were attributable to the changes in the number of military personnel stationed in Alaska. In contrast to the military, civilian Federal employment has remained essentially constant at around 15,000 since the late 1960s. Despite the drop in the total number of Federal employees, the nominal dollar wages and salaries paid by the government have risen dramatically as a result of increases in wage rates.

While overall Federal employment was declining, state and local employment were increasing rapidly. In 1981, 36,000 persons were employed by state and local governments, compared with 18,000 in 1970 and 8,000 a decade before that. Wages and salaries to these government employees increased at even a faster rate than the number of personnel. In fact, government wage rates increased more rapidly than the wage rates in other Alaskan industries. Between 1970 and 1981, state and local government employment doubled, but their payrolls rose fivefold. As of 1981, combined Federal, state, and local government payrolls accounted for more than $2 billion, or nearly 40% of the state's total personal income of $5.8 billion.

The construction boom brought about by the building of the oil pipeline transportation system from the North Slope altered the state and Railbelt economies appreciably. The pipeline, which cost more than $8 billion, extends 800 mi (1,300 km) from Prudhoe Bay on the northern coast of Alaska to the northernmost ice-free harbor in the United States at Port Valdez in the Southcentral region of Alaska on the Gulf of Alaska. Construction began in 1974 and was completed in 1977. As a consequence, construction employment of all types went from less than 5,000 individuals in 1970 to a peak of more than 26,000 persons in 1976. As of 1981, construction employment in Alaska was back to 7,000 persons. Other categories of employment which benefited from the pipeline construction phase, but which did not suffer the decline after its completion, include oil and gas extraction employment, pipeline transportation employment, and food products employment.

Regionally, the Railbelt benefited most from the pipeline. A major reason for this is that Anchorage alone of all Alaskan cities has attained a "critical mass" in terms of a market for both goods and services. The physical remoteness, small size, and fragmentation of communities outside the Railbelt historically have resulted in very high costs of doing business there. It has been cheaper to produce goods outside the state and then ship them into Alaska, rather than produce them in small, high-cost plants within the state. Transportation costs, as a consequence, are a significant component of the delivered price of nearly everything in Alaska. The smaller the size of the destination market, the greater the per-unit transportation costs typically associated with the product being sold. The service sector is also subject to economies of scale, and here as well the size of the Anchorage market has given that locale a comparative advantage over other Alaskan communities. When employment on the North Slope, hundreds of miles beyond the Railbelt, expanded in the mid-1970s, the markets within the state that absorbed most of the expenditures by that labor force were in Anchorage, and to a lesser extent, Fairbanks. Anchorage was and is, by a wide margin, the largest economic region in the state; by 1978 more than 48% of all non-military jobs in Alaska were located in the Anchorage area. As stated by Kresge et al. (1978):

> Anchorage also had the largest regional share of employment within most individual industry groups. As the state's trade and commercial center, Anchorage's dominance of the support sector is particularly striking. This is especially significant since the support sector is the major area of growth in Alaska's economy. In addition to growing very rapidly, the support sector has also become increasingly concentrated in the Anchorage area.

Between 1970 and 1978, service sector employment (including government, but exluding the military) rose by 41% for the state as a whole. For Anchorage, the increase was in excess of 55%. Civilian employment for the region as a whole grew by slightly more than 50% between 1970 and 1981. Over the same period, civilian earnings grew by nearly 300%, and, after adjusting for inflation, those earnings rose by 69% in real terms. Four years after the completion of the pipeline, the Railbelt could claim a real per-capita increase in personal incomes of 25% during the 1970-1981 period. During this period, the regional inflation rate actually lagged well back of the rate of the United States as a whole. Thus, in terms of the local prices, real incomes per capita grew even more.

1.2.1.2 Energy Use in the Region

The use of energy within the state, as well as the Railbelt, mirrored the pace set by the economy. For the state, energy consumption totalled 180.6 trillion Btu in 1970 and 316.0 trillion Btu in 1978--an increase of 75%. Residential energy use doubled over the same period. Electrical energy generation for the state went from 1,044 GWh in 1970 to 2,609 GWh in 1978--an increase of 150%.

Expenditures for energy increased at a faster rate than usage because energy prices increased during the 1970s. However, those price increases were far less than were experienced in the rest of the United States. Residential electricity expenditures, for instance, increased from $14 million to $56 million between 1970 and 1980. Adjusting for inflation and putting those expenditures on a per-capita basis, however, means that annual Alaskan residential electricity expenditures went from $45.43 to $65.03 in constant 1970 dollars (an increase of slightly less than 45%). Energy prices in the aggregate [i.e., sales-weighted average price of natural gas, distillate fuel oil, LPG (bottled gas) and electricity] for the residential sector increased by slightly in excess of 30% between 1970 and 1980. In the context of statewide increases in real per-capita incomes of 38% during the period, energy costs as percentage of incomes declined in absolute terms for Alaskans.

Within the Railbelt, the energy picture is even more striking than that for the state. Natural gas consumption to the residential sector, for instance, went from 6.4 trillion Btu to 12.4 trillion Btu between 1970 and 1978. Expenditures for the gas decreased in real terms, however, going from $9.7 million to $6.3 million on a constant 1970 dollar basis. During that period, the real price of Alaskan natural gas delivered to the residential sector decreased by 48%. Annual electricity expenditures by residential consumers in the Railbelt went from $56.59 per capita in 1970 to $79.25 in 1980 (figured in constant 1970 dollars). This represents a 40% real increase in per-capita expenditures. The average increase in the real price of energy of all types to the residential sector during 1970-1980 was slightly in excess of 10% in the Railbelt. During the same time period, the increase in real per-capita incomes within the Railbelt was approximately 35%. Here again, the percentage of per-capita incomes that was spent on energy declined during the period, despite an increase in per-capita Btu consumption on the order of 100%.

1.2.2 Present Energy Scenario

Data collected by the Alaska Department of Commerce and Economic Development provides a fairly complete picture of the 1981 energy situation for both the state and the Railbelt region. In that year, Alaskans used 543 trillion Btu of primary energy. Of this, approximately 184 trillion Btu of refined products, ammonia/urea, and liquefied natural gas (LNG) were exported from Alaska. Some 86 trillion Btu were lost in refining operations, electricity generation, and the processing of natural gas for ammonia/urea and LNG. Approximately half the total, or 273 trillion Btu, were consumed in the form of delivered energy to the residential, commercial, industrial, transportation and national defense sectors within the state. Oil, natural gas, coal, and hydroelectricity were the four main sources of the energy consumed in the final demand sectors. Oil and natural gas predominate, supplying approximately 93% of the delivered Btu. A regional breakdown of that energy consumption is shown in Table 1-1.

Table 1-1. 1981 Alaskan Fuel Consumption†[1]
(trillion Btu)

Region (Population)	Fuel Type					All Fuels†[2]
	Petroleum	Natural Gas	Coal	Hydro	Wood	
Railbelt†[3] (313,767)	137.1	81.0	12.6	2.9	1.6	235.2
Southeast (51,689)	19.9	--	--	3.3	1.2	24.4
North Slope (3,282)	11.9	1.7	--	--	--	13.6
Bush (53,449)	29.8	--	--	--	0.3	30.1
Total State (422,187)	198.7	82.7	12.6	6.2	3.1	303.2

†[1] Includes 30 trillion Btu lost in conversion to electric power.

†[2] Does not include LNG or ammonia/urea.

†[3] Railbelt figures include the Valdez/Cordova area, with a population of 9,301.

Source: Computed by FERC Staff from data in 1983 Long Term Energy Plan--State of Alaska.

The Railbelt region accounts for more than 75% of the total energy delivered to the six basic consumption sectors in Alaska. Of total energy delivered to the Railbelt, 11% is for national defense, 41% (exclusively petroleum) goes to the transportation sector, and the remaining 48% is delivered to the residential, commercial, industrial, and electric utility sectors. Natural gas provides most of the energy for space heating and electric generation.

The relative mix of fuels used within the Railbelt reflects the prices at which those sources of energy are available. Natural gas, for instance, presently is priced at less than $2.00 per thousand cubic feet (Mcf) [$7.06 per 100 cubic meters (m^3)] to the residential sector (the lowest price in any state). Where a gas distribution pipeline system makes natural gas available to consumers, this fuel clearly is more cost effective to use (on a cost per Btu basis) than the alternatives--electricity, distillate oil or liquid propane--as shown in Table 1-2.

Table 1-2. Comparative Cost of Heating Fuels in the Railbelt for 1981†[1]
(1981 $/MM Btu)

Fuel	Anchorage	Fairbanks	Matanuska
Electricity	11.49	26.B3	12.58
Fuel Oil	9.45	9.94	10.24
Natural Gas	1.65	--	--
Wood	6.36	5.23	4.87
Propane	13.82	13.85	17.86

†[1] Does not account for efficiencies of equipment used to produce heat from specific fuel.

Source: Computed by FERC Staff from data in 1983 Long Term Energy Plan--State of Alaska.

The Railbelt prices of fossil fuels reflect local market conditions, which in turn are affected by conditions internationally. Natural gas, for instance, is exceptionally inexpensive due to the bountiful supplies associated with petroleum production in the Cook Inlet area, coupled with the lack of an extensive export market (despite significant efforts to develop one). Conversely, the cost of coal within the Railbelt is currently greater than it perhaps might otherwise be because production economies of scale cannot be obtained without the expanded production which the export markets would permit. Fuel oil, by comparison, is competitive with prices observed elsewhere in the United States, in part, because the active export market has enabled the local market to benefit from the economies of large-scale production and transportation of crude petroleum. The high production costs of the small-scale refineries in Alaska are more than offset by avoiding the transportation costs of fuel refined outside the state. A more detailed discussion of the inter-relationship between the prices of energy in the Railbelt and the price of crude oil in world markets is presented in Appendix B. An appraisal of the current energy infrastructure of the Railbelt requires, among other things, an inventory of crude oil reserves, petroleum refineries, natural gas reserves, natural gas processing capabilities, coal reserves, and electric power production and distribution capabilities.

<u>Oil</u>. While lying beyond the Railbelt proper, the North Slope oil deposits are in some ways an important energy source of the region by virtue of the single transportation link to those resources. The Trans-Alaska pipeline runs through the interior section of the Railbelt and feeds the second largest refinery in the state just outside Fairbanks. Further, the Valdez pipeline supplies crude oil to a second refinery within the Railbelt, on the Kenai Peninsula. Proven reserves of crude oil in the state that impact directly on the Railbelt are estimated at nearly 9 billion barrels [1,200 metric tons (MT)], including some 600 million barrels (80 million MT) of oil in the Cook Inlet. The aggregate reserve-to-production ratio in Alaska is nearly 14 years at current production levels. For specific fields, the rate can vary from as little as two years for certain reservoirs in the Cook Inlet, to as high as 15 years for fields on the North Slope.

<u>Petroleum Refineries</u>. The three largest refineries in the State of Alaska are located within the Railbelt territory. The Chevron refinery at Kenai is rated at a capacity of 22,000 barrels (3,000 MT) per day and is supplied by tanker from Valdez. The Tesoro refinery, also at Kenai,

is rated at 48,500 barrels (6,600 MT) per day and is supplied from the Cook Inlet for some 90% of its throughput. The Mapco refinery at North Pole, outside of Fairbanks, has a capacity of 46,000 barrels (6,300 MT) per day and processes North Slope crude. The Chevron refinery and the Mapco refinery produce jet fuel and distillate fuel oil for local consumption. In addition to these products, the Tesoro refinery produces motor gasoline and LPG for consumption within the Railbelt

Natural Gas. The only natural gas reserves currently of importance to the Railbelt are those located in the Cook Inlet. This gas is used primarily to serve heating and electric demand of Railbelt residential, commercial, and industrial sectors. Production from these gas fields was slightly more than 200 billion cubic feet (Bcf) (5.7 billion m^3) in 1982. Of this amount, nearly half is processed for export, either as liquefied natural gas or as ammonia and urea. The LNG processing facility located at Kenai exports to Japan under a contract which has just been renewed for five years. The ammonia and urea production is mostly exported to the continental United States. Natural gas takes are almost evenly split, at 50 Bcf (1.4 billion m^3) per year each, between these latter two uses.

Coal. There are two major coal fields located within the Railbelt. The Beluga coal field located near Anchorage has proven reserves of 275 million tons (250 million MT) and indicated reserves of more than ten times that amount. The Nenana field, located south of Fairbanks, has proven reserves of 861 million tons (781 million MT) with indicated reserves of 6 billion tons (5.4 billion MT). The Nenana field contains the only currently producing mine, at Healy, with 1982 production of better than 800,000 tons (725,000 MT). This coal is used for electric generation in the Fairbanks area and potentially may be used for export to a South Korean electric utility company.

Electric Power. The 1982 installed capacity (nameplate rating) for utilities within the Railbelt is reported by the Alaska Power Administration to total 1,063 megawatts (MW). Other generating capacity within the Railbelt includes 18 MW owned by the University of Alaska at Fairbanks and, based on a survey done by Battelle Pacific Northwest Laboratories, some 96 MW of capacity owned by the military at various installation within the region. That same survey indicated that approximately 28 MW of additional capacity was owned by industrial concerns within the Railbelt as of 1981. A summary breakdown of the capacity by type, and generation by fuel category, in 1982 is presented in Table 1-3 for the utility generating stations in the Railbelt.

Table 1-3. Capacity (by prime mover) and Generation (by fuel) for Railbelt Utility Generating Stations, 1982

	Hydro	Diesel	Gas Turbine	Steam Turbine	Total
Capacity (MW)	45	40	820	153	1,063
	Hydro	Oil	Gas	Coal	Total
Net Generation (GWh)	192	121	2,254	359	2,926

The existing electric transmission system within the Railbelt is composed of isolated networks in the Anchorage and Fairbanks areas. An interconnection currently under construction between Willow and Healy will link the two areas by 1984. The transmission system is shown in Figure 1-2. Details of hydroelectric plants are shown in Table 1-4.

Other Resources. While a number of so-called "renewable" sources of energy are discussed in a subsequent section addressing non-hydroelectric alternatives, as well as in Appendix B, one such fuel deserves mention as a significant component of the present energy picture within the Railbelt. That resource is wood. Currently, firewood finds widespread use as a secondary fuel for space heating in residences. In the Matanuska Valley area of the Railbelt, 15% of the homes used wood as the primary means of heating. Even in the Anchorage area, where energy costs are among the lowest in the state, a survey conducted in 1981 found that 23% of the homes used wood as a secondary heating fuel.

Claims that the expanded use of wood for space heating in individual homes is constrained by resource availability seem misplaced as the forest resources of Alaska are immense. There are two distinct forest ecosystems: the coastal rain forest and the interior forest. The interior forest covers 106 million acres [43 million hectares (ha)], over 22 million acres (9 million ha) of which is classified as commercial forest land. These 22 million acres compare in both size

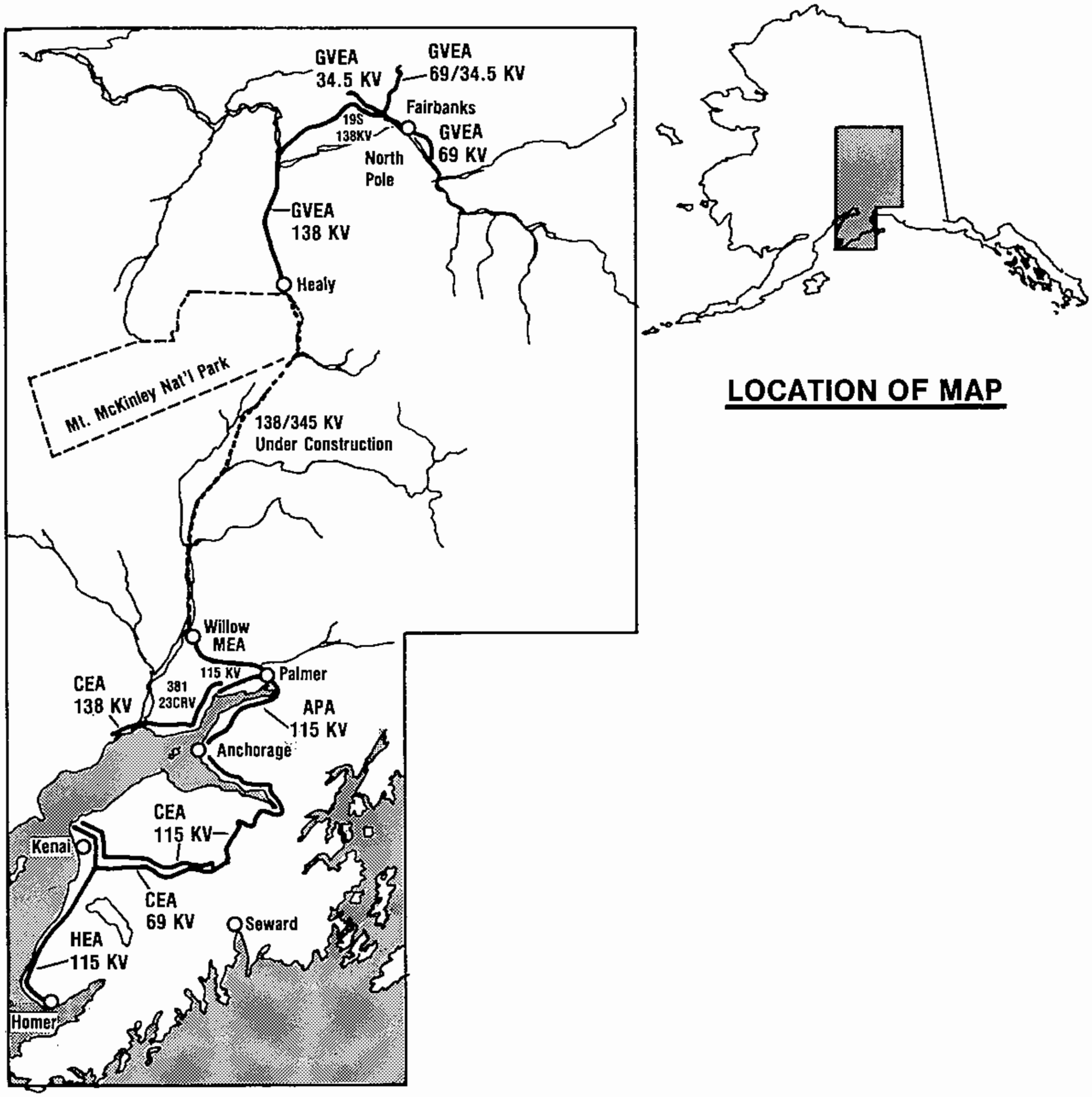

Figure 1-2. Electrical Transmission System of the Railbelt. [Source: Alaska Power Authority, as Modified by FERC Staff]

Table 1-4. Hydroelectric Plants in the Railbelt

Name	Date	Energy (GWh)	Nameplate Capacity (MW)	Utility
Eklutna	1955	148	30.0	Alaska Power Admin.
Cooper Lake Units 1 & 2	1961	42	15.0	Chugach Electric Assn.
		190	45.0	

and growth productivity to the combined forests of Minnesota, Michigan, and Wisconsin. One of the state's four largest interior forests is located within the Railbelt area in the Matanuska District. The coastal rain forests contain nearly 6 million acres (2.4 million ha) of commercial forests, and again, some of the largest of these forests are located within the Railbelt near Anchorage.

A household using approximately 1000 gallons (3 MT) of fuel oil per season could meet its thermal needs with less than 10 cords (4 m^3) of wood. It takes about 2 acres (0.8 ha) to support a sustained annual harvest of 1 cord (4 m^3), so the household would need access to 18 to 20 acres (7.3 to 8.1 ha) of timberland. However, according to the state's Division of Energy and Power Development, recent energy efficient house designs reduce the annual wood consumption to the level of two to three cords (7-10 m^3) instead of ten cords (36 m^3) per year. Current prices for wood are in the vicinity of $90 to $120 per cord ($25 to $33 per m^3) in the urban areas of the state; this compares favorably with oil costs of $1.30 per gallon ($400 per metric ton).

1.2.3 Future Energy Resources

A schedule of known planned utility additions is shown in Table 1-5.

Table 1.5. Schedule of Planned Utility Additions

Unit	Type	MW	Year	Average Energy (GWh)
Bradley Lake	Hydro	90.0	1988	347
Grant Lake	Hydro	7.0	1988	33
Total		97.0		380

1.2.4 Load Growth Forecast

1.2.4.1 Alaska Power Authority Forecasts

1.2.4.1.1 Methodology

The Applicant has submitted a number of alternative load forecasts for the Railbelt, based upon varying world oil price scenarios. All of these forecasts were generated by means of the same modeling structure. That structure employs three computer-operated models that provide, respectively, projections of (1) regional demographic, and state economic and fiscal variables; (2) regional electricity demands given specific energy price assumptions; and (3) least-cost generation expansion programs given a demand forecast. The last two models are iterated to determine a consistent electricity demand forecast given the cost of power projected by the generation expansion program appropriate to that demand forecast.

1.2.4.1.2 Load Projection

The Applicant has prepared load projections for the time period 1983-2010 under a wide range of alternative scenarios.* Each forecast scenario is characterized by a specific trajectory for the price that crude oil will command in world markets over the forecast horizon.

There are at least three reasons that the world oil price is chosen as the single exogenous variable that is to be altered in attempting to bracket the load growth in the Railbelt. First, world oil prices affect the level of petroleum revenues to the State of Alaska, mainly through severance taxes and royalty payments. These revenues account for more than 80% of total state revenues, and the state is the single largest economic force acting on the Railbelt economy. Second, world oil prices affect directly the costs of electricity generated in the Railbelt because of the linkage between crude prices and prices of other fossil fuels. The Railbelt is, as demonstrated in Section 1.2.2, heavily dependent on fossil-fired electric generation. Third, world oil prices through their influence on other fuel prices affect the substitution possibilities that exist for electricity in the Railbelt.

1.2.4.1.3 World Oil Price

APA OIL PRICE AND LOAD PROJECTION

The APA takes as its reference case for the world oil price scenario a projection made by Sherman H. Clark Associates (SHCA), a California-based energy consulting firm. The forecasters responsible for this oil price projection have assigned a 35% probability of occurrence to this particular scenario. Among other things, this forecast, according to the APA, assumes "that OPEC will continue operating as a viable entity and will not limit production during the forecasted period. Recent trends in economic growth in the United States and the free world will continue at reasonable rates." The particular prices for world crude associated with this reference case are shown in Table 1-6.

State petroleum revenues consistent with this world oil price trajectory are computed and are input to the Man in the Arctic Program (MAP) model to begin the load forecasting sequence. The results of that forecast procedure are shown in Table 1-7. The Applicant presented other alternative load projections, described in Appendix A. For purposes of comparison, four of these alternative load projections are depicted graphically in Figure 1-3.

Using APA's "reference" case as a standard for comparison, it should be noted that there is little to distinguish these projections in the near-term. Variation around that reference case load projection is less than 3.5% in 1985, as seen in Table 1-8. By 1990, however, significant differences are seen to exist in the forecasts. Implied annual growth rate in kWh loads during that period are shown in Table 1-9.

1.2.4.2 FERC Staff Projections

The FERC Staff has independently evaluated the various possibilities for future oil prices and identified the following mid-range projection shown in 1983 dollars:

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

The range of staff's projections are shown in Figure 1-4. Various forecasts of others are shown in Figure 1-5.

The Staff judged the world oil price trajectories described in Appendix A to be more plausible than the oil price scenarios recommended by the Applicant. The Staff projection is based on an assumption that the strength of economic forces now acting in the direction of reducing oil prices (fuel switching, conservation, and the growth of non-OPEC oil production) will continue throughout the 1980s to exceed the strength of economic forces tending to increase oil prices (renewed world economic growth). Several oil price projections by Alaska's Department of Revenue, consultants to the Alaskan Power Authority (SHCA), and DOE are shown in Figure 1-5. The SHCA and DOE projections are all postulated on an assumption that the combination of economic forces will cause a sufficient growth in demand for oil to allow OPEC to increase its output, and hence maintain its market power.

*Forecasts produced by the RED model were extended by the Applicant from 2010 to 2020 using the average annual growth for the period 2000-2010.

Table 1-6. APA Reference Case, World Oil Price Scenario

Years	Price in Final Year of Period (1983$/bbl)	Annual Rate of Change in Price (%)
1983	28.95	-14.9
1984	27.61	-4.7
1985-1988	26.30	-1.2
1989-2010	50.39	2.6

Conversion: The price of $1/barrel = $7.35/metric ton.

Source: Compiled by FERC Staff from data presented in Susitna Hydroelectric Project, Vol. 2A, Alaska Power Authority, 1983.

Table 1-7. APA Reference Case, Railbelt Load Projection, 1983-2010

Year	Energy (GWh)	Peak Demand (MW)
1983	2,803	579
1985	3,096	639
1990	3,737	777
1995	4,171	868
2000	4,542	945
2005	5,093	1,059
2010	5,858	1,217

Source: Compiled by FERC Staff from data presented in Susitna Hydroelectric Project, Vol. 2C, Alaska Power Authority, 1983.

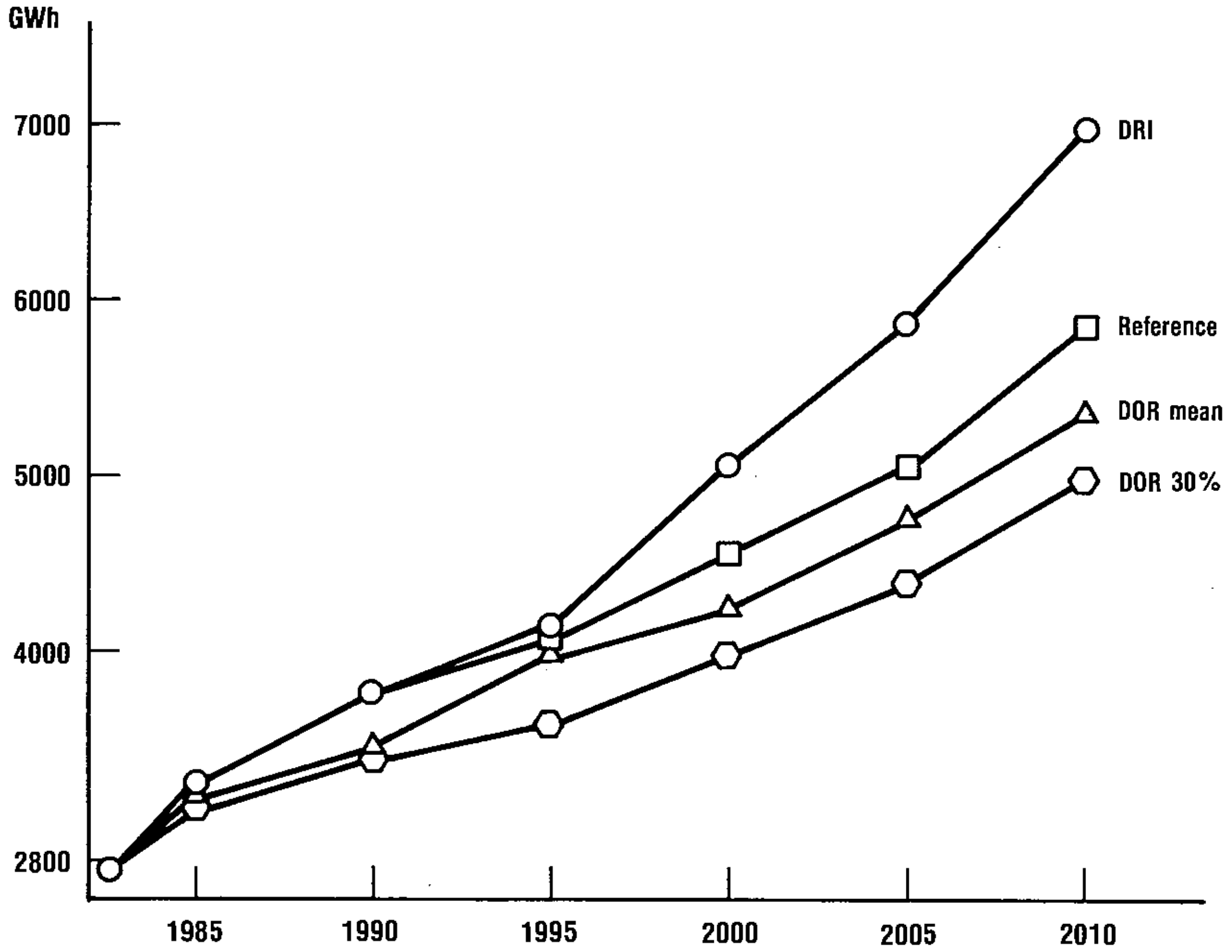

Figure 1-3. Alternative APA Load Projections for 1985-2010 Comparing Data Resources, Inc., Reference, Alaska Department of Revenue Mean, and Alaska Department of Revenue 30% Cases.

Table 1-8. APA Load Projections Relative to the Reference Case Forecast

Forecast Scenario	Year 1985	1990	1995	2000	2010
DRI†[1]	1.00	0.99	1.04	1.11	1.19
Reference	1.00	1.00	1.00	1.00	1.00
DOR Mean†[2]	0.99	0.94	0.92	0.93	0.92
DOR 30%†[3]	0.97	0.90	0.85	0.86	0.85

†[1] Data Resources, Inc.

†[2] Alaska Department of Revenue mean case.

†[3] Alaska Department of Revenue 3D% case.

Table 1-9. Annual Load Growth (%) Implied by APA Forecasts

Forecast Scenario	Years 1985-1990	1990-1995	1995-2000	2000-2010
DRI†[1]	3.64	3.15	3.04	3.29
Reference	3.84	2.22	1.72	2.60
DOR Mean†[2]	2.84	1.87	3.80	2.47
DOR 30%†[3]	2.22	1.14	1.79	2.44

†[1] Data Resources, Inc.

†[2] Alaska Department of Revenue mean case.

†[3] Alaska Department of Revenue 30% case.

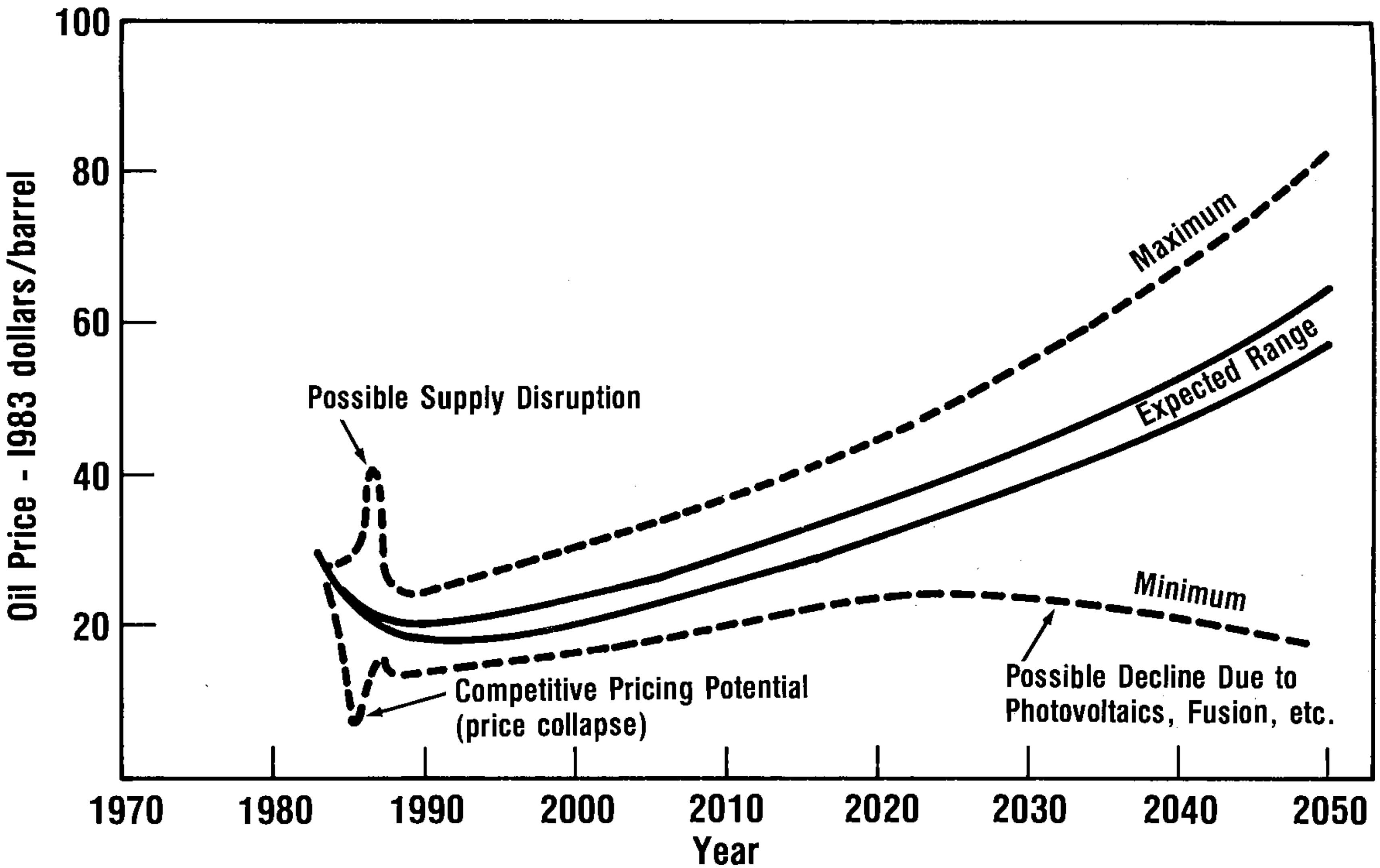

Figure 1-4. Projected World Oil Prices in 1983 Dollars per barrel, Including Possible Supply Disruption.

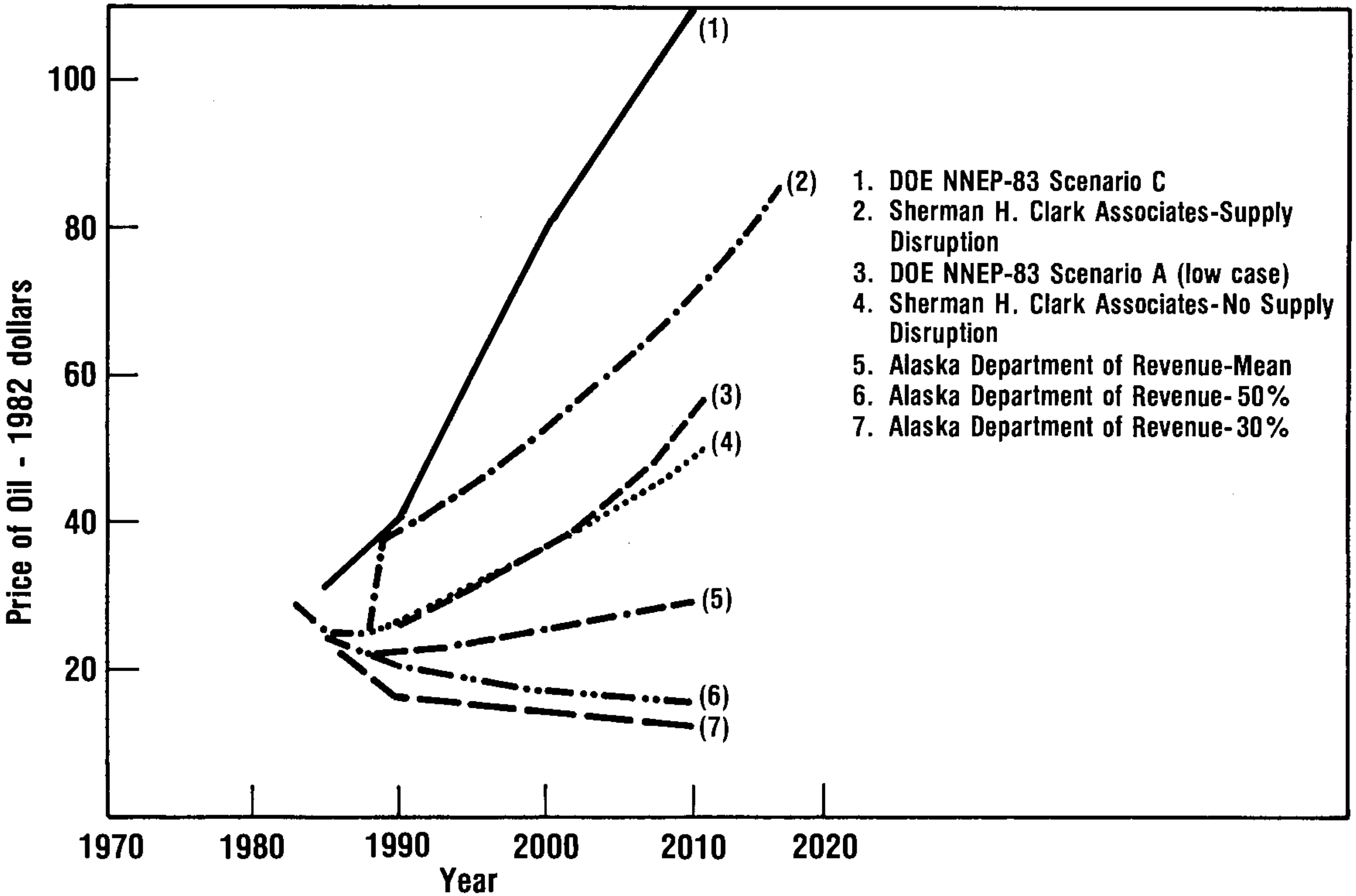

Figure 1-5. Price of Oil Using Various Forecasts, Including U.S. Department of Energy, Sherman H. Clark Associates, and Alaska Department of Revenue.

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

A series of load projections have been made utilizing Staff world oil price forecasts. The projections use the same modeling apparatus constructed by the APA and required conversion of the world oil price forecast to a forecast of state petroleum revenues for use in the MAP model. This conversion was carried out in a manner consistent with the one used by APA. Further, the Railbelt Electricity Demand (RED) model input requirements for end-user fuel prices were made consistent with Staff world oil price trajectories. The load projections that resulted for the medium and high world oil price assumptions are shown in Tables 1-10 and 1-11.* A graphical comparison of APA and FERC Staff projections of electric demand is shown in Figure 1-6.

It should be noted that in addition to the changes in world oil price scenarios that Staff chose to make, alterations to the MAP model were also pursued. The objective in making those alterations was to improve what Staff judged to be the economic consistency of what appears to be a sophisticated forecasting tool. Nevertheless, where the specification of an equation could be altered to add economic content, as well as improve both the statistical fit and significance of coefficients in the equation, then such a modification was made. In those instances when an equation was successfully altered, it was also the case that substitution of the new equation into the model caused the system to become unstable. This was the case because critical linkages within the system of equations were broken as a consequence of the changes made by Staff. This can occur despite the changes having improved the particular equation viewed in isolation. This is not an unreasonable circumstance given a model with the complexity of the MAP system. For this reason, Staff has judged that the forecasting models employed by the Applicant could not be improved upon in the time allotted, and these same models have been adopted for purposes of generating the Staff Railbelt forecasts.

1.2.5 Generation-Load Relationships of Existing and Planned Railbelt System

The existing and presently planned additions to generating resources of the Railbelt system (without Susitna) are summarized in Table 1-12 in relation to the Staff's medium oil price load growth projections. The peak loads are the point-of-use figures given in Table 1-10 increased by an average 9% transmission loss to represent loads at the generator busbars. Table 1-12 shows reserve margins above 20% until the mid 1990s without further additions. The existing capacity retirement schedule considered in Table 1-12 is shown in Table 1-13. However, a reserve margin figure is not per se a sufficient indicator of power supply adequacy. The probable availability for service of individual generating units, especially at peak load periods, is the principal determinant of reserve requirement. Probable availability varies with generating unit type, size and age. In the case of hydropower generation, energy limitations (water supply) may not permit a unit to develop its full power capability for each successive daily peak in the peak load period, thus restricting the load-carrying ability of a unit to less than its rating.

The load-carrying characteristics of the various forms of existing and planned Railbelt generation were examined in terms of the shape of the Railbelt load duration curve to determine the point at which further generation additions will be needed. This analysis showed that additional Railbelt generation will be needed in 1994 to limit the probable unserved system energy requirement.

Although Table 1-12 shows a 36% reserve margin in 1993, based on installed capacity ratings, the analysis showed that generating resources are only marginally adequate in that year.

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

Table 1-10. Railbelt Load Forecast, FERC Staff
Medium World Oil Price Scenario,
1983-2022

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

Table 1-11. Railbelt Load Forecast, FERC Staff
High World Oil Price Scenario,
1983-2022

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

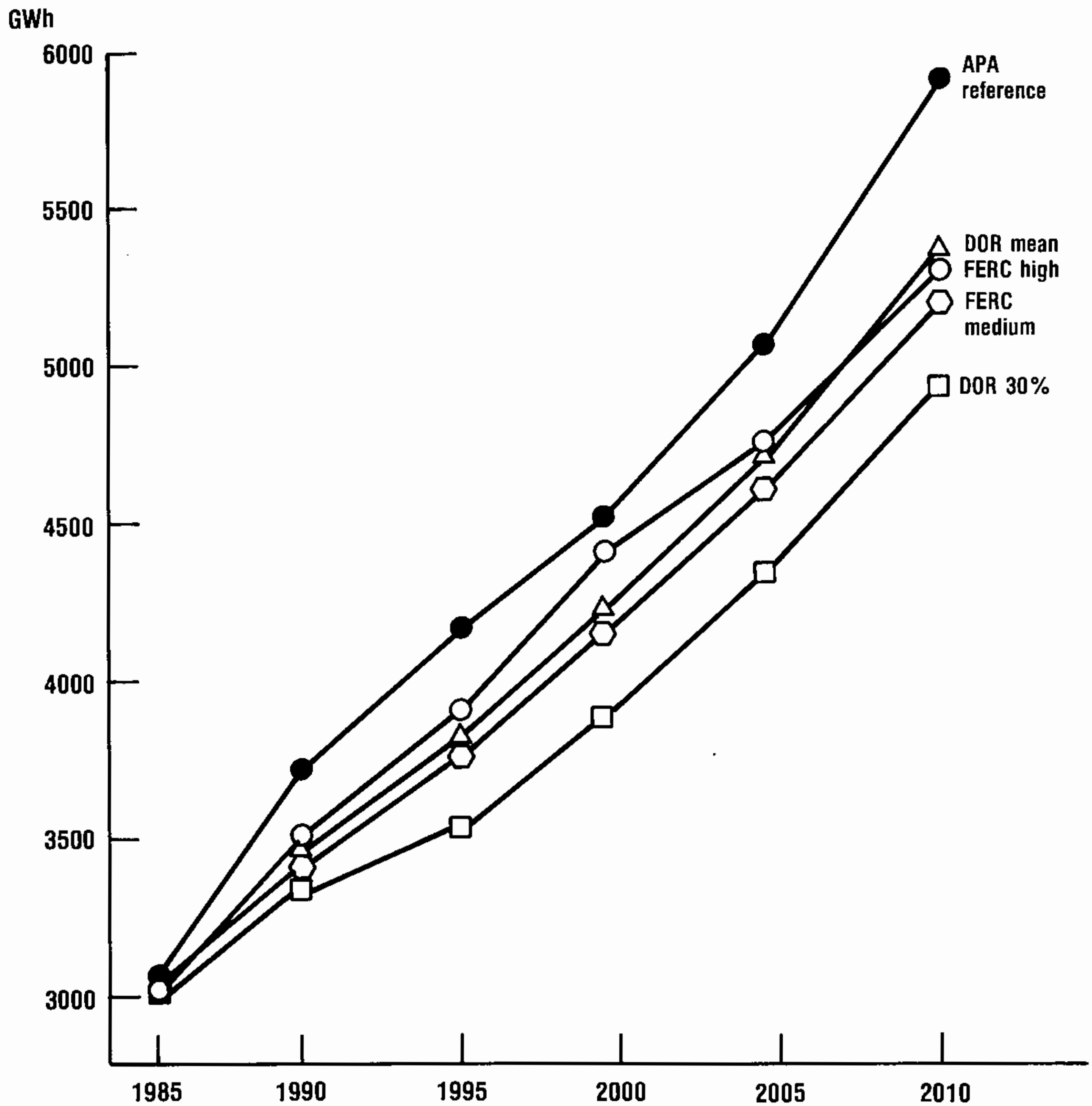

Figure 1-6. FERC Staff Load Projections and Selected APA Load Projection for 1983-2010, Including APA Reference, Department of Revenue Mean, FERC High, FERC Medium, and Department of Revenue 30% Cases.

Table 1-12. System Generation Capability--Selected Years (medium oil price level)

Parameter	1993	1994	1995	2000	2010	2020	2022
Existing generating capacity (1992) (MW)	1,034	1,034	1,034	1,034	1,034	1,034	1,034
Planned additions (1988) (MW)	97	97	97	97	97	97	97
Available capacity (1992) (MW)	1,131	1,131	1,131	1,131	1,131	1,131	1,131
Retirements (MW)	16	47	76	304	537	989	989
Net available capacity (MW)	1,115	1,084	1,055	827	594	142	142
Peakload (as generated) (MW)	818	845	859	944.7	1,184	1,452	1,513
Margin (MW) ( ) = deficit	297	239	196	(117)	(590)	(1,310)	(1,371)

Table 1-13. Susitna Schedule of Retirements

	Capacity (MW) Retired						
		Gas Turbine					
Year	Coal	Gas	Oil	Diesel	Combined Cycle	Annual Total	Cumulative
1993		9		7		16	16
1994		30		1		31	47
1995		14	8	7		29	76
1996			65			65	141
1997		3	65	1		69	210
1998		50				50	260
1999						--	260
2000	25	18		1		44	304
2001						--	304
2002		51				51	355
2003		53				53	408
2004						--	408
2005	21	58				79	487
2006		23				23	510
2007		26				26	536
2008						--	536
2009						1	537
2010						--	537
2011				6	139	145	682
2012		116			178	294	976
2013						--	976
2014						--	976
2015	13					13	989
Total	59	451	138	24	317	989	

1.3 ALTERNATIVE ACTIONS

1.3.1 Alternative Project Designs

The Staff's analysis of alternative development plans for the Susitna River Basin is based on its study of the previous site-selection studies done by the Applicant, the State of Alaska, the U.S. Army Corps of Engineers (Corps), and the Bureau of Reclamation (Bureau).

1.3.1.1 Previous Studies

The first major study of the Susitna Basin was performed by the Bureau in 1953. The following ten damsites were identified above the railroad crossing at Gold Creek:

(1)	Gold Creek	(6)	Vee
(2)	Olson	(7)	Maclaren
(3)	Devil Canyon	(8)	Denali
(4)	Devil Creek	(9)	Butte Creek
(5)	Watana	(10)	Tyone

Field reconnaissance eliminated half of these upper basin sites, with further Bureau consideration centered on Olson, Devil Canyon, Watana, Vee, and Denali. All of the Bureau studies since 1953 have regarded these sites as the most appropriate for further investigation.

In 1974, the Office of the Governor, State of Alaska, commissioned a study that became known as the Kaiser Proposal. In this study it was proposed that the initial Susitna development consist of a single dam known as High Devil Canyon. Subsequent developments suggested in the study included a downstream dam at the Olson site and an upstream dam at a site known as Susitna III.

The Corps undertook the most comprehensive study of the potential of the upper Susitna River Basin prior to the Applicant's studies. The Corps studies, performed in 1975 and 1979, involved analysis of 23 alternative developments, including those proposed by the Bureau.

The Corps study initially recommended construction of an earthfill dam at Watana with a height of 810 ft (247 m). In the longer term, development of Devil Canyon and Denali sites were discussed. Further investigations on the Susitna Basin by the Corps in 1979 reaffirmed Devil Canyon and Watana as appropriate sites, and alternative dam types were investigated.

1.3.1.2 Applicant's Studies

The Applicant's studies included review of the 12 damsites previously identified in the upper portion of the Susitna Basin. These sites are listed in Table 1-14 along with relevant data concerning cost, installed capacity, and energy potential. Figure 1-7 illustrates which sites are mutually exclusive, i.e., cannot be developed jointly, since development of the downstream site would inundate the upstream site.

The Applicant's screening process reduced the original 12 sites by eliminating those that would obviously not be included in the initial stages of the Susitna development plan, and that therefore did not deserve further study at this stage. Three basic screening criteria were used to eliminate sites: excessive environmental damage, mutually exclusive sites, and insufficient or uneconomical energy contribution.

The Applicant's screening process resulted in the elimination of the Gold Creek, Olson, Tyone, Devil Creek and Butte Creek sites. The remaining sites upstream from Vee, i.e., Maclaren and Denali, were retained to "insure that further study be directed toward determining the need and viability of providing flow regulation in the headwaters of the Susitna" (Exhibit B, p. B-1-7].*

In its next screening, APA considered engineering layouts and more reliable cost estimates for the seven remaining developments. The results of this screening indicated that the Susitna Basin development plan should incorporate a combination of dams and powerhouses located at one or more of the following sites:

(1) Devil Canyon
(2) High Devil Canyon
(3) Watana
(4) Susitna III
(5) Vee

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*Throughout this document, references to specific "Exhibits" are to the exhibits submitted to FERC as part of Alaska Power Authority's Susitna Hydroelectric Project License Application. References to specific "Appendices" (App.) are to the appendices provided in Volumes 2 through 7 of this Draft Environmental Impact Statement.

Table 1-14. Potential Susitna Basin Hydroelectric Developments

Site	Dam		Upstream Regulation	Capital Cost ($ million 1980)	Installed Capacity (MW)	Average Annual Energy (GWh)	Economic†[1] Cost of Energy ($/1,000 kWh)	Source of Data
	Proposed Type	Height (ft)						
Gold Creek†[2]	Fill	190	Yes	900	260	1,140	37	USBR 1953
Olson (Susitna II)	Concrete	160	Yes	600	200	915	31	USBR 1953 KAISER 1974 COE 1975
Devil Canyon	Concrete	675	No	830	250	1,420	27	This study
			Yes	1,000	600	2,900	17	This study
High Devil Canyon (Susitna I)	Fill	855	No	1,500	800	3,540	21	This study
Devil Creek†[2]	Fill	Approx. 850	No	--	--	--	--	--
Watana	Fill	880	No	1,860	800	3,250	20	This study
Susitna III	Fill	670	No	1,390	350	1,500	41	This study
Vee	Fill	610	No	1,060	400	1,370	37	This study
Maclaren†[2]	Fill	185	No	530†[4]	55	100	124	This study
Denell	Fill	230	No	480†[4]	60	245	81	This study
Butte Creek†[2]	Fill	Approx. 150	No	--	40	130†[3]	--	USBR 1953
Tyone†[2]	Fill	Approx. 60	No	--	6	22†[3]	--	USBR 1953

†[1] Includes AFDC, insurance, amortization, and operation and maintenance costs.

†[2] No detailed engineering or energy studies undertaken as part of this study.

†[3] These are approximate estimates and serve only to represent the potential of these two dam sites in perspective.

†[4] Includes estimated costs of power generation facility.

Conversion: To convert feet to meters, multiply by 0.305.

Source: Susitna Application, Exhibit B, Table B.1

	GOLD CREEK	OLSON	DEVIL CANYON	HIGH DEVIL CANYON	DEVIL CREEK	WATANA	SUSITNA III	VEE	MACLAREN	DENALI	BUTTE CREEK	TYONE
GOLD CREEK												
OLSON			890 (30)									
DEVIL CANYON				1030 (160)	1070 (200)							
HIGH DEVIL CANYON						1465 (445)						
DEVIL CREEK						1465 (405)						
WATANA							1810 (355)	1925 (470)				
SUSITNA III								1925 (125)	2320 (520)			
VEE									2320 (405)			
MACLAREN												
DENALI												
BUTTE CREEK												
TYONE												

LEGEND

COMPATIBLE ALTERNATIVES

MUTUALLY EXCLUSIVE ALTERNATIVES

1465 (405) — DAM IN COLUMN IS MUTUALLY EXCLUSIVE IF FULL SUPPLY LEVEL OF DAM IN ROW EXCEEDS THIS VALUE - FT.

VALUE IN BRACKET REFERS TO APPROXIMATE DAM HEIGHT.

Figure 1-7. Mutually Exclusive Developments. [Source: Application Exhibit B, Fig. B.5]

The following conclusions were drawn by the APA from the screening process (Exhibit B, p. B-1-12):

- "For energy requirements of up to 1750 GWh, the High Devil Canyon, Devil Canyon or the Watana sites individually provided the most economic energy.

- For energy requirements of between 1750 and 3500 GWh, the high Devil Canyon site is the most economic.

- For energy requirements of between 3500 and 5250 GWh, the combinations of either Watana and Devil Canyon or High Devil Canyon and Vee are most economic.

- The total energy production capability of the Watana-Devil Canyon development is larger than that of the High Devil Canyon-Vee alternative and is the only plan capable of meeting energy demands in the 6000 GWh range."

The Applicant studied four tunnel schemes as alternative developments to the Devil Canyon dam in the Watana-Devil Canyon development plan. The tunnel schemes could develop similar head for power generation and provide environmental advantages by avoiding inundation of Devil Canyon. The need for upstream regulation of flows would preclude a tunnel alternative from being other than a second-stage development of an upstream storage reservoir such as Watana. The four basic schemes developed by the Applicant are shown schematically in Figure 1-8. The economic analysis of the four schemes by the Applicant indicated that tunnel scheme 3 would produce the lowest cost energy by a factor of two.

The Applicant's review of the environmental impacts associated with the four tunnel schemes indicated that scheme 3 would have the least impact, primarily because it offers the best opportunities for regulating daily flows downstream from the project. Based on this assessment and because of its superior economics, tunnel scheme 3 was the only tunnel alternative selected for further study by the Applicant.

1.3.1.3 Staff Studies

The FERC Staff's studies of alternative hydro developments in the upper Susitna River Basin made use of the economic and environmental screening performed by the Applicant. The Staff considered the five major dam projects investigated by the Applicant along with the tunnel scheme 3 alternative as possible candidate sites for meeting Railbelt energy requirements. From these six basic alternative developments, 19 development schemes were formulated for the upper Susitna River for further study. Table 1-15 shows the costs, installed capacity, and average annual energy associated with the developments, and Figures 1-9 through 1-13 show profile representations with the river mile of the dam sites and normal pool elevations.

The Corps program entitled Simulation of Flood Control and Conservation Systems (HEC-5) was used to develop the energy capability of the 19 alternatives. The program was developed by the Corps to assist in planning studies for evaluating proposed reservoirs in a system and to assist in sizing the flood control and conservation storage requirements.

The HEC-5 program was used to evaluate the energy potential of the Susitna alternatives by simulating the hydro operation of each project using 33 years of Susitna River flow records at Gold Creek and rule curves to simulate power operations. The constraints modeled were: minimum flow requirements at Gold Creek and tandem operation constraints of combined alternatives such as Watana and Devil Canyon. The tandem constraints included hydraulic balance of the turbines and usable reservoir storage of the respective reservoirs.

Case C (Exhibit B, Table B.54) minimum flows were used in the analysis of project output. The output of the HEC-5 program was the monthly energy generation for all 33 years of simulation. From the water years utilized in the study, the average power year selected was November 1967 to October 1968.

1.3.2 Other Hydroelectric Alternatives

The Staff's analysis of the non-Susitna River hydro alternatives began with a review of the Applicant's studies of Alaska hydro potential. The Applicant reviewed all earlier studies that inventoried potential sites throughout Alaska and indexed the various economic data in the inventories to a constant base. The Applicant then applied a multiple-step screening process to reduce the vast number of potential non-Susitna hydro projects to those considered the most economical and environmentally acceptable. The two main inventories used by the Applicant in the screening process were those published in the Corps' National Hydropower Study and the APA's "Hydroelectric Alternatives for the Alaska Railbelt." These combined inventories identified a total of 91 potential hydro projects located outside the mid-Susitna River that were technically feasible.

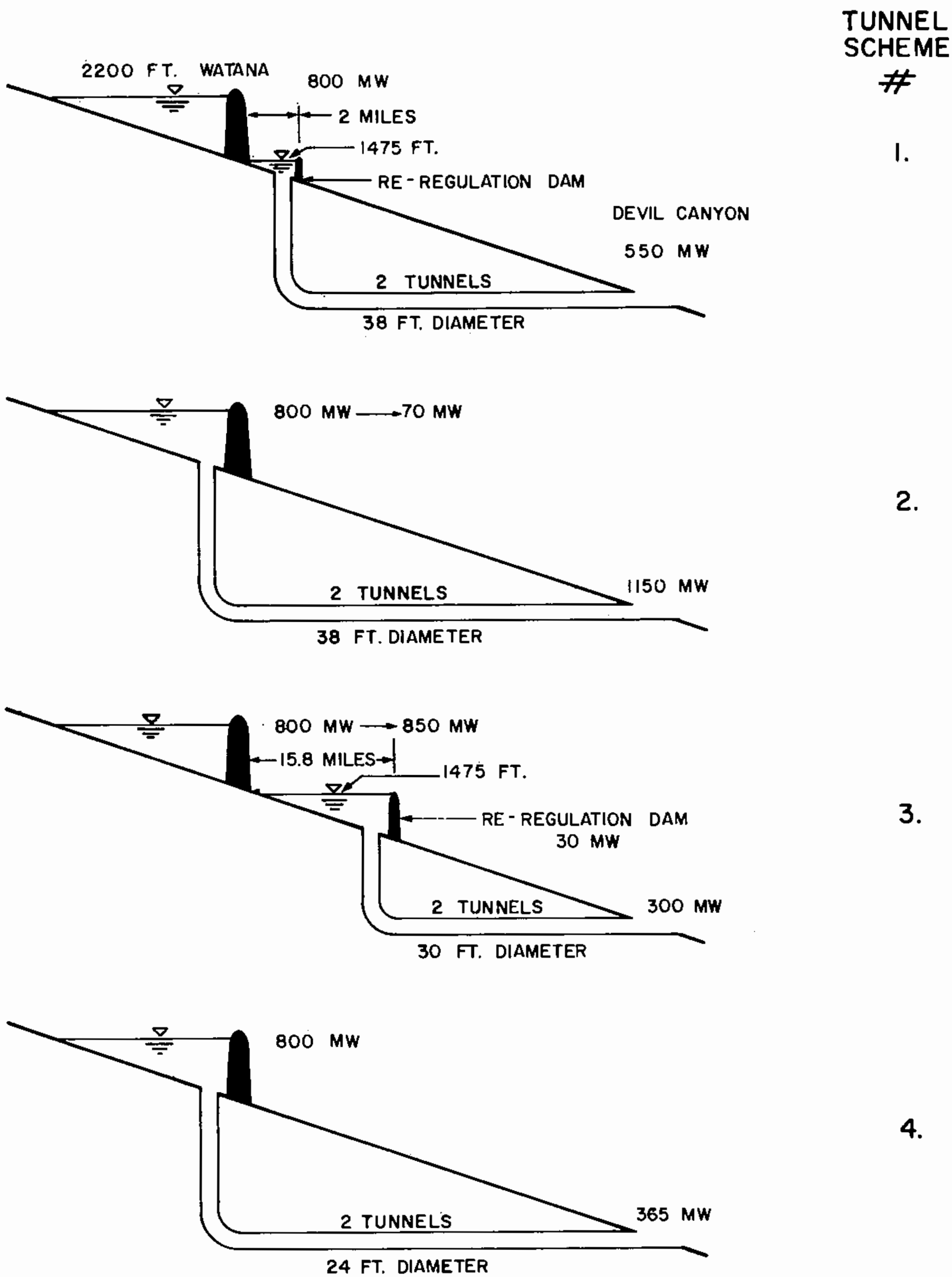

Figure 1-8. Schematic Representation of Tunnel Alternatives. [Source: Application Exhibit B, Fig. B.13]

Table 1-15. Data on Staff Susitna Basin Alternatives

Susitna Basin Alternative Investigated	Estimated Total Cost of Project ($ million 1982)	Total Installed Capacity of Alternative (MW)	Average Annual Energy of Alternative (GWh)
Watana†1	4,062	1,020	3,260
Watana I	3,494	900	2,958
Watana II	3,168	720	2,307
H. Devil Canyon	2,255	800	2,034
Watana-Devil Canyon†1	5,565	1,620	6,574
Watana I-Devil Canyon	4,997	1,500	6,120
Watana II-Devil Canyon	4,671	1,320	5,356
H. Devil Canyon-Vee	4,570	1,200	5,076
H. Devil Canyon-Susitna III	5,302	1,250	5,478
Watana-Tunnel 3 (300 MW)	5,453	1,350	5,549
Watana-Tunnel 3 (450 MW)	5,512	1,500	5,890
Watana I-Tunnel 3 (450 MW)	4,944	1,380	5,433
Watana II-Tunnel 3 (450 MW)	4,618	1,200	4,658
Watana-Modified H. Devil Canyon	5,355	1,420	5,640
Watana I-Modified H. Devil Canyon	4,787	1,300	5,183
Watana II-Modified H. Devil Canyon	4,461	1,120	4,451
Watana-Tunnel Rereg	4,827	1,220	4,341
Watana I-Tunnel Rereg	4,259	1,100	3,948
Watana II-Tunnel Rereg	3,933	920	3,246

†1 Proposed project.

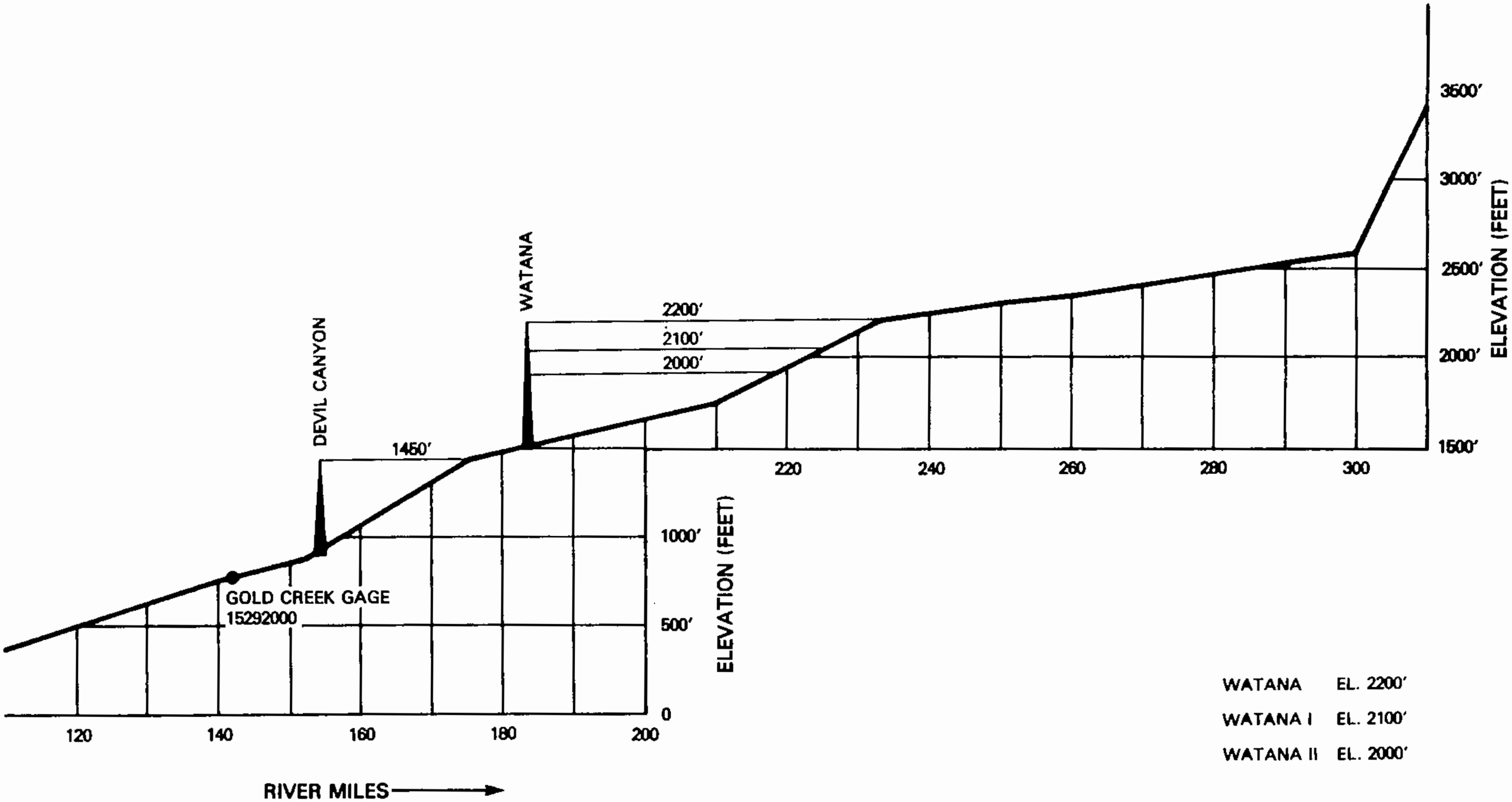

Figure 1-9. Profile: Watana-Devil Canyon Development.

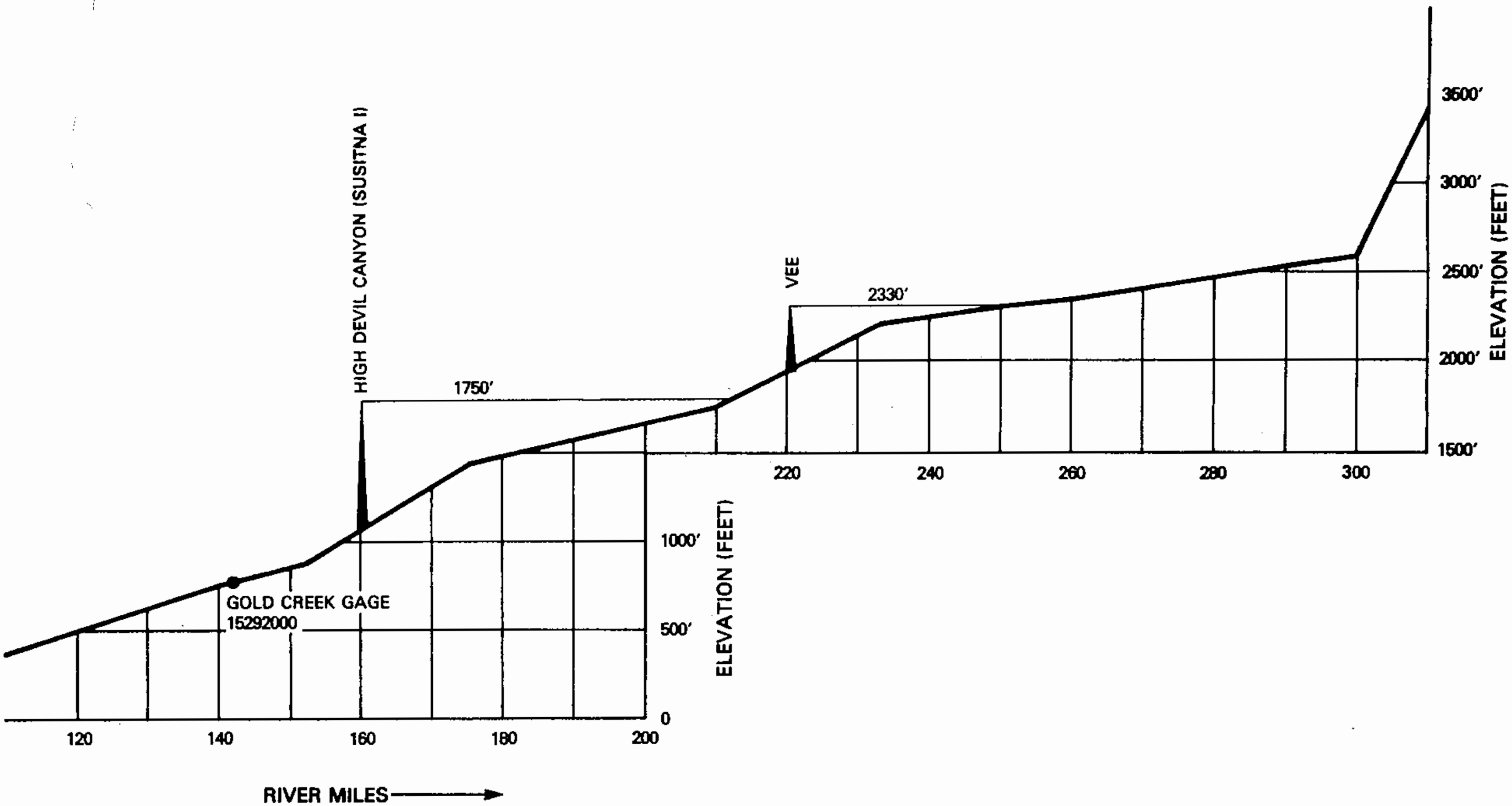

Figure 1-10. Profile: Vee-High Devil Canyon Development.

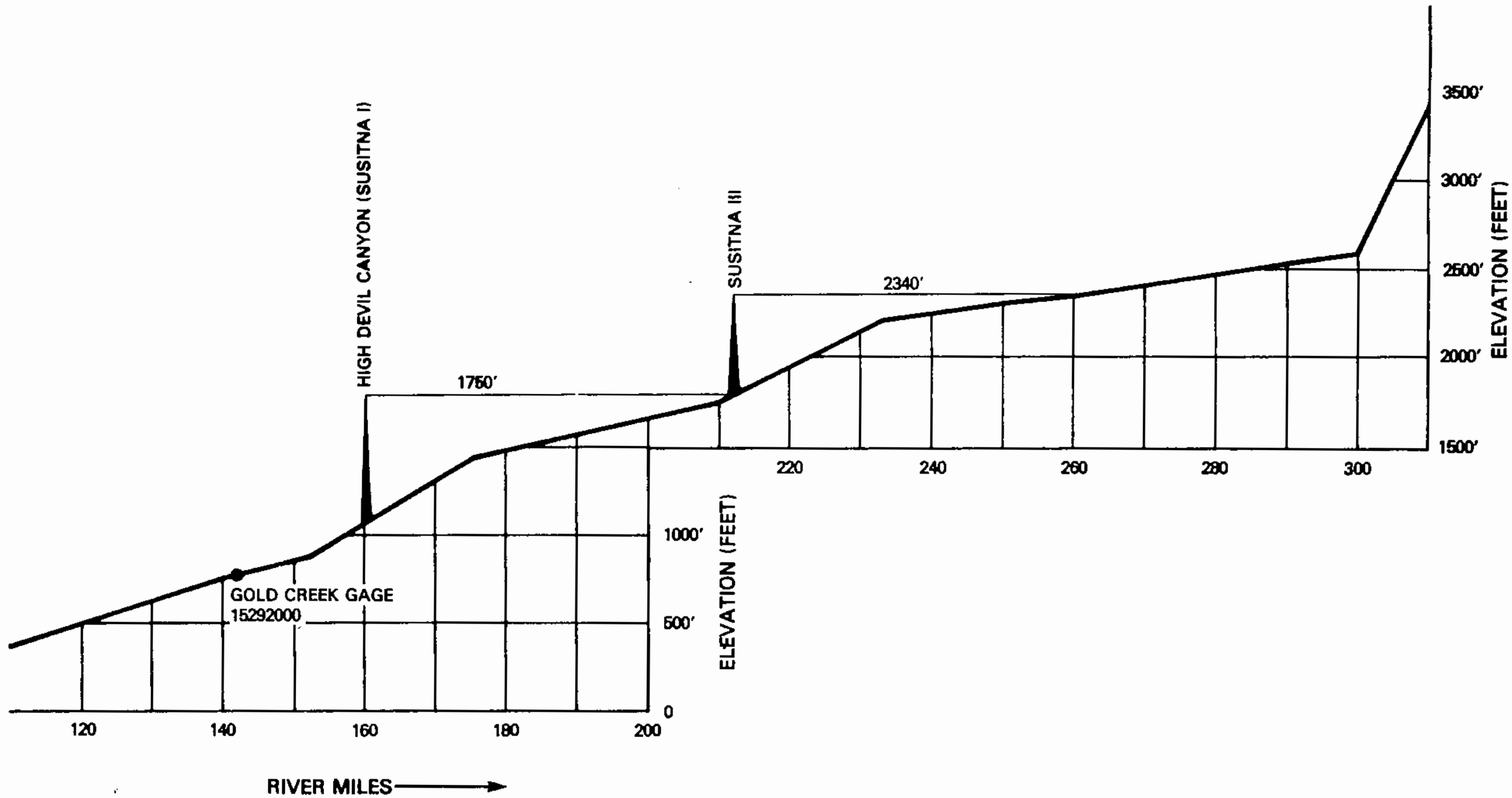

Figure 1-11. Profile: Susitna III-High Devil Canyon Development.

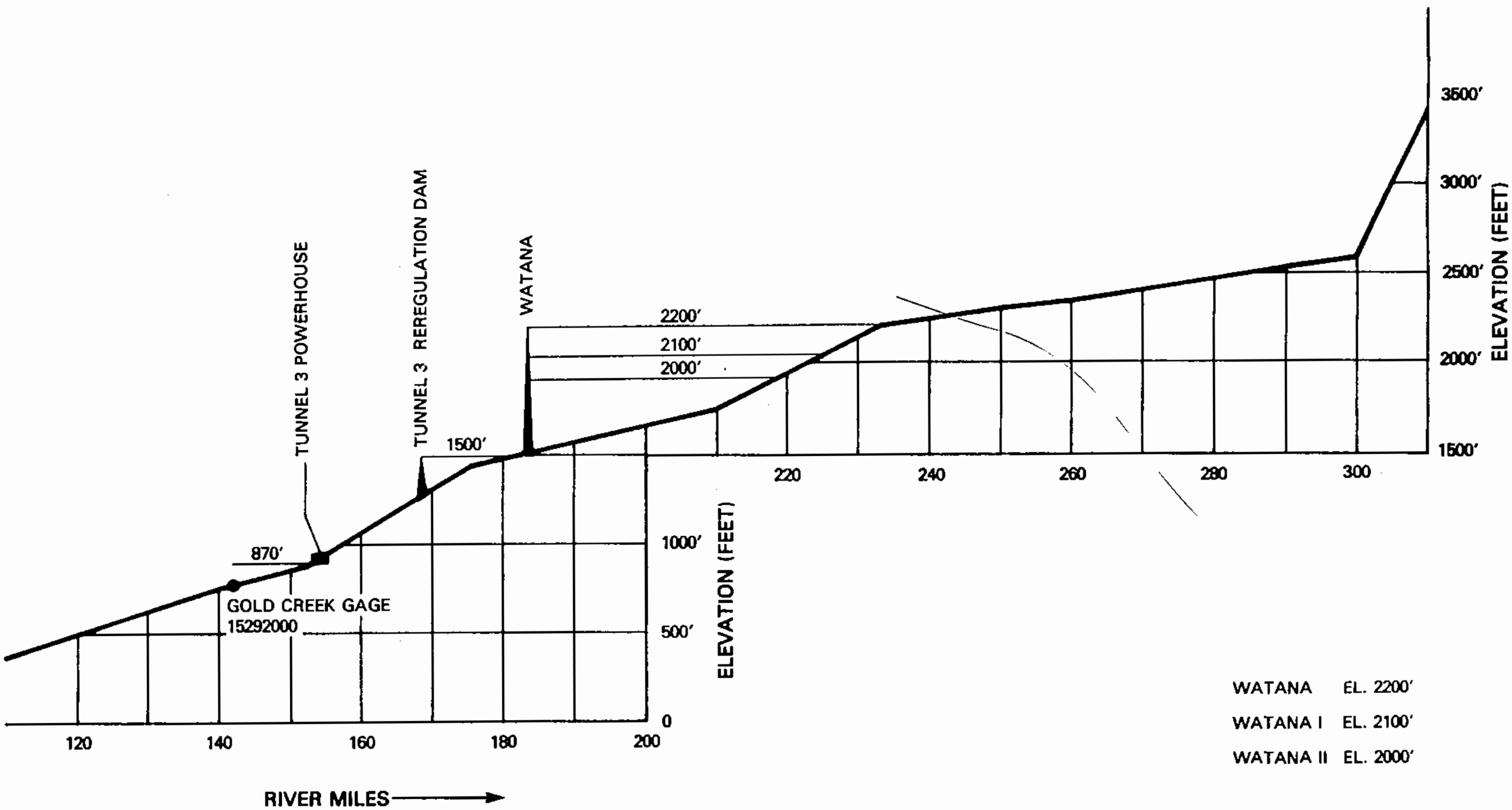

Figure 1-12. Profile: Watana-Tunnel 3 Development.

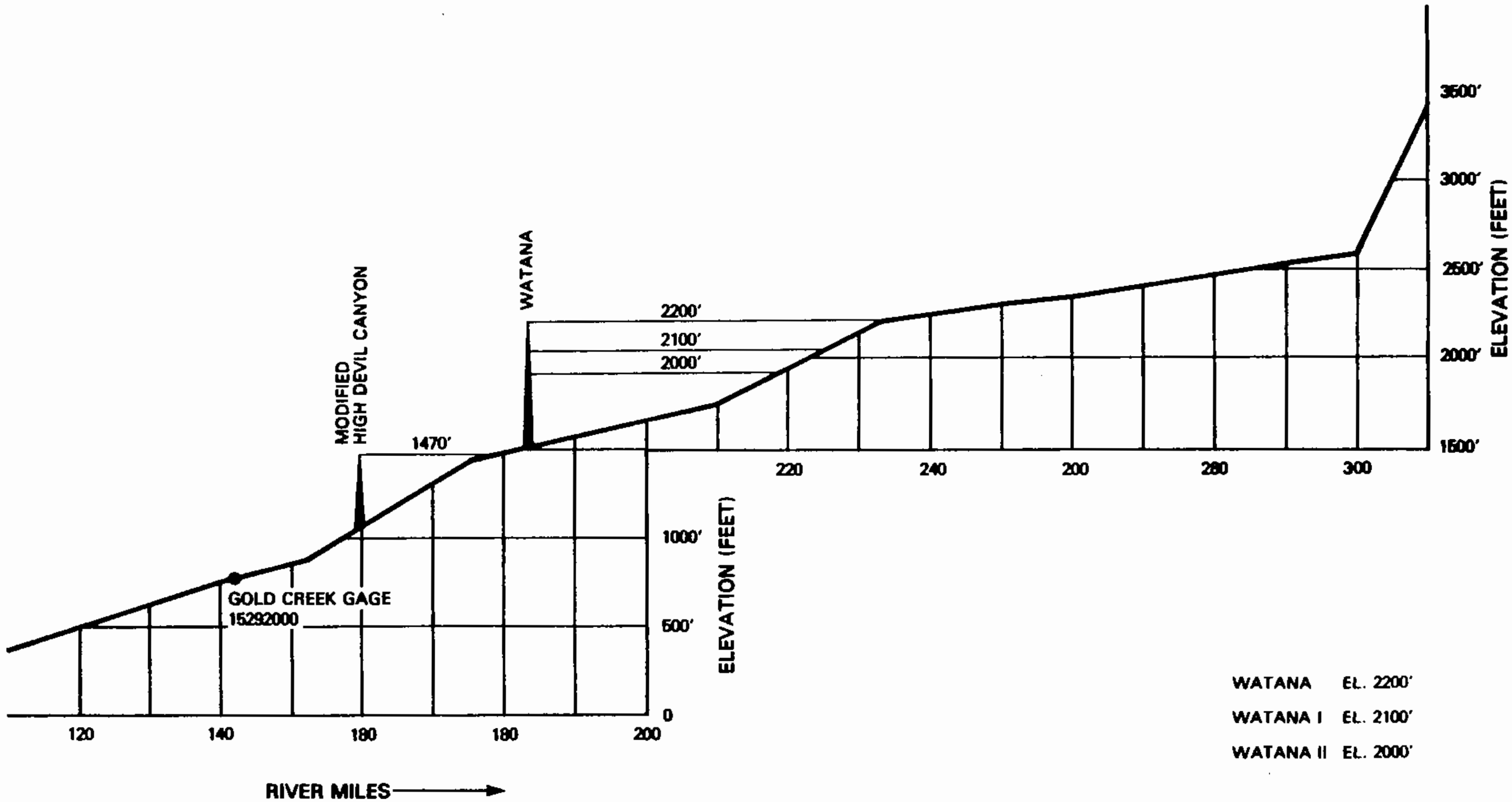

Figure 1-13. Profile: Watana-Modified High Devil Canyon Development.

The screening process carried out by the Applicant required the application of several iterations with progressively more stringent criteria until a field of ten potential non-Susitna projects were chosen. The Applicant assumed the Bradley Lake and Grant hydro projects would be added to the Railbelt system prior to 1990, and therefore these two projects were considered planned additions rather than alternatives.

The Staff considers the Applicant's general approach acceptable but believes it appropriate to consider the 18 sites that remained after the Applicant's fourth iteration. Table 1-16 summarizes the results of the Applicant's screening process by identifying the 91 original sites compiled from two inventories and the sequence of progressive elimination after the application of screening criteria. The 18 "shortlisted sites" that survived the Applicant's fourth iteration are listed in Table 1-17, along with the environmental rating of the sites.

FERC Staff selected for study those projects that had an environmental rating of good or acceptable and the lowest energy cost. The five alternatives selected by the Staff along with their respective costs, installed capacity, and average annual energy, are shown in Table 1-18. The values listed for average annual energy of the sites were derived with the Corps' HEC-5 computer model, using historic streamflow data for each river basin along with appropriate minimum flow criteria for fishery habitat maintenance.

1.3.3 Non-Hydroelectric Alternatives

The physical availability of fuels for thermal generation in the Railbelt is not a significant issue. There are sufficient reserves of oil, gas and coal, each taken individually, to meet the most optimistic projections of internal Railbelt thermal generation from now until well past the mid-21st Century. Physical supply is simply not a constraint. The cost at which any of those resources will be made available to Railbelt consumers is what is at issue, and the estimation of non-hydroelectric fuel cost is central to the evaluation of thermal alternatives.

1.3.3.1 Petroleum Fuels

The supply of petroleum fuel is related to the supply of crude oil. From Alaska's point of view, its crude oil reserves are so large relative to its internal needs that supply should not be a constraint on the use of petroleum fuels for the foreseeable future. Price is another matter. If oil prices rise relative to other energy resources, which are also abundant in Alaska, then the state may receive the greatest economic benefit from "exporting" its petroleum resources while consuming its lower cost resources. Petroleum fuel consumption could become "demand constrained."

1.3.3.2 Natural Gas

Alaska's proven gas reserves far exceed its internal needs for the foreseeable future under even the most optimistic projections of growth. Further, its potential gas resources may materially exceed its proven reserves. The amount of gas required to generate all of the Railbelt's electric power needs for the next half century, about 3 trillion cubic feet (Tcf) (85 billion m^3) is likely less than 10% of Alaska's proven gas reserves and perhaps 4% of its potential gas resources. However, the bulk of Alaska's gas may not be accessible for use to generate power in the Railbelt area, may be accessible only after it is needed, or may be accessible only at a cost that prohibits its use. Unless oil prices increase materially, a pipeline to transport Prudhoe Bay gas may not be constructed. If oil prices follow the Staff's projections, for instance, Prudhoe Bay gas may remain locked in place well into the next century. The Cook Inlet proven reserves, while readily accessible to the lower-Railbelt area, may not be sufficient to meet the area's power needs for more than about 20 years if consumption continues at the present rate.

In addition to the approximately 3.4 Tcf (96 billion m^3) of proven reserves in the Cook Inlet area, the United States Geological Survey (USGS) indicates that there is likely another 1.3 to 13 Tcf (37 to 370 billion m^3) of gas as yet undiscovered in the area. If so, then there could be more than adequate gas to meet the Railbelt's power needs for the next half century. But since such potential reserves are not proven, and may not materialize, it is argued that it would be imprudent to plan on the use of the as yet undiscovered gas. Further, it is argued, that even if the gas is present, gas prices will have to rise materially to ensure that it is discovered and developed. If Prudhoe Bay gas reserves remain locked in place, and if no new reserves are discovered in the Cook Inlet area, then a strategy by Anchorage area electric utilities to rely upon natural gas as a fuel for power generation could result in their units running out of fuel early in the 21st Century.

However, it is possible that circumstances may result in Alaska's continued receipt of abundant, low-cost gas supplies that could provide by far the least-cost power supply for many Alaskans in the future, as it has during recent years. A discussion of this potential is included in

Table 1-16. Summary of Results of Screening Process

Site†[1]	Elimination Iteration†[2]				Site†[1]	Elimination Iteration†[2]				Site†[1]	Elimination Iteration†[2]				Site†[1]	Elimination Iteration†[2]			
	1	2	3	4		1	2	3	4		1	2	3	4		1	2	3	4
Allison Creek					Fox	*				Lowe				*	Talachulitna River	*			
Beluga Lower			*		Gakona		*			Lower Chulitna				*	Talkeetna R. - Sheep	*			
Beluga Upper				*	Gerstle			*		Lucy	*				Talkeetna - 2				
Big Delta	*				Granite Gorge			*		McClure Bay			*		Tanana River			*	
Bradley Lake				*	Grant Lake			*		McKinley River		*			Tanzlina				*
Bremmer R. -Salmon	*				Greenstone			*		McLaren River	*				Tebay Lake		*		
Bremmer R. -S.F.	*				Gulkana River			*		Million Dollar		*			Teklanika		*		
Browne					Hanagita		*			Moose Horn	*				Tiekel River	*			
Bruskasna					Healy		*			Nellie Juan River	*				Tokichitna				*
Cache					Hicks					Nellie Juan R. -Upper				*	Totatlanika	*			
Canyon Creek	*				Jack River	*				Ohio			*		Tustumena				*
Caribou Creek	*				Johnson				*	Power Creek		*			Vachon Island		*		
Carlo		*			Junction Island		*			Power Creek - 1	*				Whiskers				*
Cathedral Bluffs				*	Kanhshna River			*		Ramport		*			Wood Canyon		*		
Chakachamna					Kasilof River		*			Sanford		*			Yanert - 2		*		
Chulitna E.F.	*				Keetna					Sheep Creek			*		Yentna			*	
Chulitna Hurrican			*		Kenai Lake				*	Sheep Creek - 1	*								
Chulitna W.F.	*				Kenai Lower			*		Silver Lake				*					
Cleave		*			Killey River	*				Skwentna				*					
Coal			*		King Mtn	*				Snow			*						
Coffee				*	Klutina				*	Solomon Gulch			*						
Crescent Lake			*		Kotsina	*				Stelters Ranch	*								
Crescent Lake - 2		*			Lake Creek Lower		*			Strandline Lake									
Deadman Creek	*				Lake Creek Upper				*	Summit Lake	*								
Eagle River	*				Lane				*	Talachulitna			*						

†[1] Final site selection underlined.

†[2] An asterisk (*) denotes site eliminated from further consideration.

Source: Exhibit E, Table E.10.1.

Table 1-17. Shortlisted Sites

Environmental Rating	Capacity (MW)		
	0-25	25-100	100
Good	Strandline Lake†[1] Allison Creek†[1] Tustumena Silver Lake	Hicks†[1] Snow†[1] Cache†[1] Bruskasna†[1]	Browne†[1] Johnson
Acceptable		Keetna†[1]	Chakachamna†[1]
Poor		Talkeetna-2†[1] Lower Chulitna	Lane Tokichitna

†[1] One of ten selected sites.

Source: Application Exhibit E, Table E.10.11.

Table 1-18. Data on Staff Non-Susitna Basin Alternatives

Alternative Investigated	Estimated Total Cost of Project ($ million 1982)	Total Installed Capacity of Alternative (MW)	Average Annual Energy of Alternative (GWh)
Johnson	319	210	920
Chakachamna	905	333	1,300
Snow	305	100	375
Keetna	519	100	420
Browne	681	100	418

Appendix B. The questions with regard to future power (after the next decade or so) are will gas be available (1) where it is needed, (2) when it is needed, and (3) at a price that allows economic power generation?

FERC Staff's gas price projections are based on an assumption that sufficient volumes of gas will be discovered in the Cook Inlet to meet the future power requirements of the lower-Railbelt area, and that the electric utilities will be able to obtain several contracts for such gas. The price projections are higher than net-back prices should be for decades, but are projected eventually to be somewhat lower. While the gas price projections are considered to be reasonable estimates and should be sufficient to insure additional exploration, there is considerable uncertainty in both the underlying assumption of Cook Inlet gas availability and the gas price projections.

1.3.3.3 Coal

Because the only significant market for coal within the Railbelt is as a boiler fuel for production of electricity, it does not compete with electricity as an end-use energy source. Furthermore, unlike petroleum fuels and natural gas, coal as an energy source is not linked as directly to the price of crude oil. The reason that this has been, and will likely continue to be, the case is that coal is not a close substitute for oil. The major uses to which coal is likely to be put are the conventional ones--as a boiler fuel for producing industrial process heat and for powering steam turbines for generating electricity by the utility industry. It is the latter use that is the internal market for coal within the Railbelt. The export market for the Railbelt's coal will likely entail both uses for this resource. The developing export market in the near term is, however, as a fuel for generating electric power.

Should the market develop for Railbelt coal exports, then the export price that coal commands will constitute the real cost of consuming that fuel locally. The outlook for such expansion is mixed. First, the competition among coal suppliers to the Pacific Rim is substantial and will increase in the near future. Second, the motivating factor for the diversification away from petroleum and into coal, among other fuels, has diminished measurably during the last 18 months as the outlook for real escalation in world prices has moderated and the prospects for falling crude prices have become reality. Thus, the value of the coal available for electricity generation within the Railbelt is likely to be the cost of extracting and transporting it to the generator. Given the vast supplies available to serve both the domestic as well as export markets, there is no persuasive reason to anticipate that the real costs of supplying the coal will escalate.

1.3.3.4 Peat

Alaska contains permafrost-free peat deposits that are estimated at 27 to 107 million acres (11 to 43 million ha), and represent more than half of total U.S. peat reserves. Forty-seven million acres (19 million ha) are located 5 ft (1.5 m) or less from the surface. Some 30 million acres (12 million ha) show promise as an energy resource. A 1980 survey by the Department of Energy investigated large peat fields located in three separate locations within the Railbelt (the Matanuska-Susitna valleys, Fairbanks, and the Kenai Peninsula) and concluded that those fields constituted a potentially valuable source of fuel, particularly for remote communities. According to the Division of Energy and Power Development of Alaska, peat for use in steam electric generation plants appears competitive with coal priced at $2.00 per million Btu, however, developmental and operational issues associated with prototype plants would have to be addressed before commercial plants could be contemplated.

1.3.3.5 Geothermal Energy

Several areas of Alaska have geothermal potential, particularly areas near or within the Railbelt. To date, however, only a fraction of that potential has actually been tapped--in the form of hot springs used for space heating and resort spas. Such springs are located at Manley Hot Springs, Chenea Hot Springs, and Tolovana. A number of geothermal sites are being investigated for their thermal energy and electric generation potential. Areas containing hot igneous systems, in or bordering the Railbelt, include Mt. Drum, Mt. Wrangell, and Double Peak. In most cases, however, geothermal heating systems are not currently economically competitive with conventional heating alternatives. Drilling costs are extremely high, and the resource value of geothermal energy is critically dependent upon the proximity to the end user. The heat distribution system for these wells can increase costs by a factor of five or six. According to the Division of Energy and Power Development, estimates of heat distribution piping average about $150/ft ($500/m), so even a small village of 50 residences, each about 150 ft (46 m) apart, would pay over $1 million for just the distribution system.

1.3.3.6 Tidal Power

Tidal energy is potentially available in Alaska, primarily in the Cook Inlet areas of the Railbelt, where the height of tidal variation and the volume of tidal flow are sufficient to make tidal power projects practical. Tidal energy can be converted into electricity by capturing both the potential energy associated with the height of tidal fluctuations as well as the kinetic energy associated with the flow of tidal water in and out of a contained area. If all the potential and kinetic energy of Cook Inlet were captured and made available to users in the Railbelt area of Alaska, it would provide electric power for the entire region well beyond the year 2050. A study prepared by Acres American identified 16 sites in the Cook Inlet area whose total energy capacity exceeded 186,000 GWh, with a total potential capacity of 73 GW. The Division of Energy and Power of Alaska concluded early in 1983 that development of commercial tidal power is more than a decade away.

1.3.3.7 Solar Energy

Solar energy is not regarded as a potential source of power within the Railbelt, either in the form of photovoltaic energy or solar heat. Despite the long hours of daylight that characterize the summers in the Railbelt, the periods of greatest energy need are during the winter, when solar energy production in Alaska will be negligible. In order to justify even the projected low investment costs in solar devices, it would be necessary for such equipment to make substantial contributions to the supply of energy when energy requirements are greatest.

1.3.4 Non-Structural Alternatives

Non-structural alternatives to construction of new electric generating capacity are being emphasized in many states because of the high capital costs of new generation and the resulting need for rate increases. The most important non-structural alternatives are conservation (of energy), rate revision, and load management. In an effort to advance these alternatives, the Congress has passed three related Acts: (1) the National Energy Conservation Act of 1978; (2) the Powerplant and Industrial Fuel Use Act of 1978; and (3) the Public Utility Regulatory Policies Act (PURPA) of 1978. Provisions of these Acts that may be pertinent are included in Appendix C. A separate action to advance the effects of non-structural alternativs (rate revision and load management) is a study proposed by the National Association of Regulatory Utility Commissioners (NARUC). This study, known as the NARUC Resolution No. 9 Study, has been in progress for some time, and is described in Appendix C.

1.3.4.1 Effects of Conservation on Demand

Conservation of electric energy has been advocated as one means of reducing the demand for electric power, thereby reducing the need to install new generating facilities. To date, most conservation measures have been voluntary and have been encouraged through public education or Federal programs. These measures include encouraging the use of major appliances during off-peak hours, lowering the thermostat setting of heating units, and raising the thermostat setting on air conditioning units. Conservation could also be encouraged by providing tax incentives or low-cost Federal loans for insulating residential and commercial establishments, for designing and constructing energy-efficient homes and offices, and for manufacturing energy-efficient equipment.

There are three principal types of conservation programs that play a part in the current energy scenario of the Railbelt. Those program categories are: (1) the State Residential Energy Conservation Program; (2) the Municipality of Anchorage Low-Income Weatherization Program; and (3) various Railbelt utility-sponsored conservation assistance programs.

The state-sponsored program has undertaken the following: (1) the training of energy auditors; (2) the performance of residential energy audits entailing the physical inspection of the premises; (3) the provision of grants and loans for conservation improvements recommended by the audit; and (4) provision of retrofitted insulation and weatherization for qualifying low-income households. The Municipality of Anchorage's program provides grants of up to $1,600 for energy conservation materials and repairs. The utility-sponsored conservation programs, at least so far as they address residential consumers, can best be described as educationally oriented. Distributing brochures, making presentation to groups, and counseling customers regarding conservation techniques appear to characterize the bulk of this activity. Most assessments of these conservation programs (including the assessments of the sponsoring organizations) indicate modest impacts, particularly in the Anchorage area. The trend appears to be curtailment rather than expansion of most of these efforts. Experience in other states suggests that consumer conservation measures are generally undertaken when electric rates become burdensome and the savings available from specific measures are well identified.

1.3.4.2 Effects of Rate Revision on Demand

Restructured or redesigned electric tariffs, developed to reduce electric energy consumption, should attempt to more accurately represent the true cost of producing the electric power. The cost in terms of economic resources to produce a unit of electricity for the supply of utility system loads changes continuously. Cost depends on the size of the system load, which is constantly varying in hourly, daily, weekly, and seasonal cycles, and on the availability and efficiency of generation capacity, which often varies in a 12-month cycle. To the extent that rates reflect these costs, rates provide signals to customers about the amount of power consumption that is consistent with the efficient use of energy resources. In theory, seasonal rates designed to account for the average seasonal difference in the cost of producing energy might be used; or, if the cost of implementing them can be justified, time-of-day rates--rates that reflect the marginal cost of producing energy, a cost that fluctuates with each change in system load--should be used.

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

As a result of a number of experiments conducted in the 1970s, it appears that revised rate designs and load management, in the absence of major changes in the general rate level, will reduce but not eliminate the need for substantial amounts of new peaking capacity. It is doubtful that in the near future, rate design and load management will invalidate the need for additional generation.

1.4 SCENARIO DEVELOPMENT

FERC Staff examined several alternative power resource development scenarios for the Railbelt. These scenarios include development of the Susitna River Basin using the Susitna project as proposed by the Applicant and numerous other alternatives for Susitna River development; the development of smaller hydroelectric resources outside of the Susitna River Basin; the use of thermal generation expansion patterns fueled predominantly by either coal or gas; and the use of a combination of resource types. All of the scenarios considered technologies currently available, and the combination scenario considered some technologies expected to be commercially available in the next decade. Each scenario is discussed separately in the following sections.

1.4.1 Susitna Basin Development

The Staff studied the 19 alternatives for Susitna Basin hydropower development identified in Section 1.3.1 (Table 1-15) to determine which projects would meet the system load requirements for the Railbelt through the year 2013 with the least total system cost. The Railbelt power system costs were determined for the alternative projects using the OPCOST program model. The Applicant's data for the existing system characteristics with planned additions and retirements and Staff estimates of fuel costs, fuel cost escalation, and load projections were used. The system operation was simulated from 1993 to 2042, with load growth and real fuel cost escalation assumed from 1993 to 2013, but constant load and constant real fuel cost assumed from 2014 to 2042. OPCOST was run for each generation alternative using the Staff's high, low, and medium load forecasts.

The OPCOST program simulates the hour by hour operation of an electric power generating system subject to constraints imposed by the system generating unit characteristics, unit loading criteria, and user-specified system operating rules. Input data are the hourly system loads, individual generating unit data, and assumed load and fuel escalation rates. Output consists of a tally of the energy production, fuel consumption, and costs incurred for each unit. Results are also aggregated into monthly and yearly system total costs, system total energy production, and various other system operating statistics.

The OPCOST runs identified a total of six alternative hydropower development plans for the Susitna River that meet system load requirements through the year 2013 and provide low overall system costs for all three load forecasts. Table 1-19 contains a summary of the levelized annual system power costs (in constant 1982 dollars) for the proposed project and each of the six alternative plans for both the high and low load forecasts, and for a range of real discount rates from 3.5% to 7.0%. These costs include the levelized capital, operation, and maintenance costs of the hydroelectric developments.

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Table 1-19. Summary of OPCOST Data on Susitna Basin Alternatives, Proposed Project and Preferred Alternatives

Susitna Development Scenario	Discount Rate (%)	Levelized Total Power Cost†[1] ($ million 1982) High Load Forecast	Low Load Forecast
Watana-Devil Canyon (Application)	3.5	192.6	183.5
	5.2	195.7	188.4
	7.0	193.4	187.7
Watana I-Devil Canyon	3.5	186.1	172.8
	5.2	184.9	174.4
	7.0	180.9	172.7
Watana II-Devil Canyon	3.5	184.6	169.1
	5.2	181.2	169.0
	7.0	175.0	166.0
High Devil Canyon-Vee	3.5	163.6	158.3
	5.2	159.3	154.3
	7.0	155.5	147.2
Watana I-Modified High Devil Canyon	3.5	185.2	172.4
	5.2	187.1	172.3
	7.0	179.1	170.3
Watana II-Modified High Devil Canyon	3.5	186.9	170.9
	5.2	182.1	169.4
	7.0	175.0	165.0
Watana I-Tunnel Rereg	3.5	192.0	172.3
	5.2	190.8	175.9
	7.0	188.4	177.4

†[1] Power cost includes fuel and operating costs of existing and planned Railbelt generation, less retirements, plus the capital and operating costs of the specified combinations of alternative hydropower additions.

The six alternatives were screened on the basis of relative cost and energy capability and environmental acceptability. This screening resulted in three preferred alternative development scenarios for the Susitna River. Each includes Watana I as the first-stage development, with either Devil Canyon, Modified High Devil Canyon, or Tunnel 3 Reregulating dam as the second stage. The most environmentally acceptable of the plans appears to be the Watana I development with the Tunnel 3 Reregulating dam.

1.4.2 Non-Susitna River Hydroelectric Development Plans

The Staff studied the optimum development schedule for the five non-Susitna hydropower projects identified in Table 1-18. The analysis included development plans for the Chakachamna site, as well as plans without Chakachamna but with a combined cycle plant or a coal plant and gas turbine as replacements. The various scenarios were analyzed using the Staff's OPCOST program to determine the Railbelt system power cost in the same manner as discussed in Section 1.4.1. The results of the analysis for the four lowest-cost scenarios are summarized in Table 1-20. The studies indicate that the "with Chakachamna" scenarios 1 and 2 and the "without Chakachamna" scenarios 3 and 4 have almost identical total levelized costs. In all cases thermal generation additions are needed to meet load requirements through the year 2013, as indicated in Table 1-20.

1.4.3 Natural-Gas-Fired Generation Scenario

The proven and estimated natural gas resources in the Cook Inlet area of the Railbelt (see Fig. 1-14) and the possibilities for transport of North Slope natural gas to the Railbelt justify consideration of natural gas generation as an alternative to the proposed project. In its gas

Table 1-20. Summary of OPCOST Data of Preferred Non-Susitna Basin Development Plans

Development Plan	Discount Rate (%)	Levelized Total Power Cost†[1] ($ million 1982) High Load Forecast	Low Load Forecast
With Chakachamna			
(1) 1993-Johnson 2003-Chakachamna & Snow 2008-Browne & Keetna & Coal Plant			
	3.5	139.9	118.9
	5.2	120.9	104.3
	7.0	98.1	85.2
(2) 1993-Johnson 1998-Chakachamna 2003-Snow 2008-Browne & Keetna & Coal Plant			
	3.5	138.1	117.9
	5.2	120.6	104.9
	7.0	99.2	87.6
Without Chakachamna			
(3) 1993-Johnson 2003-Snow & Keetna 2008-Browne & Combined Cycle & Coal Plant			
	3.5	140.0	117.8
	5.2	119.1	101.6
	7.0	96.3	82.5
(4) 1993-Johnson 1998-Snow & Keetna 2008-Browne & Combined Cycle & Coal Plant			
	3.5	140.3	118.6
	5.2	120.8	103.7
	7.0	99.7	86.4

†[1] Power cost includes fuel and operating costs of existing and planned generation, less retirements, plus the capital and operating costs of the specified combinations of alternative hydropower additions.

scenario, the Staff assumed that adequate supplies of natural gas will be available in the Cook Inlet area at the assumed price to fuel all generating units added by 2022. The scenario also includes the assumption that an exemption from the Fuel Use Act will allow the use of natural gas as a fuel for base-load power generation.

1.4.3.1 Scenario Evaluation

The gas scenario was evaluated by determining the annual operating costs associated with the scenario, as developed by the PRODCOST production costing model over the 30-year period 1993-2022. The analysis was based on an assumed real escalation of fuel costs but no escalation of other costs. Fuel costs were escalated from 1982 through 2022 and held constant thereafter.

Total power costs of each year include the operating and maintenance cost of that year plus the plant investments made in that year. To reflect costs beyond 2022, the total operating cost experienced in 2022 was assumed to be repeated for an additional 20 years. These total annual costs were adjusted to 1982 present worth and then levelized over the 50-year life of a hydroelectric license, using discount rates of 3.5%, 5.2%, and 7.0%. The gas scenario requires eight 200-MW combined-cycle units and two 70-MW combustion-turbine units to be installed by 2022 to meet medium load growth.

Costs were examined for high and medium demand levels, with both high and medium fuel escalation rates. Results of the analysis are shown Table 1-21.

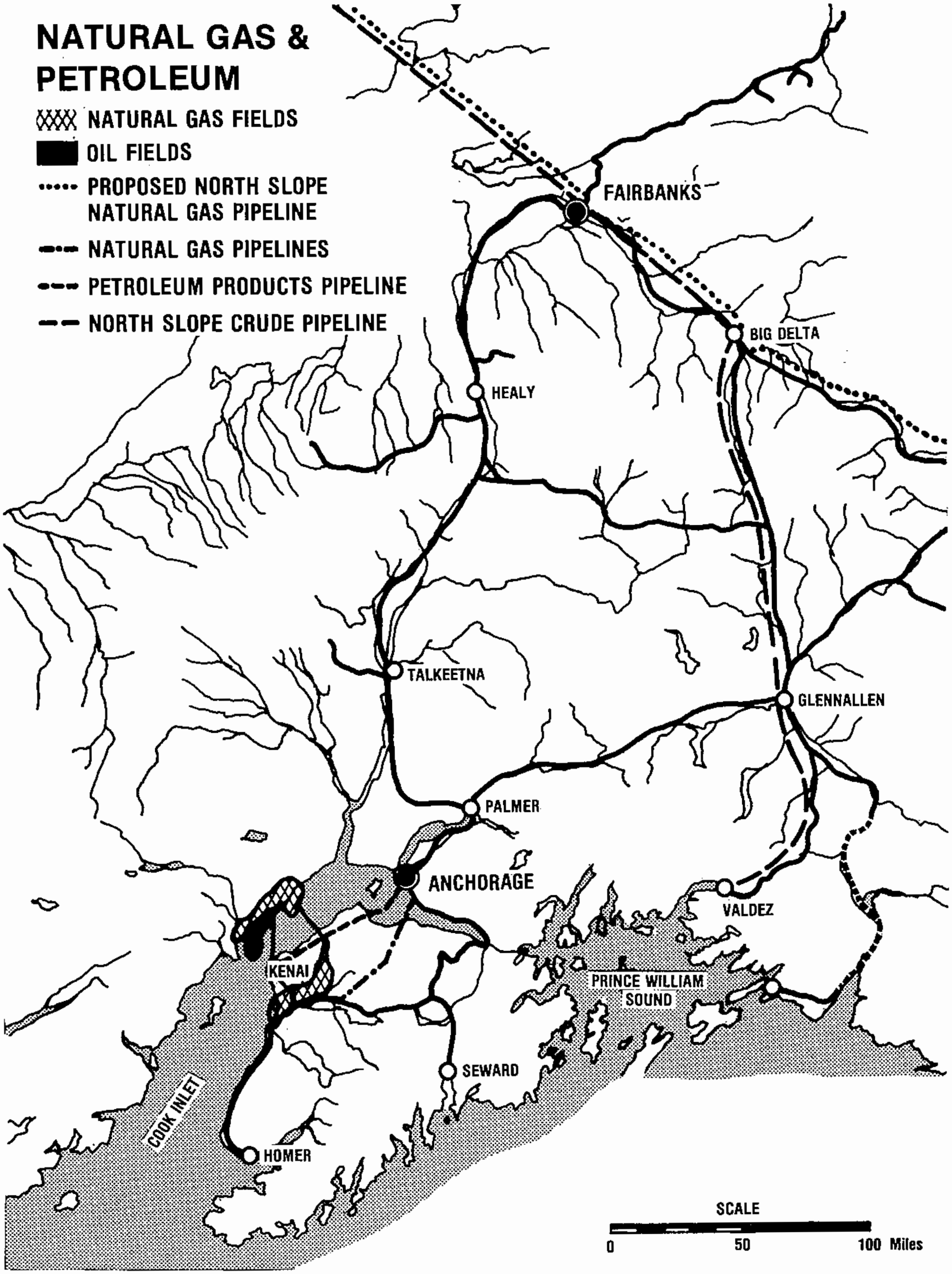

Figure 1-14. Natural Gas and Petroleum Resources of the Railbelt Area, Including Natural Gas, Petroleum Products, and Crude Pipelines. [Source: Battelle Pacific Northwest Laboratories, 1982b]

Table 1-21. Cook Inlet Gas Scenario Cost Comparison with Proposed Susitna Project; Present Worth (PW) and Levelized Total Annual Cost†[1] (LAC)--$\$10^6$ (\$ 1982)

	Discount Rate (%)					
	3.5		5.2		7.0	
Scenario	PW	LAC	PW	LAC	PW	LAC
Mid Forecast and Mid Fuel Escalation Rate						
Gas	3,701	157.79	2,315	130.75	1,484	107.53
Susitna	4,383	186.86	3,368	190.22	2,615	189.48
Mid Forecast and High Fuel Escalation Rate						
Gas	4,046	172.50	2,507	141.59	1,595	115.57
Susitna	4,459	190.10	3,408	192.48	2,638	191.15
High Forecast and Mid Fuel Escalation Rate						
Gas	4,089	174.33	2,554	144.25	1,623	178.62
Susitna	4,566	194.67	3,478	196.43	2,685	194.55
High Forecast and High Fuel Escalation Rate						
Gas	4,474	190.74	2,758	156.33	1,760	127.53
Susitna	4,663	198.80	3,531	199.42	2,714	196.66

†[1] Present worth in 1982 dollars and cost levelized over 50 years.

1.4.3.2 Data Assumptions for Gas Scenario

The technical data for projected generating facilities used in the gas scenario were again adopted from the Applicant's data, after review, and as in all other scenarios, data for existing plants and their retirement schedules are the same as used by Applicant. As did the Applicant, the Staff assumed the Bradley Lake and Grant Lake hydroelectric projects were in service prior to 1993 and that the siting flexibility of gas-fired combustion turbines and gas-fired combined cycle facilities justified analysis without consideration of transmission requirements for unit additions. Location of generating resources in the Cook Inlet area would probably require reinforcement of intertie transmission to serve load in the Fairbanks area.

Staff assumptions for electric power demand and fuel cost are shown in Tables 1-22 and 1-23.

1.4.4 Coal-Fired Generation Scenario

In light of the extensive coal resources available to the Railbelt, system expansion served predominantly by coal-fired generation (but including a considerable amount of gas-fired combustion-turbine units) is a realistic alternative to the Susitna project. Among the many coal fields in the area (Fig. 1-15), two--the Nenana and Beluga fields--show superior potential for development. The Nenana coal field has proven reserves of 861 million tons (781 million MT) and indicated reserves of over 6 billion tons (5.4 billion MT). The Beluga field has proven reserves of 275 million tons (250 million MT) and indicated reserves of more than ten times that amount. The only major, currently producing mine in the Railbelt, the Usibelli mine, is located in the Nenana field. The Beluga field is currently in an exploratory and predevelopment stage and has not been producing to date.

Requirements for development of the Beluga coal field include a major export market on the order of 5 million tons (4.5 million MT) per year, a major local market with rapidly increasing coal demands, or a combination of export and local markets. In light of the uncertainty regarding development of the Beluga coal field, the existing expansion capability of the Usibelli mine, and the proven reserves available in the Nenana coal field, the Staff chose to develop a coal generation scenario that reflected the costs and environmental impacts of production from the Nenana field and electric power generation in the Nenana area. The environmental effects of locating five coal units in the Nenana area were subsequently evaluated and found to be undesirable. The location of three coal units in the Nenana area and two subsequent units in the Willow area was considered more acceptable in the Staff review. The latter arrangement would increase the coal scenario cost slightly but would not alter the general cost comparison with the Susitna project.

Table 1-22. Load Forecast Used for Thermal Alternatives Evaluation

Load Forecast	1983	1985	1990	1995	2000	2010	2020	2030	2040
High									
Energy (GWh)	2,760	3,049	3,680	4,107	4,472	5,767	7,437	9,591	12,368
Peak (MW)	573	629	765	855	930	1,198	1,545	1,992	2,569
Mid									
Energy	2,760	3,032	3,487	3,821	4,197	5,359	6,844	8,739	11,160
Peak	573	626	726	795	873	1,114	1,424	1,818	2,322
Low									
Energy	2,760	3,021	3,372	3,568	3,899	4,961	6,313	8,033	10,222
Peak	573	623	701	742	810	1,028	1,308	1,665	2,118

Table 1-23. Fuel Price Projections ($ 1982)

Fuel Forecast	1983	1985	1990	1995	2000	2010	2020	2030	2040	2050
Oil ($/bbl)										
High	29	26	31	29	32	38	46	56	68	82
Medium	29	24	20	22	24	29	36	44	54	66
Low	29	10	14	16	17	21	25	30	37	46
Gas ($/MMBtu)										
High	2.68	2.51	2.80	3.03	3.20	3.53	4.02	4.60	5.29	6.10
Medium	2.68	2.39	2.16	2.62	2.74	3.03	3.44	3.90	4.48	5.18
Low	2.68	1.58	1.81	2.25	2.33	2.54	2.77	3.09	3.49	4.02
Coal ($/MMBtu)										
High	1.55	1.55	1.55	1.57	1.59	1.64	1.70	1.76	1.82	1.89
Medium	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55
Low	--	--	--	--	--	--	--	--	--	--
Diesel Oil ($/bbl)										
High	40	37	42	40	43	49	57	67	79	93
Medium	40	35	31	33	35	40	47	55	65	77
Low	40	21	25	27	28	32	36	41	48	57

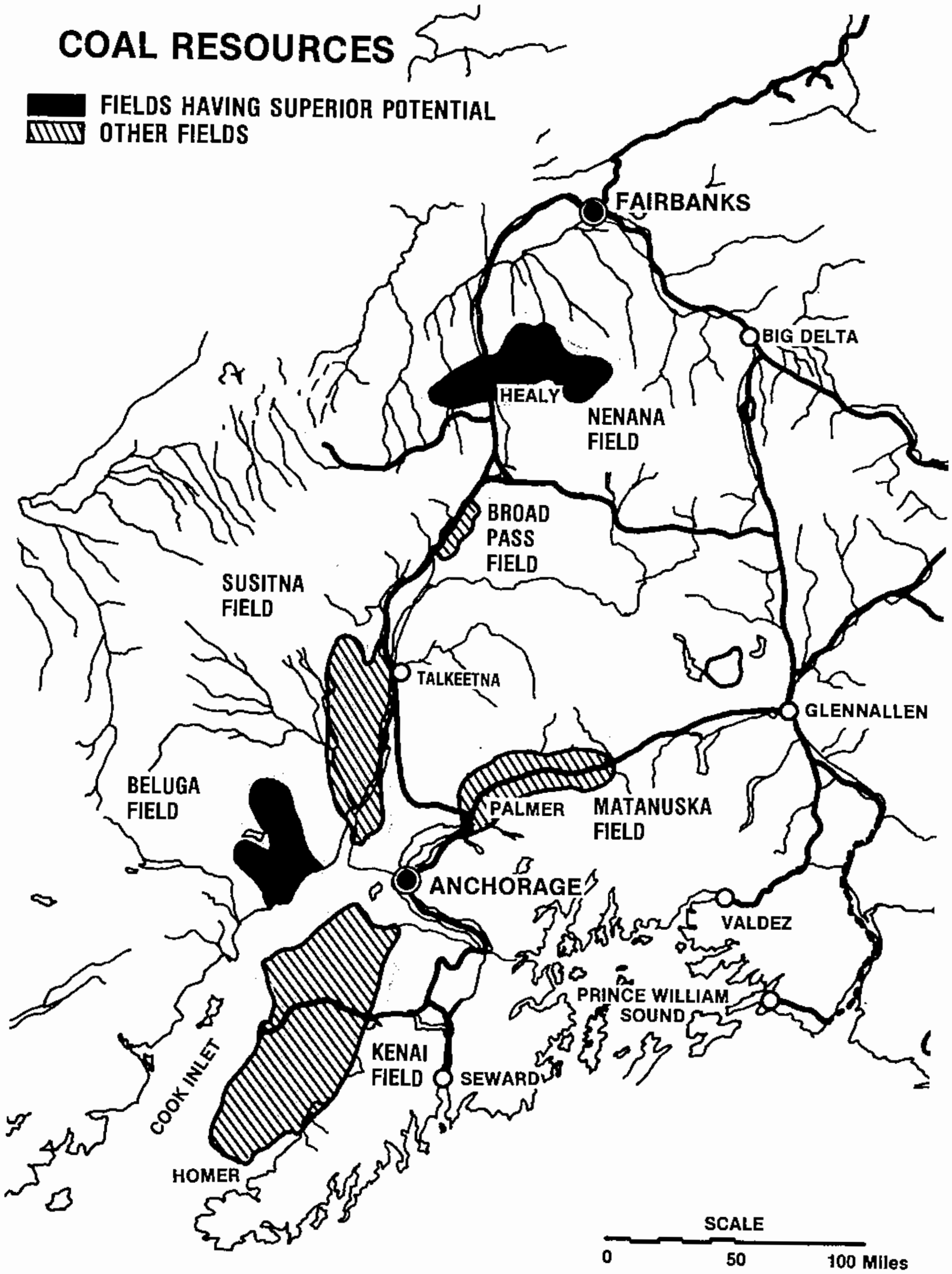

Figure 1-15. Major Coal Resources of the Railbelt Area. [Source: Battelle Pacific Northwest Laboratories, 1982a]

Analysis of a Nenana Coal generation scenario provides a reasonable cost comparison of coal generation versus the Susitna project. It illuminates environmental issues and helps determine whether there is a need to disperse Nenana-supplied coal generation along the Alaskan Railroad. It also provides information pertinent to the possible development of the Beluga coal field.

1.4.4.1 Scenario Evaluation

The coal scenario was evaluated by using the PRODCOST production costing model to simulate the annual Railbelt electric power system operation with the Susitna project in service and alternatively, with the coal scenario. System operation over the 30-year period 1993-2022 was simulated in detail. The analysis included consideration of cost escalation above a general inflation rate by including real cost escalation for thermal fuels and assumed zero escalation for all other costs. Fuel costs were escalated from 1982-2022 and held constant thereafter.

Total costs in each year reflected the operating and maintenance costs of that year plus any plant investment made that year. To reflect costs beyond the year 2022, the total operating cost experienced in 2022 was assumed to be repeated for an additional 20 years. These total annual costs were adjusted to 1982 present worth and then levelized over the 50-year life of a hydroelectric license, using discount rates of 3.5%, 5.2%, and 7.0%. The coal scenario requires five 200-MW coal units and ten 70-MW combustion-turbine units to serve the medium load growth forecast through 2022.

Sensitivity analyses included determination of system costs associated with the Staff's medium and high electric power demand forecasts, each with medium and high fuel escalation rates. The cost of the high demand/high fuel escalation rate case was also calculated with transmission requirements included. The results of the analyses are shown in Table 1-24.

1.4.4.2 Data Assumptions for Coal Scenario

The Staff reviewed and adopted as reasonable the Applicant's technical data for existing and projected generating facilities and adopted the Applicant's schedules for the retirement of existing generating facilities. The Staff also concurred in the Applicant's assumption that both the Bradley Lake and Grant Lake hydroelectric developments would be in operation prior to 1993.

Table 1-24. Nenana Coal Scenario Cost Comparison with Susitna; Present Worth (PW) and Levelized Total Annual Cost†[1] (LAC)--$\$10^6$

	Discount Rate (%)					
	3.5		5.2		7.0	
Scenario	PW	LAC	PW	LAC	PW	LAC
Mid Forecast and Mid Fuel Escalation Rate						
Coal Scenario	3,748	159.79	2,392	135.10	1,558	112.89
Susitna	4,383	186.86	3,368	190.22	2,615	189.48
Mid Forecast and High Fuel Escalation Rate						
Coal Scenario	3,912	166.78	2,492	140.74	1,620	117.38
Susitna	4,459	190.10	3,408	192.48	2,638	191.15
High Forecast and Mid Fuel Escalation Rate						
Coal Scenario	4,156	177.19	2,644	149.33	1,720	124.63
Susitna	4,566	194.67	3,490	197.11	2,696	195.35
High Forecast and High Fuel Escalation Rate						
Coal Scenario	4,351	185.50	2,759	155.82	1,789	129.63
Susitna	4,663	198.80	3,531	199.42	2,714	196.66
Coal Scenario Plus Transmission†[2]	4,656	198.5				

†[1] Present worth in 1982 dollars and cost levelized over 50 years.

†[2] Assumed 20% increase in the fixed cost portion (assumed to be 35% of total) of the total levelized annual cost.

Assumptions with regard to electric power demand and fuel cost were prepared separately (see Sec. 1.2.4). The Staff's electric power demand projections are shown in Table 1-22 and fuel costs in Table 1-23.

The forecast demands shown in Table 1-22 are preliminary figures used for computer analysis of the various scenarios. They are somewhat higher in the later years than the latest staff projections shown in Table 1-6 and result in slightly higher total costs for thermal generation. However, the slight difference has no impact on the conclusions reached by the Staff in their analyses.

1.4.5 Scenario Comparison and Combined Scenarios

1.4.5.1 Hydroelectric Scenarios

The Staff's analyses in Sections 1.4.1 and 1.4.2 show that non-Susitna Basin hydropower development plans can provide a lower-cost means of meeting the Railbelt system electric loads till the year 2013 than the three preferred Susitna Basin hydropower alternatives, and are also less costly than the Susitna development plan proposed by the Applicant. The three preferred Susitna Basin alternative plans are compared with a non-Susitna hydroelectric scenario in Table 1-25.

1.4.5.2 Thermal Scenarios

The analyses in Sections 1.4.3 and 1.4.4 indicate that the coal and gas scenarios would meet the Railbelt power requirements at lower cost than the proposed Sustina project.

1.4.5.3 Combined Scenarios

In recognition of concerns regarding sole source dependence on greatly expanded development of the Nenana coal fields or on the absence of other markets for the Cook Inlet gas reserves, the Staff also examined the economic implications of a mixed scenario consisting of a combination of gas-fired combined-cycle generation in the Cook Inlet area and coal-fired generation in the Nenana area. For medium load growth, the mixed coal and gas development consists of three 200-MW coal-fired units, four 200-MW gas-fired combined-cycle units, and four 70-MW combustion-turbine units to be installed by the year 2022. A comparison of the more prudent mixed thermal scenario with the coal and gas scenarios is shown in Table 1-26. Other combinations of thermal generating resources were also considered. The utilization of gas-based fuel cells and refuse-derived fuel for steam generation were both found to be more expensive than the gas-fired combined-cycle and coal-fired alternative forms of generation.

The results shown in Tables 1-25 and 1-26 indicate that use of Alaska's coal and gas resources, either singly or in combination, is likely to provide a more economic means of meeting the Railbelt power requirements than the proposed Susitna project or any of the preferred Susitna River Basin alternatives to the Susitna project. The tables also show that, on the basis of available construction cost estimates, a non-Susitna River hydroelectric development plan appears to be the lowest cost hydropower development scenario. A conclusion from these analyses is that, with the high construction costs of the larger hydroelectric projects and current uncertainties regarding Beluga coal development, the most prudent Railbelt generation expansion plan would be a mix of non-Susitna hydroelectric resources with a combination of gas-fired combined cycle generation in the Cook Inlet area and coal-fired generation in the Nenana area. The use of smaller, lower cost hydroelectric resources in such a plan would reduce thermal generation requirements and fuel demands through the study period.

Table 1-25. Comparison of Susitna Basin and Non-Susitna Basin Hydroelectric Development Plans

Development Scenario	Discount Rate (%)	Levelized Total Power Cost†[1] ($ million 1982) High Load Forecast	Levelized Total Power Cost†[1] ($ million 1982) Low Load Forecast
Watana I-Devil Canyon	3.5	186.1	172.8
	5.2	184.9	174.4
	7.0	180.9	172.7
Watana I-Modified High Devil Canyon	3.5	185.2	172.3
	5.2	187.1	172.3
	7.0	179.2	170.3
Watana I-Tunnel Reregulation	3.5	192.0	172.3
	5.2	190.8	175.9
	7.0	188.4	177.4
With-Chakachamna Development Plan (1)			
1993--Johnson			
2003--Chakachamna & Snow			
2008--Browne & Keetna & Coal Plant			
	3.5	139.9	118.9
	5.2	120.9	104.3
	7.0	98.1	85.2

†[1] Present worth in 1982 levelized over 50 years.

Table 1-26. Comparison of Thermal Development Plans

Development Scenario	Discount Rate (%)	Levelized†[1] Total Power Cost†[2] ($ million 1982) High Load Forecast	Levelized†[1] Total Power Cost†[2] ($ million 1982) Mid Load Forecast
Coal	3.5	177.19	159.79
	5.2	149.33	135.10
	7.0	124.63	112.89
Gas	3.5	174.33	157.79
	5.2	144.25	130.75
	7.0	118.62	107.53
Coal and Gas Mix	3.5	174.29	156.12
	5.2	146.50	131.76
	7.0	122.17	110.14

†[1] Present worth in 1982 dollars levelized over 50 years.

†[2] Mid fuel escalation rate.

REFERENCES FOR SECTION 1

Battelle Pacific Northwest Laboratories. 1982a. Coal-Fired Steam-Electric Power Plant Alternative for the Railbelt Region. Richland, WA.

Battelle Pacific Northwest Laboratories. 1982b. Preliminary Railbelt Electric Energy Plans. Richland, WA.

Kresge, D.T., Morehouse and Rogers. 1978. Issues in Alaska Development, University of Washington Press.

2. PROPOSED ACTION AND ALTERNATIVES

2.1 PROPOSED PROJECT

2.1.1 Location

The proposed project would consist of the Watana and Devil Canyon hydroelectric developments on the Susitna River about 180 miles (mi) [288 kilometers (km)] north and east of Anchorage, Alaska (see general vicinity map, Fig. 2-1).

2.1.2 Facilities

2.1.2.1 Watana Development

Watana dam would be located at River Mile (RM) 184 approximately 2.5 mi (4 km) upstream of the Tsusena Creek confluence. The earth-rock fill dam would have a central impervious core protected by fine and coarse filters. A downstream outer shell of rockfill and alluvial gravel underlain by a toe drain and filter, and an upstream outer shell of clean alluvial gravel. The nominal crest elevation of the dam would be 2,205 feet (ft) [672 meters (m)] with a maximum height of 885 ft (270 m) above the foundation and a crest length of 4,100 ft (1,250 m). The embankment crest would initially be constructed to the elevation of 2,210 ft (674 m) to allow for potential settlement. The total volume of the structure would be approximately 62 million cubic yards (yd^3) [47 million cubic meters (m^3)]. During construction, the river would be diverted through two concrete-lined diversion tunnels, each 38 ft (11.6 m) in diameter and 4,100 ft (1,250 m) long, to be driven through the north bank abutment of the dam.

The Watana dam would create a reservoir approximately 48 mi (77 km) long, with a surface area of 38,000 acres (15,400 hectares (ha)], and a gross storage capacity of 9.5 million acre-feet (ac-ft) (11.7 billion m^3) with the water surface at elevation 2,185 ft (666 m), the normal maximum operating level. The maximum water surface elevation of the reservoir would be 2,201 ft (671 m). The minimum operating level of the reservoir would be 2,065 ft (671 m), providing a live storage of 3.7 million ac-ft (4.6 billion m^3). A plan of the Watana reservoir is shown in Figure 2-2.

The power intake would be located on the northern bank, with an approach channel excavated in rock. The concrete intake structure would be controlled with multilevel gates capable of operation over the full 120-ft (36.6-m) drawdown range. From the intake structure, six concrete-lined penstocks, each 17 ft (5.2 m) in diameter would lead to an underground powerhouse housing six 170-megawatt (MW) generating units. Access to the powerhouse would be by means of an unlined access tunnel and a road that would pass from the crest of the dam, down the southern bank of the river valley and across the embankment near the downstream toe. The turbines would discharge through six draft tube tunnels to a surge chamber downstream from the powerhouse, thence to the river through two 34-ft (10.4-m) diameter concrete-lined tailrace tunnels. A separate transformer gallery just upstream from the powerhouse cavern would house nine single-phase 15/345-kilovolt (kV) transformers (three transformers per group of two generators). The transformers would be connected by three 345-kV single-phase, oil-filled cables through two cable shafts to the switchyard at the surface.

Outlet facilities would be located on the northern bank and would be designed to discharge flood flows of up to 24,000 cubic feet per second (cfs) [680 cubic meters per second (m^3/s)]. Combined with 7,000 cfs (200 m^3/s) passing through the powerhouse, two units operating, the outlet facilities would handle the estimated 50-year flood with an increase in the pool elevation from 2,185 ft (666 m) to 2,193 ft (668 m) due to flood surcharge. The upstream gate structure for the outlet works would be adjacent to the power intake and would convey flows through a 28-ft (8.5-m) diameter concrete-lined tunnel to six fixed-cone discharge valves downstream of the dam. These valves would be housed beneath the spillway flip bucket and would be used to dissipate energy and eliminate undesirable nitrogen supersaturation in the river downstream from the dam during spillway operations.

The main spillway would be located on the northern bank and would consist of an ogee control structure with three vertical fixed-wheel gates and an inclined concrete chute and flip bucket designed to pass a maximum discharge of 120,000 cfs (3,400 m^3/s). This spillway, together with the outlet facilities and the powerhouse, would be capable of discharging the estimated 10,000-year flood [156,000 cfs (4,400 m^3/s)]. An emergency spillway and fuse plug on the northern bank would provide sufficient additional capacity to permit discharge of the Probable Maximum Flood (PMF) without overtoping the dam. Emergency release facilities would be located in one of the diversion tunnels after closure to allow lowering of the reservoir over a period of time to permit emergency inspection or repair of impoundment structures.

A local depression on the northern rim of the reservoir upstream of the dam would be closed by a low dike with a crest elevation of 2,210 ft (674 m). Provision would be made for monitoring potential seepage through this area and placement of appropriate filter blankets at Tsusena Creek downstream. Diagrams of the proposed Watana facilities are shown in Figures 2-3 and 2-4.

2.1.2.2 Devil Canyon Development

The Devil Canyon arch dam would be located at the upstream entrance of the Devil Canyon gorge at RM 152 approximately 32 river miles (51 km) downstream from Watana dam. The Devil Canyon dam would be a thin arch concrete structure 646 ft (197 m) high with a crest length-to-height ratio of approximately two. It would be designed to withstand dynamic loadings from intense seismic shaking. The dam would have a crest elevation of 1,463 ft (446 m) [not including a proposed 3-ft (1-m) parapet] and be supported by mass concrete thrust blocks on each abutment. On the southern abutment, the lower bedrock surface would require the construction of a large thrust block and adjacent to this thrust block, a 245-ft (74.7-m) high earth and rockfill saddle dam to provide closure to the southern bank. The saddle dam would be a central core type similar in cross section to the Watana dam, with a nominal crest elevation of 1,469 ft (447.7 m) plus an additional 3 ft (1 m) of overbuild for potential seismic settlement.

The Devil Canyon dam would form a reservoir approximately 26 mi (42 km) long with a surface area of 7,800 acres (3,200 ha) and a gross storage capacity of 1.1 million ac-ft (1.4 billion m^3) at elevation 1,455 ft (443.5 m), the normal maximum operating level. The maximum water surface elevation of the reservoir would be 1,466 ft (446.8 m), and the minimum operating level would be 1,405 ft (428.2 m), providing a live storage of 350,000 ac-ft (432 million m^3). During construction, the river would be diverted through a single 30-ft (9.1-m) diameter concrete-lined tunnel on the southern bank of the river.

A power intake on the northern bank would consist of an approach channel excavated in rock leading to a reinforced concrete gate structure. From the intake structure, four 30-ft (9.1-m) diameter concrete-lined penstock tunnels would lead to an underground powerhouse housing four 150-MW generating units.

Access to the powerhouse would be by means of an unlined access tunnel approximately 3,200 ft (975 m) long and a 950-ft (290-m) deep vertical access shaft. The turbine discharge would return to the river through a single 38-ft (12-m) diameter tailrace tunnel extending from the surge chamber downstream of the powerhouse cavern. A separate transformer gallery just upstream of the powerhouse cavern would house 12 single-phase 15/345-kV transformers. The transformers would be connected by 345-kV single-phase, oil-filled cables through a cable shaft to the switchyard at the surface.

Outlet facilities consisting of seven individual conduits would be located in the lower part of the main dam. These would be designed to discharge all flood flows of up to 38,500 cfs (1,090 m^3/s), the estimated 50-year flood at Devil Canyon. This is based on the assumption that one of the generating units would be operating. Each outlet conduit would have a fixed-cone valve similar to those provided at Watana to dissipate energy and minimize undesirable nitrogen supersaturation in the flows downstream. The main spillway would be located on the northern bank, and would consist of an upstream ogee control structure with three vertical fixed-wheel gates, and an inclined concrete chute and flip bucket designed to pass a maximum discharge of 123,000 cfs (3,480 m^3/s).

This spillway, together with the outlet facilities, would be capable of discharging the estimated 10,000-year flood. An emergency spillway and fuse plug on the southern bank would be designed to permit discharge of the probable maximum flood (PMF) without overtopping the dam.

A site layout of the Devil Canyon development is provided in Figure 2-5, and a reservoir plan is shown in Figure 2-6.

2.1.2.3 Construction and Permanent Site Facilities

2.1.2.3.1 Watana

Support facilities would be required throughouth the construction period for the Watana development. Following construction, the operation of the Watana hydroelectric project would require permanent staff and facilities to support the operation and maintenance program. The most significant facility would be a combination camp and village constructed and maintained at the

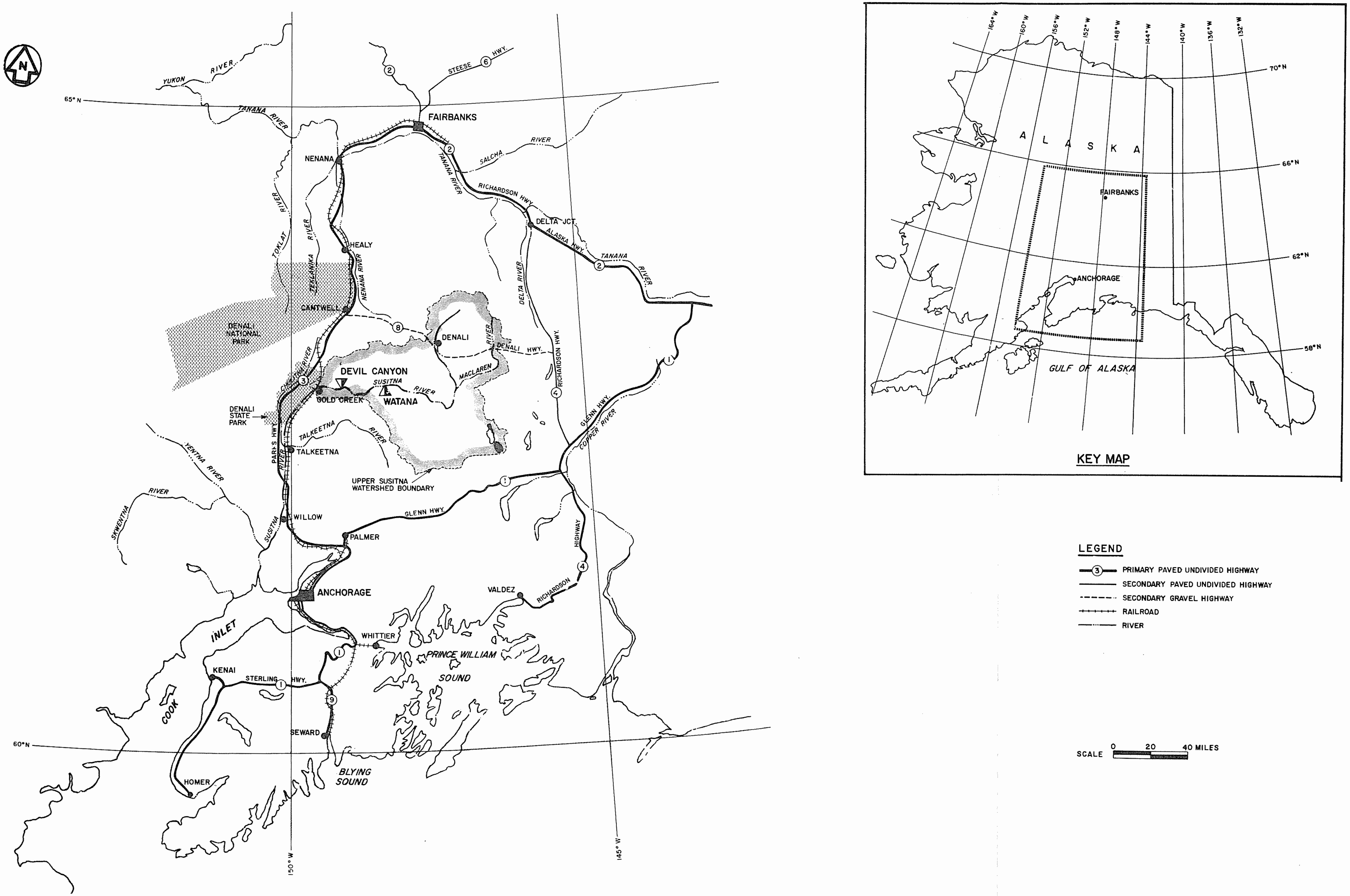

Figure 2-1. Vicinity Map--Susitna Development. [Source: Application Exhibit F, Plate F1]

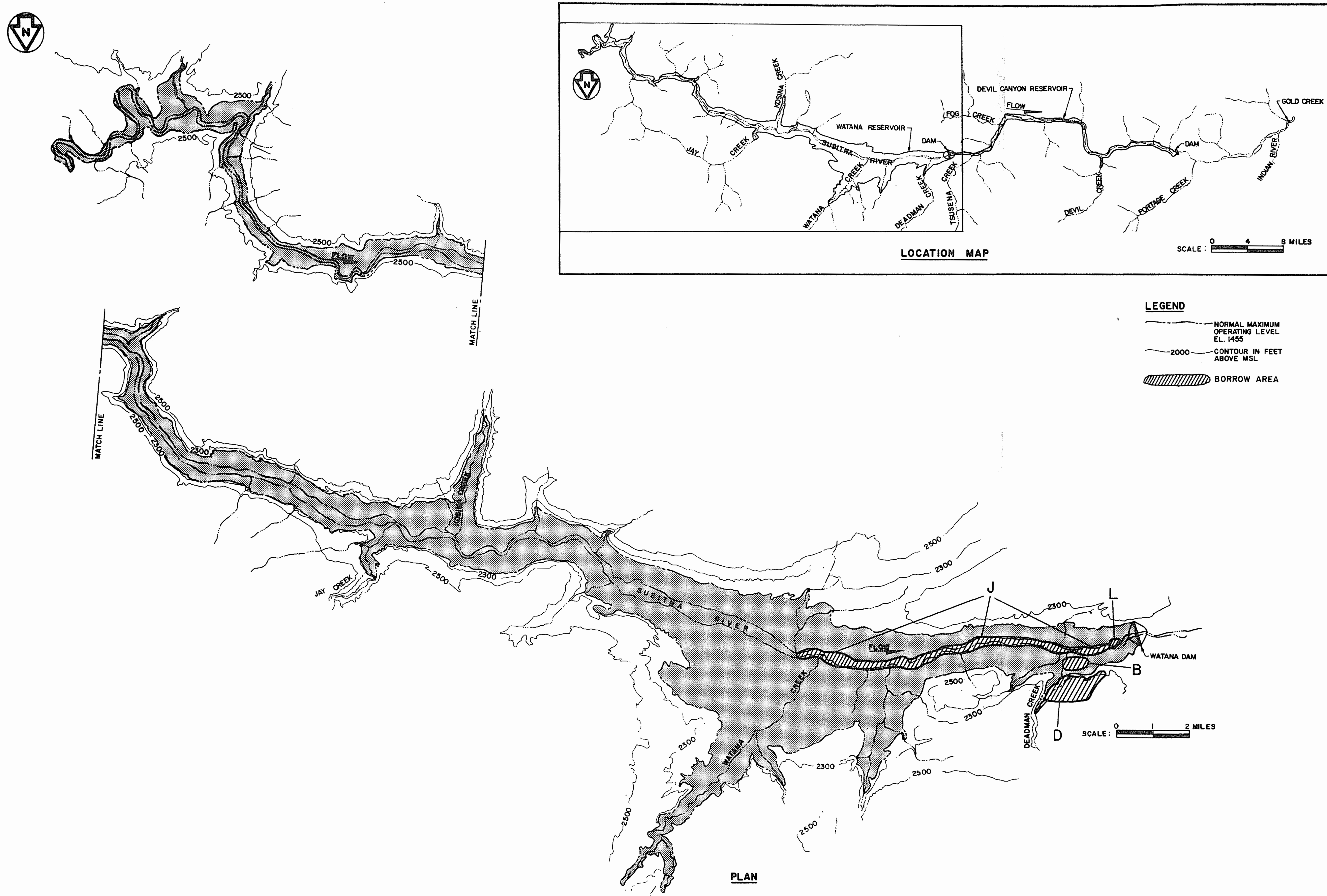

Figure 2-2. Watana Reservoir Plan and Generalized Location of Borrow Areas (letters).
[Source: Modified from Application Exhibit F, Plate F2].

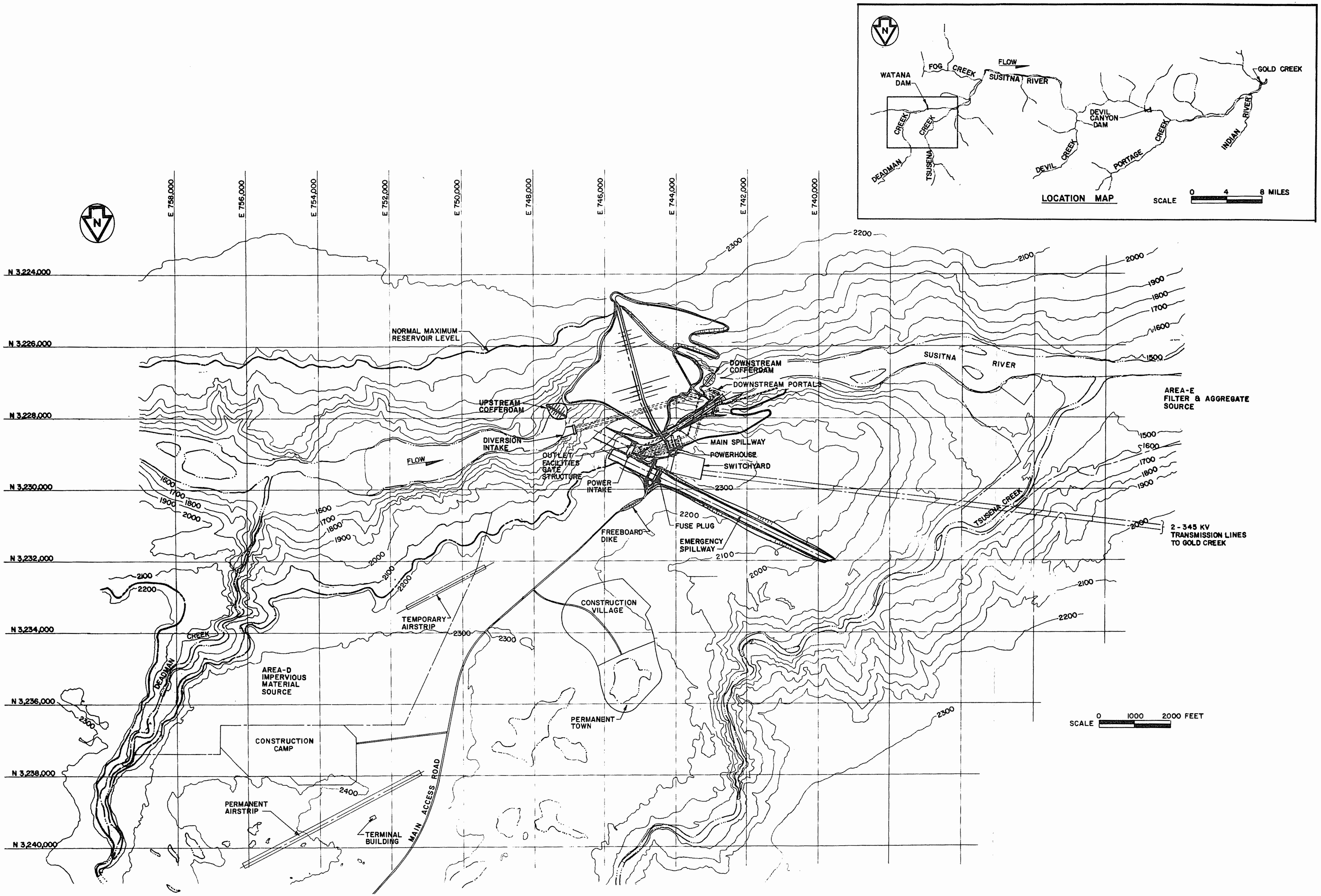

Figure 2-3. Watana Facilities--Plan. [Source: Application Exhibit F, Plate F3]

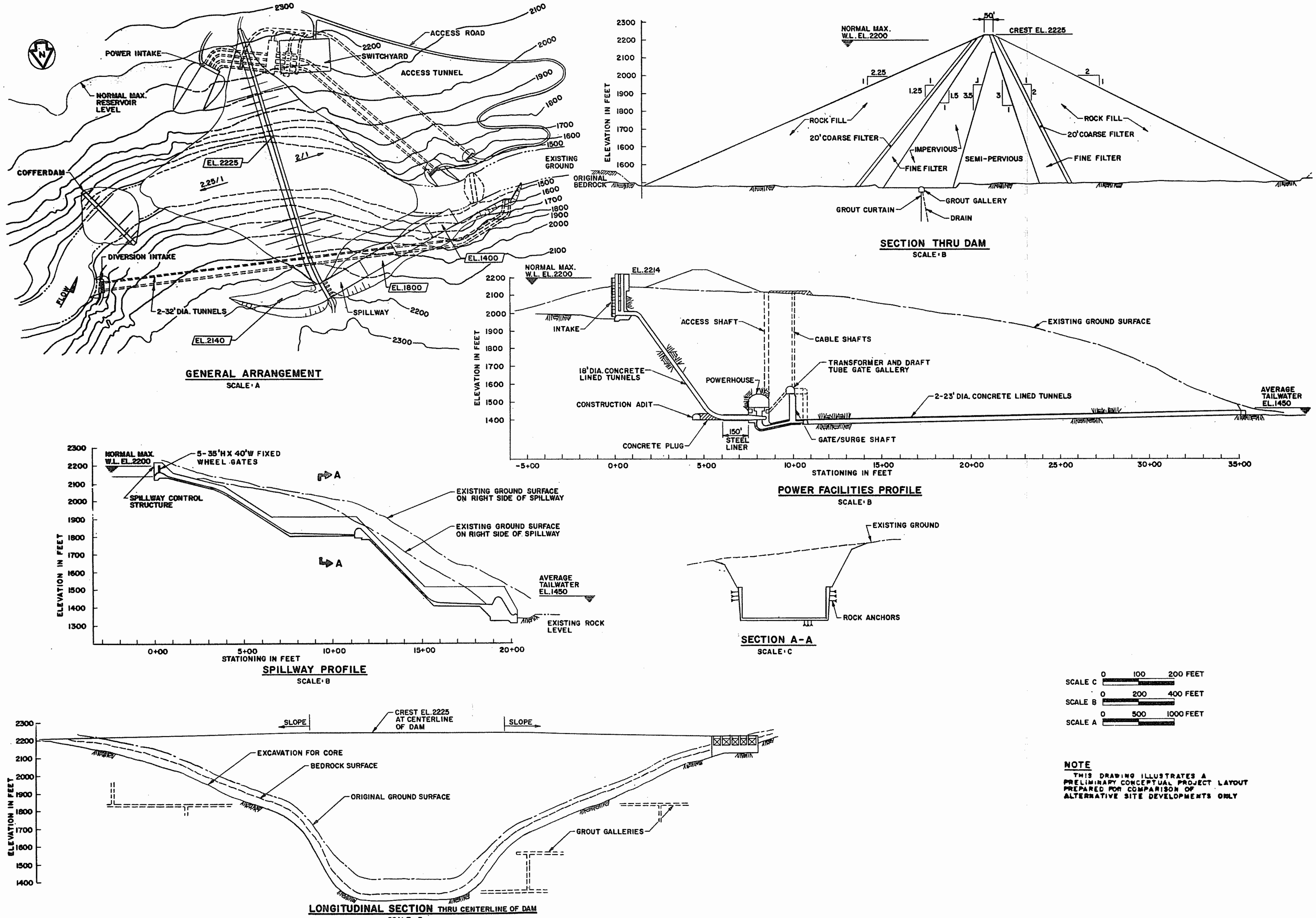

Figure 2-4. Watana Facilities--Sections. [Source: Application Exhibit B, Fig. B.7]

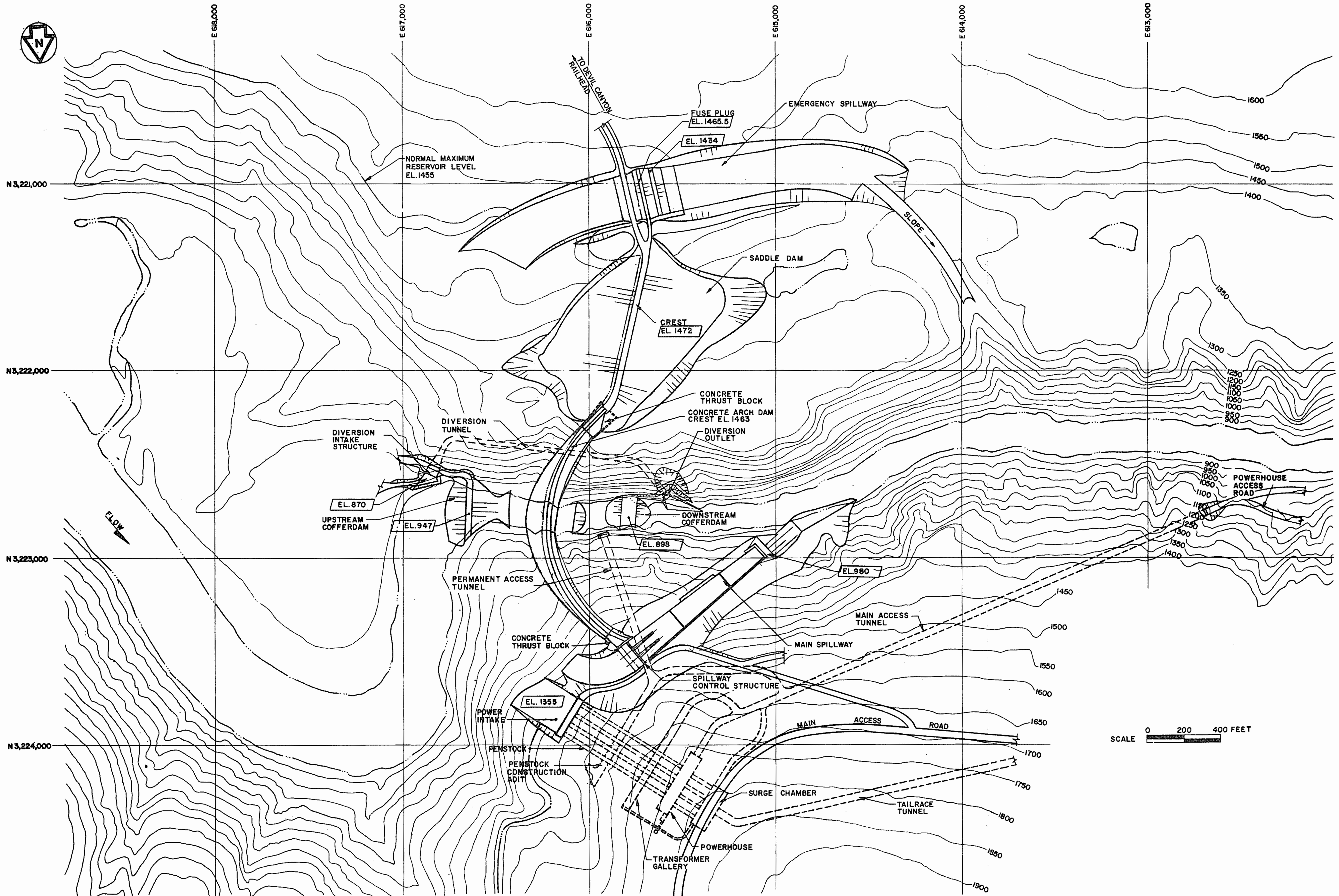

Figure 2-5. Site Layout--Devil Canyon Development. [Source: Application Exhibit F, Plate F41]

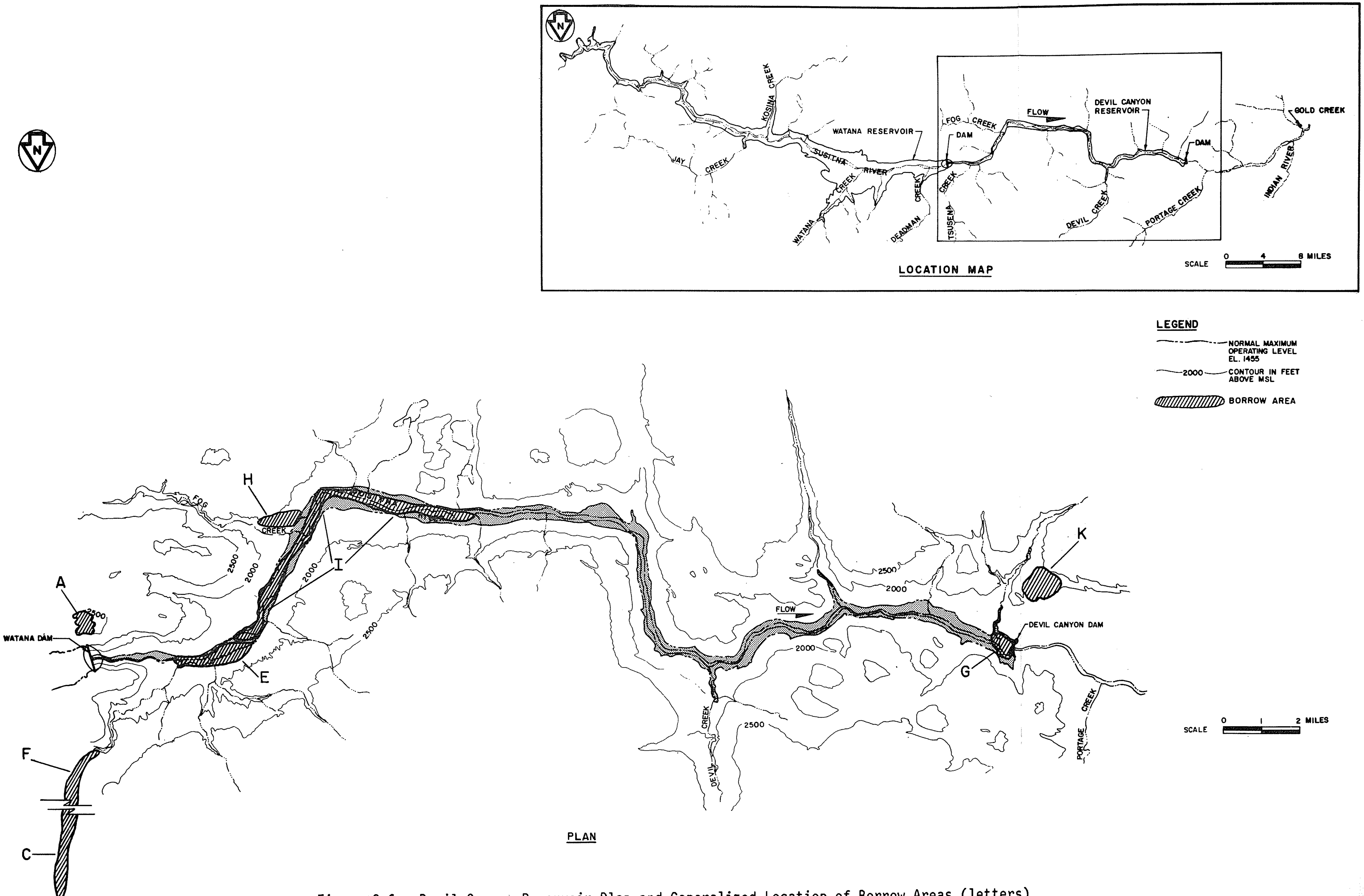

Figure 2-6. Devil Canyon Reservoir Plan and Generalized Location of Borrow Areas (letters).
[Source: Modified from Application Exhibit F, Plate F39]

project site. The camp/village would be a largely self-sufficient community housing 3,300 people during construction of the project. After construction was completed, most of this facility would be dismantled and the area reclaimed. The dismantled buildings and other items from the camp would be used, as much as possible, during construction of the Devil Canyon development. Other site facilities would include contractors' work areas, site power, services, and communications. Items such as power and communications would be required for construction operations independent of camp operations, as would a hospital or first aid room.

Permanent facilities would include a town or small community for approximately 130 staff members and their families. Other permanent facilities would include a maintenance building for use during operation of the power plant.

2.1.2.3.2 <u>Devil Canyon</u>

A camp and construction village would be constructed and maintained at the Devil Canyon project site. The camp/village would provide housing and living facilities for 1,800 people during construction. Other site facilities would include contractors' work areas, site power, services, and communications. Items such as power, communications, and hospital services would be required for construction operations independent of camp operations.

If possible, buildings used at the Watana development during construction would be used at Devil Canyon. These buildings would be retrofitted from fuel oil to electric heat. The camp village would be dismantled and the site reclaimed after construction. Electric power would be provided by the Watana development. Following construction, operation and maintenance activities would be centered at Watana; therefore, a minimum number of permanent facilities would be required at the Devil Canyon site to maintain the power facility.

2.1.2.3.3 <u>Project Transmission</u>

The project as proposed by the Applicant would require construction of a number of transmission line segments and associated substations to carry the electricity generated by the project to the load centers in the Anchorage and Fairbanks areas. Some of the transmission additions would parallel an existing line and use the same or adjoining right-of-way. Other segments would require new routes and rights-of-way.

Not a part of the project, but presently planned for 1984 operation, is a new 170-mi (274-km) long, single-circuit transmission line between the Willow substation, about 30 mi (48 km) north of Anchorage, and the Healy substation, about 100 mi (160 km) south of Fairbanks. This line will interconnect the two major load centers and for the first time permit synchronous operation and power transfers throughout the Railbelt area. The line will operate initially at 138 kV but is designed for eventual operation at 345 kV. It would become part of the transmission system of the proposed project.

Transmission and substation additions would be constructed in stages keyed to the differing dates for the Watana and Devil Canyon generation. Transmission facilities that would be constructed for Watana include: (1) two 37-mi (60-km), single-circuit, 345-kV outlet transmission lines to connect the powerhouse substation with a new Gold Creek substation located on the existing Willow-to-Healy line (which would then be operated at 345 kV), (2) a second 345-kV line, 170 mi (274 km) long, from Willow to Healy paralleling the existing line, (3) a pair of single-circuit, 345-kV lines, 63 mi (101 km) long, extending from Willow to the new Knik Arm and University substations in the Anchorage area, and (4) a pair of single-circuit, 345-kV lines, 100 mi (160 km) long, extending from Healy to the new Ester substation in the Fairbanks area.

Transmission facilities that would be constructed for Devil Canyon include: (1) 8 mi (13 km) of 345-kV, double-circuit outlet transmission from the powerhouse substation to the Gold Creek substation, and (2) an additional 345-kV circuit, 123 mi (198 km) long, from Gold Creek to Knik Arm, paralleling the previously constructed two single-circuit lines.

The lines from Willow to the Anchorage area must reach the east side of the Knik Arm, which extends northeastward from the head of Cook Inlet at Anchorage. The Applicant's primary proposal is to construct an overhead line from Willow to the Lake Lorraine area, opposite Anchorage, and 3 to 4 mi (4.8 to 6.4 km) of underwater cable passing under Knik Arm to its east side, above Anchorage and Six Mile Creek. Alternative longer, all-overhead line routings through the Matanuska Valley also have been examined.

At the Ester substation, 138-kV interconnections would be made with the Fairbanks Municipal and Golden Valley Electric Association systems. At the University substation, interconnections would be made with the Anchorage Municipal Light and Power, Chugach Electric Association, and Matanuska Electric Association systems. Other portions of the Anchorage area load are served from the Willow and Knik Arm substations.

Figure 2-7 shows the configuration of the proposed ultimate transmission system for the project.

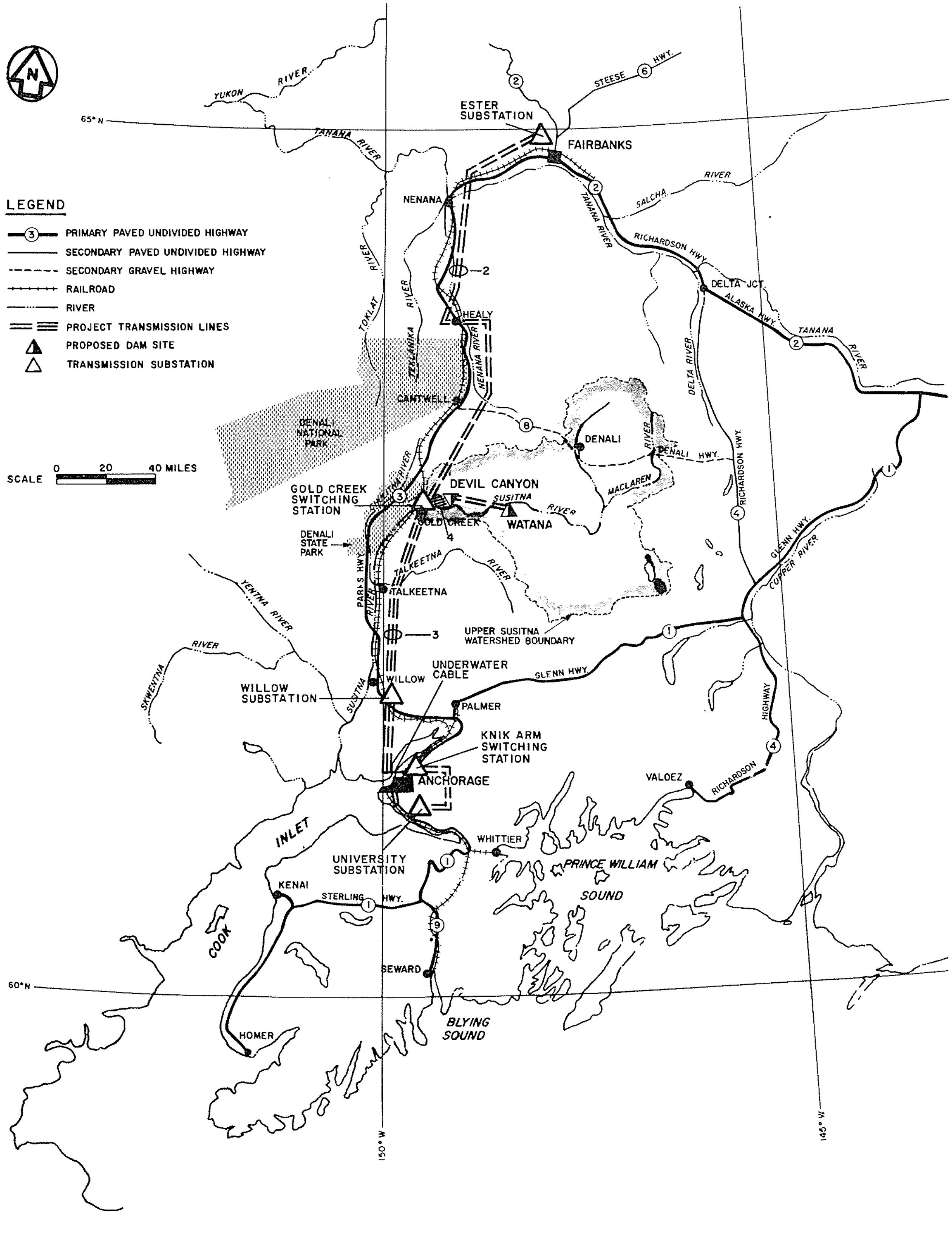

Figure 2-7. Susitna Project 345-kV Transmission System (ultimate configuration). [Source: Modified from Application Exhibit F, Plate F1]

2.1.3 Construction Schedule

The Applicant's proposed construction schedule spans a period from April 1985, beginning with access road construction at Watana, to October 2002, when commercial operation of Devil Canyon units would commence. This schedule is predicated on the assumption that a FERC license would be awarded by December 31, 1984.

2.1.3.1 Watana

The Applicant's proposed schedule for construction of Watana is shown in Figure 2-8. Two constraints were considered in the development of this schedule: the issuance date of the FERC license and the need to have four units on-line by January 1994 in order to meet Railbelt load growth as projected by the Applicant.

The critical path of activities to meet these constraints was determined to be through site access, site facilities, diversion and main dam construction. In general, construction activities leading up to diversion in 1987 are on an accelerated schedule, whereas the remaining activities are on a normal schedule.

The proposed schedule requires that extensive planning, bid selection, and commitments be made before the end of 1984 to permit work to progress on schedule during 1985 and 1986. The rapid development of site activities is required in order that construction operations have the needed support.

The spillway and intake structures have been scheduled for completion one season in advance of the requirement to handle flows. In general, excavation for these structures does not have to begin until most of the excavation work has been completed for the main dam. Excavation of the access tunnel into the powerhouse complex has been scheduled to start in late 1987. Stage I concrete would begin in 1989, with start of installation of major mechanical and electrical work in 1991. The first four units are scheduled to be on line by the beginning of 1994 and the remaining two units in early 1994. Construction of the transmission lines and switchyards has been scheduled to begin in 1989 and to be completed before commissioning of the first unit.

Road access to the site would be required by October 1, 1985, and equipment would be transported overland during the winter of 1984 in order for an airfield to be constructed by July 1985. This would allow site facilities to be developed in a very short time to support the main construction activities. A camp to house approximately 1,000 men would be constructed during the first 18 months. Onsite power generating equipment must be installed in 1985 to supply power for camp and construction activities and, an aggregate processing plant and concrete batching plant must be operational to start diversion tunnel concrete work by April 1986.

Construction of diversion and dewatering facilities, the first major activity, would start by mid-1985. Excavation of the portals and tunnels would require a concentrated effort to allow completion of the lower tunnel for river diversion by October 1986. The upstream cofferdam must be in place by October 1986 to divert riverflow and then the cofferdam must be raised sufficiently by the following spring to avoid overtopping. The upper tunnel must be complete by May 1987 to handle spring runoff.

The progress of work in the main dam is critical throughout the period 1986 through 1993. Mobilization of equipment and start of site work must begin in 1986. Excavation of the right abutment and of river alluvium under the dam core would begin in 1986. During 1987 and 1988, dewatering, excavation, and foundation treatment must be completed in the riverbed area and a substantial start made on placing fill. An average six-month construction season was assumed for the period required to place approximately 62 million yd^3 (47 million m^3) of fill.

2.1.3.2 Devil Canyon

The Applicant's proposed schedule for construction of Devil Canyon is shown in Figure 2-9. The development of site facilities at Devil Canyon would begin slowly in 1994, with a rapid acceleration in 1995 through 1997. Within a short period of time, construction would begin on most major civil structures. This schedule was developed to meet the on-line power requirement of all four units in 2002. The critical path of activities was determined to follow through site facilities, diversion and main dam construction. It has been assumed that site access built to Watana will exist at the start of construction. A road would be constructed connecting the Devil Canyon site to the Watana access road, including a high-level bridge over the Susitna River downstream of the Devil Canyon dam. At the same time, a railroad spur would be constructed to permit rail access to the southern bank of the Susitna near Devil Canyon. These activities would be completed by mid-1994.

Excavation and concreting of the single diversion tunnel would begin in 1995. River closure and cofferdam construction would be scheduled so as to permit start of dam construction in 1996. The construction of the arch dam would be the most critical construction activity from start of excavation in 1996 until topping out in 2001. The concrete program has been based on an average eight-month placing season for 4-1/2 years. The spillway and intake would be scheduled for completion by the end of the year 2000 to permit reservoir filling the next year. Excavation of access into the powerhouse cavern would be scheduled to begin in 1996. Stage I concrete would begin in 1998, with start of installation of major mechanical and electrical work in 2000. The additional transmission facilities needed for Devil Canyon would be scheduled for completion by the time the final unit was ready for commissioning in late 2001.

2.1.4 Construction Workforce Requirements

Projected workforce requirements for Watana and Devil Canyon construction activities are shown in Table 2-1. Workforce requirements for construction of the Watana development would vary from approximately 1,100 persons at the start of access road construction in 1985 to a peak of about 3,500 in 1990. Workforce levels would also vary seasonally. A rapid drop in workforce needs would occur between 1990 and 1995, when construction would be complete and the operation staff of 105 would occupy the permanent town.

Workforce requirements for construction of the Devil Canyon development would vary from about 100 in 1994 to a peak of 1,700 in 1998, reducing to a permanent staff of about 25 in 2002.

2.1.5 Operation and Maintenance

2.1.5.1 Operation

Based on the Applicant's schedule, the first four Watana units would be on-line in early 1994, followed by the remaining two Watana units in mid-1994. Startup of four Devil Canyon units would be in October 2002.

2.1.5.1.1 Operation within the Railbelt System

The Susitna project would be the single most significant power source in the Railbelt system. The dispatch and distribution of power from all sources by the most economical and reliable means would therefore be essential. Under current conditions in the Railbelt, a total of nine utilities with limited interconnections share responsibility for generation and distribution of electric power. The proposed arrangement for optimization and control of the dispatch of Susitna power to Railbelt load centers is based on the expectation that a single entity would eventually be set up for this purpose and that sufficient interties would be developed to allow for the economic dispatch of Susitna power to the various load centers in the Railbelt. A Susitna Area Control Center would be located at Watana to control both the Watana and the Devil Canyon power plants. The control center would be linked through a supervisory system to the Central Dispatch Control Center at Willow.

Operation would be semiautomatic, with generation instructions input from the Central Dispatch Center at Willow, but with direct control of the Susitna system at the control center at Watana and Devil Canyon power plants for testing/commissioning or during emergencies. The Susitna Area Control Center would be capable of completely independent control of the project in case of system emergencies. Similarly, it would be possible to operate the Susitna units in an emergency situation from the Central Dispatch Center.

2.1.5.1.2 Susitna Project Operation

Watana would operate as a baseload plant until Devil Canyon commenced operation. At that time the Devil Canyon development would operate baseload and Watana would shift to peak and reserve operation. The operation simulation of the project reservoirs and the power facilities by the Applicant was carried out on a monthly basis to assess the energy potential considering minimum flow releases and flood control.

The Applicant considered seven operational flow cases covering a range of minimum target flows at Gold Creek as shown in Table 2-2. The flow cases analyzed include the operational flows that would produce the maximum amount of usable energy from the project, neglecting all other considerations (referred to as Case A) and the operational flows that would have resulted in essentially no impact on the downstream fishery during the anadromous fish spawning period (referred to as Case D). The Applicant's analysis of these flow cases resulted in the recommendation of Case C as the operational flow.

The Case A, A1, and A2 minimum flows would increase the economic benefits of the proposed project over the proposed Case C by allowing a greater power draft of Watana reservoir during the winter peak-load period and reducing the amount of surplus energy generated during the summer refill period. Cases C1, C2, and D would decrease project benefits by restricting the amount of winter

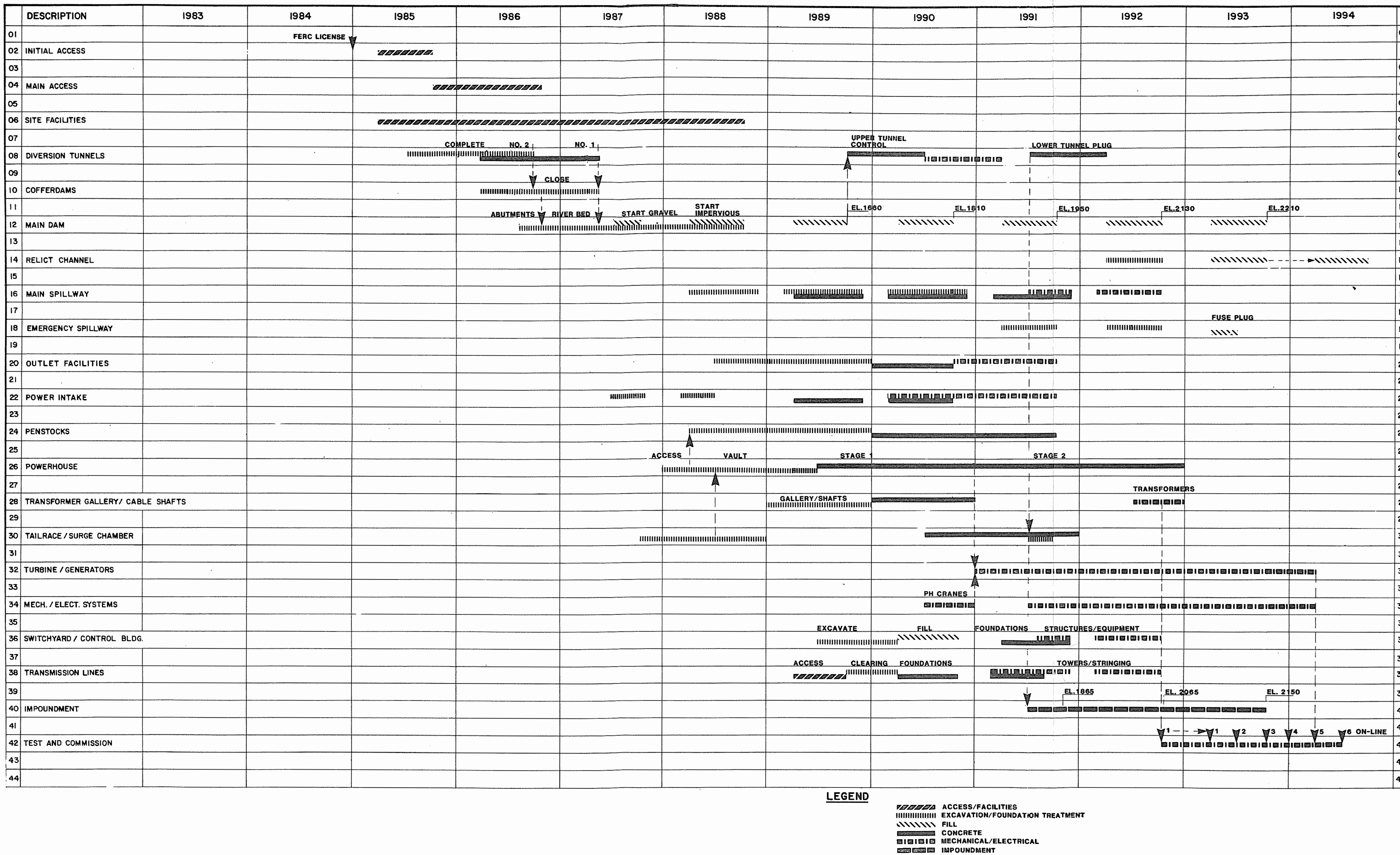

Figure 2-8. Construction Schedule--Watana. [Source: Application Exhibit C, Fig. C.1]

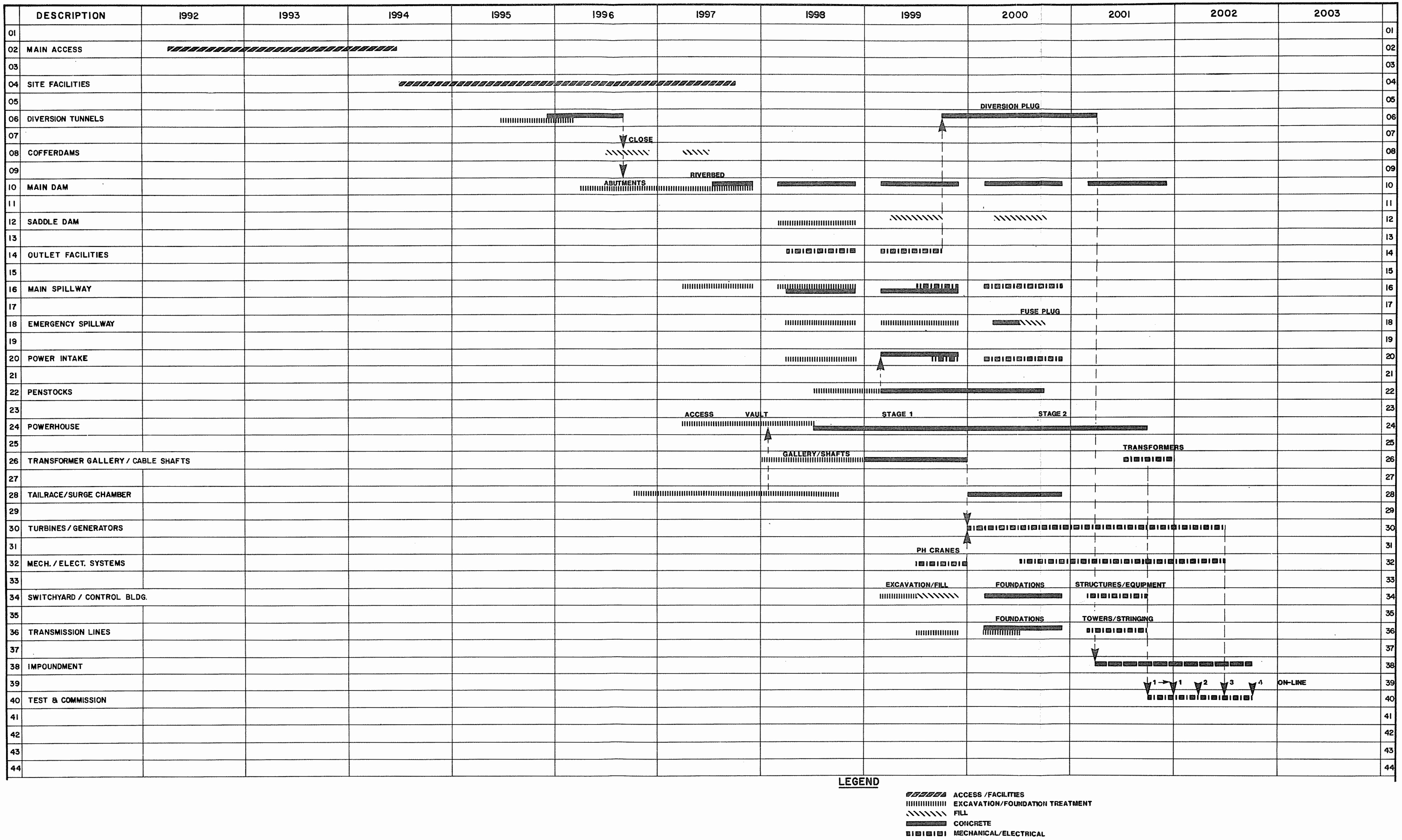

Figure 2-9. Construction Schedule--Devil Canyon. [Source: Application Exhibit C, Fig. C.2]

Table 2-1. Onsite Construction and Operations Workforce Requirements--1985 to 2002

Phase/ Month	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Construction																		
January	330	405	571	750	840	1050	976	750	390	240	151	239	376	479	510	449	270	45
February	341	419	590	775	868	1085	1008	775	402	248	156	247	388	495	527	464	279	47
March	473	581	818	1075	1205	1504	1398	1075	558	344	217	343	539	686	730	643	387	65
April	726	891	1255	1650	1849	2309	2146	1650	857	528	333	527	827	1054	1121	988	594	100
May	792	972	1370	1800	2017	2519	2341	1800	935	576	363	575	902	1149	1223	1077	648	109
June	957	1175	1655	2175	2437	3044	2829	2175	1130	696	439	694	1090	1389	1478	1302	783	131
July	1089	1337	1883	2475	2773	3463	3219	2475	1285	792	499	790	1241	1581	1681	1481	891	149
August	1100	1350	1902	2500	2801	3498	3252	2500	1298	800	504	798	1253	1596	1698	1496	900	151
September	990	1215	1712	2250	2521	3149	2927	2250	1169	720	454	718	1128	1437	1529	1347	801	136
October	759	932	1312	1725	1933	2414	2244	1725	896	552	348	551	865	1102	1172	1033	621	104
November	561	689	970	1275	1429	1784	1658	1275	662	408	257	407	639	814	866	763	459	77
December	385	473	666	875	980	1224	1138	875	454	280	177	279	439	559	594	524	315	53
Peak Const./Yr	1100	1350	1902	2500	2802	3498	3251	2500	1299	800	504	798	1253	1596	1698	1496	899	151
Operations/Maintenance																		
Subtotal - Year									70	145	145	145	145	145	145	145	145	170
Total	1100	1350	1902	2500	2802	3498	3251	2500	1369	945	649	943	1398	1741	1843	1641	1044	321

Source: Frank Orth & Associates, Inc., as reproduced in Exhibit E, Volume 7, Table E.5.28; annual workforce requirements and trade mixes for peak years provided by Acres American, Inc.

power draft of Watana and increasing the surplus energy generated during the summer refill months. The minimum flow requirements studied by the Applicant are shown in Table 2-2.

Gross storage volume of the Watana reservoir at its normal maximum operating level of 2,185 ft (660 m) would be 9.5 million ac-ft (11.7 billion m^3), about 1.6 times the mean annual flow (MAF) at the damsite. Live storage in the reservoir would be about 3.7 million ac/ft (4.6 billion m^3) (75% of MAF). Devil Canyon reservoir would have gross storage of about 1.1 million ac/ft (1.4 billion m^3) and live storage of 0.34 million ac/ft (419 million m^3). The minimum reservoir level at Watana would be 2,045 ft (623 m) during normal operation, resulting in a maximum drawdown of 140 ft (42.7 m). The Devil Canyon reservoir would be operated to maintain a normal level of 1,455 ft (443 m) whenever possible. Figure 2-10 shows the monthly target reservoir levels for both reservoirs. These levels were determined by the Applicant based on Case C operational flows at Gold Creek.

2.1.5.2 Maintenance

2.1.5.2.1 <u>Monitoring Program</u>

Instrumentation would be installed to permit monitoring designed to ensure that the performance of the dams and structures was within the limits assumed in the design and to enable any variations beyond those limits to be recognized quickly so that remedial action could be taken without delay.

An essential part of the monitoring program would be a routine visual inspection of all exposed parts of the structures and the area downstream of the dams for any unusual features, such as local settlement or other movement, zones of seepage discharge, wet areas, and changes in vegetation. All exposed concrete surfaces would be inspected and records kept of any signs of distress, cracking, or deterioration.

The most important aspects of the monitoring program and areas of possible maintenance requirements include foundation and abutment pore pressure relief system monitoring. Since sections of the foundation would be frozen, the grouted cutoff might not be fully effective, and leakage might increase as the rock temperature increased. This condition would be indicated by increased discharge from the drainage system and would be remedied by additional grouting from the grouting gallery, possibly combined with additional drainage holes. Any discoloration of the drainage system discharge would indicate the leaching of fine material either from the rock foundation or from the core. The problem area would be located and additional grouting carried out. Water quality would also be monitored for any change in mineral content.

Structural deformation monitoring as observed by settlement and lateral movements instrumentation would be expected to occur soon after construction and under initial filling of the reservoir. Deformation records would be correlated with such data as reservoir level, occurrence of heavy storms, and seismic activity to determine problem areas. Particular attention would be paid to monitoring the entire area of the relict channel. This monitoring would include regular readings of piezometers and thermistors, determination of surface elevation, survey monitoring, and inspections of the discharge zone for changes in seepage flows and any signs of piping failure.

2.1.5.2.2 <u>Periodic Maintenance</u>

The generating plant would undergo periodic maintenance to ensure safe and reliable operation to correct deficiencies which might result in reduced efficiency of the plants. Experience records from machines similar to those at Watana and Devil Canyon indicate that a minimum maintenance period of five to six days is required for each machine, resulting in an outage of 150 to 170 MW capacity for an average period of 50 to 60 days in the year. In exceptional cases, certain machines may be down for greater maintenance periods. It is therefore reasonable to allow a total of 2-1/2 to 3 months planned outage as a conservative approach to system generation and maintenance planning for the Susitna units. In principle, these outages are scheduled during the months of June to August when the lower summer load demands make it possible to release the units for maintenance. The actual outages would be coordinated on a week-to-week basis with the planned maintenance of the units in the rest of the system, and would take into consideration emergency shutdowns, breakdowns, delays in construction and maintenance, and other unforeseen contingencies.

The Watana and Devil Canyon power plants each would be provided with below-ground workshops to facilitate the normal maintenance needs of each plant. These include operations for fitting and machining, welding, electrical, and relay instrumentation, with adequate stores for tools and spare parts. The Watana power plant would also be provided with surface maintenance and central storage facilities to meet the needs of both plants.

Maintenance operation planning of both plants would be centralized at Watana. Operation staff normally would be located at Watana and housed at the operators' village at Watana. With

Table 2-2. Monthly Flow Requirements (cfs) at Gold Creek

Month	Case A	A1	A2	C	C1	C2	D
Oct	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Nov	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Dec	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Jan	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Feb	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Mar	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Apr	5,000	5,000	5,000	5,000	5,000	5,000	5,000
May	4,000	5,000	5,000	6,000	6,000	6,000	6,000
Jun	4,000	5,000	5,000	6,000	6,000	6,000	6,000
Jul†[1]	4,000	5,100	5,320	6,480	6,530	6,920	7,260
Aug	6,000	8,000	10,000	12,000	14,000	16,000	19,000
Sept†[1]	5,000	6,500	7,670	9,300	10,450	11,620	13,170

†[1] Derivation of transitional flows:

Date Jul	Date Sep	Case A	A1	A2	C	C1	C2	D
25	21	4,000	5,000	5,000	6,000	6,000	6,000	6,000
26	20	4,000	5,000	5,000	6,000	7,000	7,000	7,500
19	19	4,000	5,000	5,000	7,000	8,000	8,500	9,000
18	18	4,000	5,000	6,000	8,000	9,000	10,000	10,500
17	17	4,000	5,000	7,000	9,000	10,000	11,500	12,000
16	16	4,000	6,000	8,000	10,000	11,000	13,000	14,000
15	15	5,000	7,000	9,000	11,000	12,500	14,500	16,000

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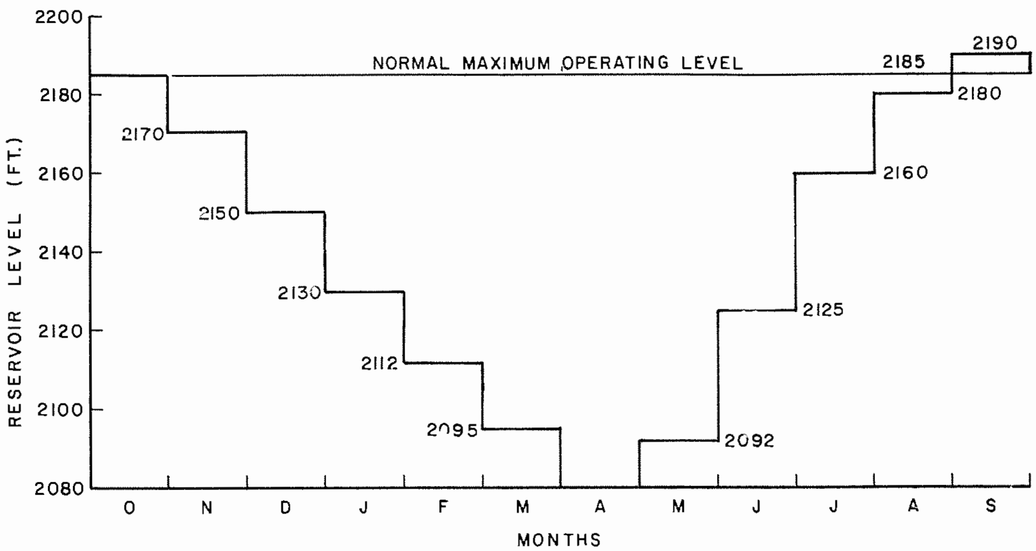
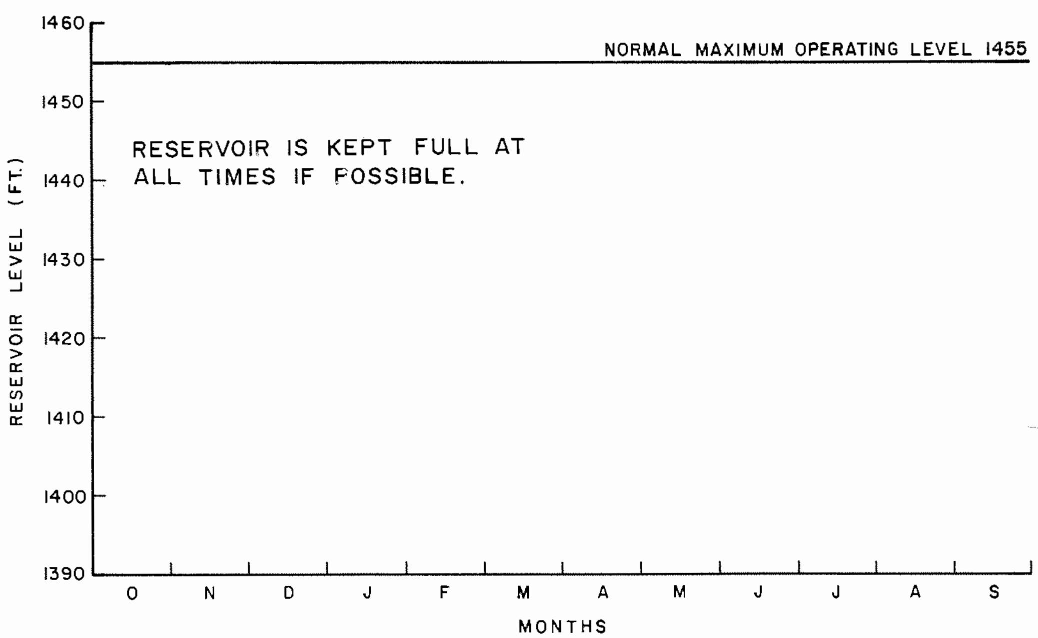
Conversion: To convert cubic feet per second (cfs) to cubic meters per second (m^3/s), multiply by 0.0283.

Source: Application Exhibit E, Vol. 5, Chap. 2, Table E.2.34.



WATANA RESERVOIR



DEVIL CANYON RESERVOIR

Figure 2-10. Reservoir Rule Curves--Watana and Devil Canyon. [Source: Application Exhibit B, Fig. B.69] centralized control of the Susitna project located at Watana, the Devil Canyon plant would not have a resident operating and maintenance staff. Proper road and transport facilities would be maintained between Watana and Devil Canyon to facilitate movement of personnel and/or equipment between the plants.

2.1.6 Safety Inspections

The FERC Staff inspects licensed projects, both during and after construction, to ensure their physical safety and the safety of the public, including recreational users, and to ensure that the licensee complies with any special construction and operating requirements of the license. Projects under construction are usually inspected at least once a month. The inspecting engineer reviews construction and testing procedures and notes the progress and quality of the various stages of construction, such as foundation and cut-off trench excavations, abutment treatment, diversion and closure, and initial filling of the reservoir.

Licenses issued for major construction include a special article that requires the licensee to employ a board of qualified independent consultants to review the design, specifications, and construction of the project. The board is required to assess the construction inspection program, the construction procedures and progress, the planned instrumentation, the filling schedule for the reservoir, and the plans for surveillance during initial filling of the reservoir.

After the project is placed in operation, it is inspected by the FERC Staff, normally once a year. During these annual inspections, staff engineers review the overall development from a safety standpoint, and also assess whether the licensee is operating and maintaining the facilities in accordance with the license provisions. A licensee is required to notify the Commission promptly of any conditions that could jeopardize the safety of the project, and special inspections are made to assess such problems. Additional Staff inspections are also made following natural disasters such as floods, landslides, or earthquakes.

Part 12 of the Commission's regulations requires periodic safety inspections of licensed dams by qualified independent consultants at regular five-year intervals. This requirement applies to those hydroelectric developments having a dam exceeding 35 ft (11 m) in height above streambed or a gross reservoir storage capacity of 2,000 ac-ft (2.5 million m^3). Inspections are performed by or directed by qualified independent consultants employed by licensees. The basic purpose of this inspection is to determine whether there are deficiencies or potential deficiencies in the design, quality, and adequacy of maintenance, or in the methods of operation of project structures that might endanger public safety.

2.1.7 Access Plan

The Applicant's proposed access plan would provide for rail and road transport of the necessary materials and equipment to the Watana - Devil Canyon construction sites. A railhead and storage facility, covering approximately 40 acres (16 ha) would be constructed along the existing Alaska Railroad in Cantwell. From the facility, access to the Watana site would be along an existing road, 2 mi (3 km) to the intersection of the George Parks and Denali highways, then easterly along the Denali Highway for 21.3 mi (34.3 km) to a new road. The new road would be constructed to Watana Camp site 41.6 mi (66.9 km) due south of the Denali Highway.

Access to the Devil Canyon site would be along a new road, approximately 20 mi (32 km) long, constructed to the Watana access road. A high-level suspension bridge would be required where the access road crossed the Susitna River downstream of the Devil Canyon dam. Rail access to the Devil Canyon site would require construction of a spur between the camp site and the existing Alaska Railroad. A plan of the proposed access routes is shown in Figure 2-11.

2.1.8 Transmission Line Electrical Effects

Transmission lines of practical design create high electric field gradients at the conductor surface which cause ionization of the surrounding air layers when the field intensity exceeds the breakdown strength of this air. The resulting corona formation on the conductors, along with random gap discharges on other line hardware, gives rise to radio noise and audible noise and generates ozone (O_3) and oxides of nitrogen (NO_x). Corona formation is a function of line voltage, conductor radius, line geometry, conductor surface condition (roughness, adherence of foreign particles, etc.), relative air density, humidity, wind, and precipitation. Corona and its associated audible and radio noise levels increase substantially during periods of foul weather, especially rain. Hence, it is neither practical nor economically feasible to design EHV lines such that they will never be in corona, as is accomplished at lower voltages, although lines are commonly designed with sufficient conductor size or bundling to limit surface gradients, within the normal operating voltage range, below the critical level at which corona begins to sharply increase.

Energized, load-carrying transmission lines also generate electric and magnetic fields that permeate the surrounding medium and induce voltages and currents in conducting objects in the vicinity, including persons and animals. The question of potential hazards of these fields from a biological and environmental standpoint has been given increasing attention in recent years, particularly with regard to lines designed for operation in the extra-high-voltage (EHV) range (345-1,000 kV) and for future lines being considered for operation in the ultra-high-voltage (UHV) range (above 1,000 kV).

In assessing the environmental impact of the expected levels of these electrical effects for the Susitna project 345-kV transmission lines, due recognition should be made of the fact that such lines have been in existence in other parts of the United States for some 30 years. These lines traverse sparsely settled rural regions as well as areas with high population density. As a result of this development, the design with regard to known electrical effects and other environmental aspects has become well established. Furthermore, the 345-kV operating voltage lies near the lower threshold voltage level at which many of the electrical effects associated with higher voltage lines become of marginal significance. Nevertheless, the Applicant had an analysis conducted to predict levels of electrical effects from the Susitna project transmission lines, calculated using methods developed at Project UHV. A survey was also made of existing radio and television broadcast signal strengths and ambient radio noise levels along the Anchorage-to-Fairbanks transmission corridor* (Willow-to-Healy section) for use in evaluating the influence of some of these line-generated electrical effects. In addition, a survey was made of sensitive communication facility locations in the vicinity of the corridor, such as microwave installations and air navigational radio beacons. Recommended minimum separation distances of those facilities from the lines were developed, based on existing guidelines and criteria. This study was performed by APA's consultant, Commonwealth Associates, Inc. (CAI). The results of this study are presented in the APA Electrical Environmental Effects Report, R-2394, dated June 4, 1982.

The presently planned routes and number of circuits ultimately to be installed as part of the Susitna project 345-kV transmission system are indicated in Figure 2-7. The calculations used to develop the predicted electrical effects in Report R-2394 were based on three single-circuit, 345-kV transmission lines on a common 400-ft (122-m) right-of-way, as shown in Appendix D, Figure D-2, operating at a voltage of 362.5 kV. This would be typical of the structure placement for the Knik Arm-Gold Creek section of the Anchorage-Fairbanks transmission corridor. Electrical effects generated by this particular transmission link should be representative of the entire 345-kV transmission configuration ultimately to be installed as part of the Susitna project, and the Report R-2394 calculations should be conservative due to the multiple-circuit right-of-way occupancy represented and the upper limit of the normal operating voltage range, 362.5 kV (5% above nominal 345-kV level). Both of these factors tend toward increased intensity of such effects as audible and radio noise and ozone production.

A review of the environmental significance of the electrical effects produced by the Susitna project transmission lines has been made. Guidelines used in this effort consisted of material contained in Report R-2394 along with reference information and data on this subject developed by the Electric Power Research Institute (EPRI) and others. Hand calculations were also performed, based on formulas and design curves (Electric Power Research Inc., 1982), which verified, to a close approximation, the audible and radio noise levels at the edge of the right-of-way, and the maximum ground-level electric field strengths reported in R-2394, calculated by computer methods.

As a result of this review, the basic conclusions reached by APA/CAI are concurred in by the Staff, i.e., no adverse environmental consequences of a permanent and irremediable nature should result which could be attributed to the operational performance of the 345-kV transmission lines to be constructed as part of the Susitna project. Specifically, the following qualitative assessment is made:

(1) No environmentally hazardous levels of corona-generated ozone or oxides of nitrogen should result from operation of the lines. In fact, the resulting increment to ambient levels due to line operation would likely not even be measurable.

(2) Audible noise generated by corona formation on the lines would not be objectionable and would not contribute significantly to ambient noise levels.

(3) Corona-generated radio noise would not be likely to interfere with AM radio broadcast reception at distances greater than 1,000 ft (305 m) from the centerline of the transmission line right-of-way even under worst-case weather conditions for noise generation, viz., rain. No interference at all is expected for FM radio reception due to

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*Hereinafter referred to as the "Anchorage-Fairbanks corridor", or simply "corridor" where the meaning is clear from the context.

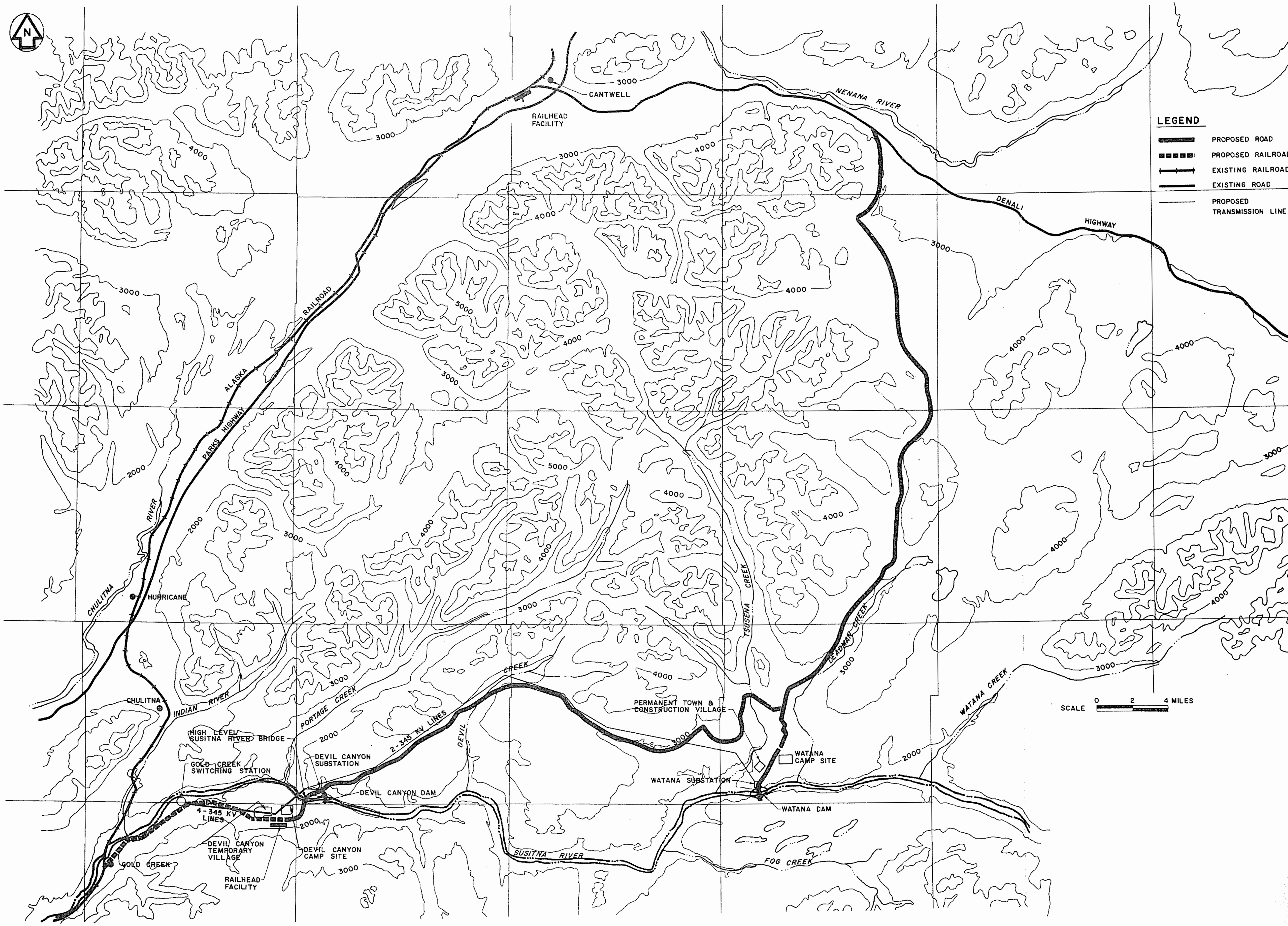

Figure 2-11. Plan of Proposed Access Routes. [Source: Application Exhibit F, Plate F32]

its inherent noise-rejection capability. Television reception should be unaffected at locations where television reception is presently good. Furthermore, problems, if any, would be expected to arise only rarely, and mitigative measures could generally be employed to alleviate any such problem on a case-by-case basis, such as by relocating receiving antennas, etc. The routing of the lines would be adjusted as necessary to allow for industry-recommended separation distances from sensitive microwave and other types of communication facilities to avoid potential interference problems.

(4) Results of studies on possible biological harm from exposure to electric and magnetic fields are inconclusive at best, and no general acceptance of such a correlation seems to exist among the scientific community. Inasmuch as the proposed line design conforms to generally accepted and long-established design practice for 345-kV transmission lines, the same normal levels of field intensity at ground level would result from these lines as for all the other numerous existing lines in this class. It is, therefore, concluded that no reasonable basis for concern exists on this account. Likewise, no shock hazards from induced potentials due to these fields would be expected.

(5) The 30-ft (9-m) minimum phase-to-ground clearances are more than sufficient to satisfy the present requirements of the American National Standards Institute (1984), including the 5-milliampere induced-current limit on large vehicles short-circuited to ground under the lines. Again, this conforms to present and long-established design practice for lines in the 345-kV class.

The foregoing conclusions apply for the Susitna lines operated within the normal ± 5% limits of their nominal design voltage level--345 kV. Initially, the first transmission link, currently being constructed along the Anchorage-Fairbanks corridor, would be operated at 138 kV, at which voltage the levels of the foregoing electrical effects should be entirely negligible.

2.1.9 Compliance with Applicable Laws

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

Federal

- Hydroelectric License
- Section 404 Permit
- Section 10 Permit
- Right-of-Way Grant & Temporary Use Permits
- FLPMA Section 302 Leases, Permits & Easements
- Free Use Permit for Gravel
- National Pollution Discharge Elimination System Permit
- Prevention of Significant Deterioration of Air Quality
- Determination of Eligibility for the National Register
- Determination of Effect on Sites

State

- NPDES Certification
- Certificate of Reasonable Assurance
- Alaska Coastal Management Program Certificate of Consistency
- Anadromous Fish Protection Permit
- Fishways for Obstruction to Fish Passage
- Land Use Permits
- Material Sales
- Water Rights Permit & Certificate of Appropriation
- Land Lease
- Permit to Construct a Dam
- Right-of-Way Permit for an Easement

Local

- Matanuska-Susitna Borough Permits and Reviews

2.1.10 Future Plans

The Applicant has no current plans for further development of the Watana/Devil Canyon system and no plans for further water power projects in the Susitna River Basin at this time. Development of the proposed projects would preclude further major hydroelectric development in the Susitna

Basin, with the exception of major storage projects in the Susitna Basin headwaters. Although these types of plans have been considered in the past, they are neither active nor anticipated to be so in the foreseeable future.

2.1.11 Recreation Plan

The Applicant has identified four primary objectives to be accommodated by implementation of the proposed project recreation plan (Exhibit E, Vol. 8, Chap. 7, Sec. 1.1)* as follows:

- To offset losses of public recreation resources due to the construction of the proposed project;
- To accommodate project-induced recreation demand;
- To estimate and provide for indicated recreation user potential within the project area; and
- To focus public access on project lands and water while protecting the scenic, recreational, cultural, and other environmental values of the project area.

The proposed recreation plan would basically involve development or enhancement of facilities or features at selected recreation resource areas, including both specific sites and corridors. The names and locations of recreation resource areas included in the recreation plan are depicted in Figure 2-12.

2.1.11.1 Inventory and Evaluation of Potential Recreation Development Areas

The Applicant's inventory of resource areas with high intrinsic recreation potential involved reviewing planimetric information, previous inventories, aerial photographs, and similar information sources. All potential resource areas were field checked, and the quality and extent of the various landscape features were defined (Exhibit E, Vol. 8, Chap. 7, Sec. 5.2.1). Features and settings indicating the distributions and locations of the recreation resources (including special views or vistas) for a given area were mapped. The objective of site inventories was to identify landscapes that support the most diverse range of recreation opportunities. Accordingly, resource areas were defined in terms of attractiveness (physical attributes), accessibility, and recreation preference type, i.e., pristine, primitive, semiprimitive, and developed. Recreation activities were identified for the various preference types, for example, mountaineering, kayak-canoeing, nature study, and big game hunting are compatible with pristine preference types. In contrast, sports, snowmobiling, tours, picnicking, and pleasure driving are compatible with developed preference types.

Potential recreation development sites were also evaluated on the basis of available recreation opportunities. Parameters of evaluation included natural value, inherent durability, visual quality, present land status, and carrying capacity. Considerations of carrying capacity included visitation estimates and peak capacity estimates (Exhibit E, Vol. 8, Chap. 7, Sec. 5.3).

2.1.11.2 Implementation and Description of the Proposed Recreation Plan

In parallel with the phased or staged development of the proposed Susitna project, the recreation plan would also be implemented in phased intervals. For example, the initiation of construction at selected recreation resource areas (Phase One development) would correspond with the beginning construction at the Watana dam site in 1985 (Exhibit C, Vol. 1, Fig. C.1). Phase Two, Three, and Four recreation developments would occur at later dates generally corresponding with initial operation of Watana facilities, beginning construction at the Devil Canyon site, and initial operation of Devil Canyon facilities. Phase Five development would occur ten years following initial operation of Devil Canyon facilities, provided such development would be needed to accommodate demand for public recreation (Exhibit E, Vol. 8, Chap. 7, Sec. 6.1.6). In general, Alaska Division of Parks design standards would be used for developed recreation facilities, since this organization would be the principal managing agency for the proposed recreation developments (Exhibit E, Vol. 8, Chap. 7, Sec. 5.4.8). Development of the required agreements, policies, and regulations for implementation of the proposed recreation plan is in progress. Community involvement will be encouraged through the Susitna Public Participation Program (Schedule B, Supplemental Items, Vol. 2, Sec. 7, Response to Comment 14). The total effort will culminate in a recreation implementation report to be submitted to the FERC.

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*Throughout this document, references to specific "Exhibits" are to the exhibits submitted to FERC as part of Alaska Power Authority's Susitna Hydroelectric Project License Application. References to specific "Appendices" (App.) are to the appendices provided in Volumes 2 through 7 of this Draft Environmental Impact Statement.

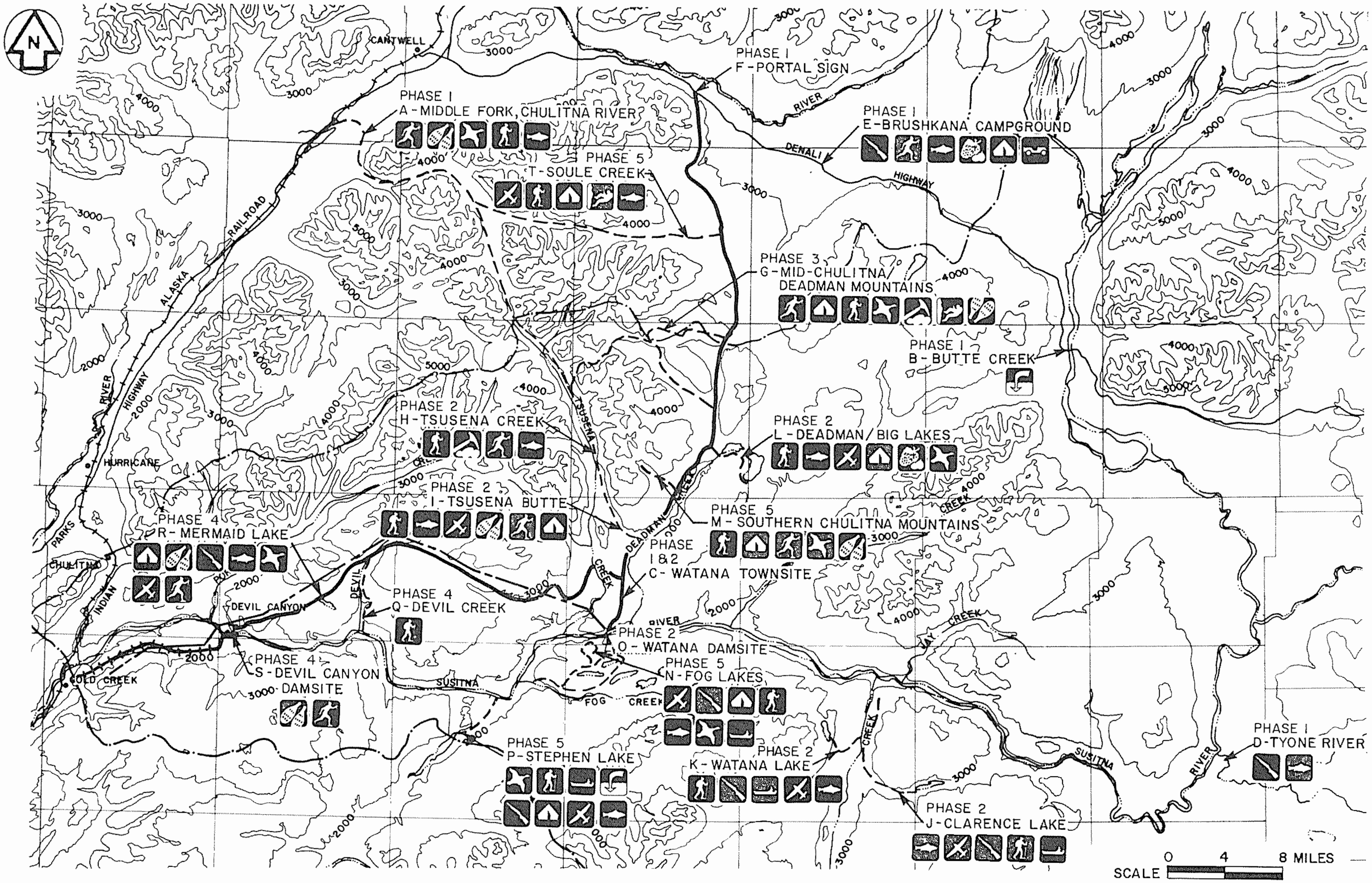

Figure 2-12. Map Showing Recreation Resource Areas Included in Applicant's Proposed Recreation Plan. [Source: Application Exhibit E, Vol. 8, Chap. 7, Fig. E.7.6]

Selected characteristics of proposed recreation resource areas and respective recreation features and/or facilities to be constructed or provided are presented below for each development phase of the recreation plan (Exhibit E, Vol. 8, Chap. 7, Sec. 5.4 and Schedule B, Supplemental Items, Vol. 2, Sec. 7, Response to Comment 9a). Locations are shown in Figure 2-12.

2.1.11.2.1 Phase One (Watana Construction)

BRUSHKANA CAMPGROUND

This existing campground consists of 33 campsites and includes picnic, fireplace, and toilet facilities. Surrounded by scenic views of distant glaciers within the Alaska Range, the campground is adjacent to Brushkana Creek, and campsites are interspersed among scattered coniferous and hardwood trees, with a strongly developed understory of tall shrub vegetation.

Proposed Recreation Plan Features and Facilities: About 0.25 mi (0.4 km) of road, 25 campsites, 3 single-vault latrines, 1 bulletin board, 8 trash cans, and 1 water well.

Recreation Opportunity Summary: Car camping, picnicking, fishing, big game hunting, photography, and berry picking.

Accessibility: The site is immediately adjacent to the Denali Highway (Mile Post 105), which intersects the Parks Highway about 30 mi (48 km) to the west.

TYONE RIVER

The site is located at the confluence of the Tyone and Susitna rivers at River Mile (RM) 246, where the Susitna River is a fixed-channel river. The adjacent terrain is a rolling open landscape of the Gulkana uplands.

Proposed Recreation Plan Features and Facilities: One shelter.

Recreation Opportunity Summary: Boating, kayaking-canoeing, camping, big game hunting, and fishing.

Accessibility: Boat launch areas include the Susitna River-Denali Highway intersection and Lake Louise (via access road from the Glenn Highway).

BUTTE CREEK

An outfall of Butte Lake, Butte Creek drains upland tundra, meandering through a broad valley to a confluence with the Susitna River. The valley encompasses small ponds, lakes, and wetlands that are in contrast with the rugged Talkeetna Mountains in the background to the south. Downstream from its confluence with Butte Creek, the Susitna River is broad, braided, and shallow.

Proposed Recreation Plan Features and Facilities: One boat launch at the Denali Highway-Susitna River intersection.

Recreation Opportunity Summary: Botanical interest sites, fishing, big game hunting, photography, boating, ski touring, and snowshoeing.

Accessibility: Butte Creek--cross-country hiking from Deadman Lake, or by boat via the Susitna River. Butte Lake--all-terrain vehicles and aircraft.

MIDDLE FORK, CHULITNA RIVER

From the Summit station on the Alaska Railroad, this proposed recreation corridor extends easterly through the Summit Lakes chain and successively parallels the Middle Fork of the Chulitna River, the lakes in Caribou Pass, the upper reach of the Jack River, and a mountain pass that extends into the upper limits of the Tsusena Creek watershed. The terrain along this 27-mi (45-km) corridor includes broad river valleys as well as narrow V-shaped valleys in glaciated mountainous landscapes. Dramatic views of the Alaska Range are observable from the Middle Fork Chulitna River basin.

Proposed Recreation Plan Features and Facilities: 25 mi (40 km) of primitive trail, 1 trailhead, 2 overnight shelters, 6 parking spaces, trash cans, 1 bulletin board, and signs.

Recreation Opportunity Summary: Hiking, backpacking, camping, collection sites, botanical interest sites, wildlife observation, ski touring (Broad Valley only), snowshoeing, big game hunting, fishing, potential for trail development.

Accessibility: Railroad stop at Summit, Parks Highway, proposed foot-trail along Tsusena Creek, and cross-country hiking from the Jack Creek and Soule Creek drainages.

PORTAL SIGN

The site is located at the junction of the Denali Highway and the proposed Denali Highway-Watana damsite access road. Development would include a portal sign displaying visitor information and pull-off parking for two or three cars.

2.1.11.2.2 Phase Two (Watana Operation)

WATANA DAM SITE

This recreation site would be located above the proposed Watana dam site on the southern side of the Susitna River (RM 184) and within the Fog Lakes area. Vantage points afford views of the Susitna River (both up- and downstream), and toward the Chulitna Mountains.

Proposed Recreation Plan Features and Facilities: One visitor exhibit building, 20 parking spaces, 2 single-vault latrines, 1 interpretive trail, 4 picnic sites, and 1 bulletin board.

Recreation Opportunity Summary: Viewpoint, visitor information, photography, picnicking, and hiking.

Accessibility: The proposed Denali Highway-Watana damsite access road, including access across Watana dam.

WATANA TOWNSITE

The townsite would be a private development site. A proposed public recreation corridor would extend from the townsite to Tsusena Creek Falls. Related recreation developments include 2 mi (3.2 km) of primitive trail, 1 trailhead, and parking.

TSUSENA CREEK

This proposed recreation corridor corresponds with the Tsusena Creek Valley, connecting with the Middle Fork, Chulitna River recreation corridor (see Phase One sites) at the upper limit of the Tsusena Creek drainage. From the headwaters area, the Tsusena Creek Valley extends southerly toward the Tsusena Lakes, which comprise almost 250 acres (100 ha). The valley floor also encompasses ponds, wetlands, and scattered stands of spruce and brush areas, some with overstories of mixed coniferous and hardwood trees. Many unusual rock formations, waterfalls, and depositional features reflect past glacial activity.

Proposed Recreation Plan Features and Facilities: 20 mi (31 km) of primitive trail, 2 shelters, 1 trailhead, and 3 parking spaces.

Recreation Opportunity Summary: Hiking, backpacking, botanical interest sites, rock hounding, wildlife observation, photography, snowshoeing, ski touring, mountaineering, fishing, and potential for trail development.

Accessibility: Proposed foot trail from the Middle Fork, Chulitna River corridor (see Phase One sites), aircraft at Tsusena Lakes, and foot trail from the proposed Watana-Devil Canyon access road.

TSUSENA BUTTE

The lower portion of Tsusena Creek Valley divides around Tsusena Butte, which is a solitary prominent feature of the local landscape. However, the fork of the valley to the east of Tsusena Butte terminates, grading into an upland terrace above the Susitna River. The Tsusena Lakes, over 1 mi (1.6 km) in length, are located between Tsusena Butte and the foothills of the Chulitna Mountains to the northeast.

Proposed Recreation Plan Features and Facilities: 4 mi (6.4 km) of primitive trail, 1 primitive campsite (2-4 capacity), 1 trailhead, and 6 parking spaces.

Recreation Opportunity Summary: Hiking, backpacking, photography, wildlife observation, ski touring, snowshoeing, and fishing.

Accessibility: Proposed Denali Highway-Watana damsite access road.

DEADMAN/BIG LAKES

Deadman and Big Lakes comprise about 1,800 acres (720 ha) at the southern base of Deadman Mountain. The terrain surrounding the lakes consists of rolling hills with rock outcrops. Deadman Creek meanders through the lake basin enroute to its confluence with the Susitna River.

Proposed Recreation Plan Features and Facilities: 4 mi (6.4 km) of primitive trail, 1 primitive campsite (5-6 capacity), 1 trailhead, and 6 parking spaces.

Recreation Opportunity Summary: Hiking, backpacking, photography, wildlife observation, and fishing.

Accessibility: Aircraft at Big Lake, and hiking from the proposed Denali Highway-Watana damsite access road.

CLARENCE LAKE

This site is located on a rolling upland terrace above and to the south of the Susitna River and includes Clarence Lake, which is a popular fly-in fishing lake. Outfall from the lake (Gilbert Creek) flows westerly into Kosina Creek, which flows northerly to its confluence with the Susitna River. Vegetation of the terrace consists of alpine tundra; mixed coniferous-hardwood stands occur only along Kosina Creek.

Proposed Recreation Plan Features and Facilities: 9 mi (15 km) of primitive trail, and signs.

Recreation Opportunity Summary: Hiking, backpacking, photography, wildlife observation, fishing, and big game hunting.

Accessibility: Aircraft at Clarence Lake and primitive trail from the proposed Watana Reservoir.

WATANA LAKE

This site includes Mt. Watana and Watana Lake located well above and to the south of the Susitna River Valley and represents the northern limits of the Talkeetna Mountains. Vegetation of the gently undulating uplands surrounding Watana Lake consists of alpine tundra which extends into the Talkeetna Mountains.

Proposed Recreation Plan Features and Facilities: 3 mi (5 km) of primitive trail, 1 footbridge, and 1 primitive campsite (2-3 capacity).

Recreation Opportunity Summary: Hiking, backpacking, photography, wildlife observation, fishing, and big game hunting.

Accessibility: Aircraft on Watana Lake and a proposed hiking trail from Kosina Creek (boat access only).

2.1.11.2.3 Phase Three (Devil Canyon Construction)

MID-CHULITNA/DEADMAN MOUNTAIN

The western half of this proposed recreation corridor is characterized by a complex mosaic of distinctive multicolored mountaintops, reflecting an intermingling of snow, glacier, and high wet tundra landscapes. The area includes headwaters of Deadman Creek, which meanders through a broad, flat tundra muskeg, then abruptly descends toward the east near Deadman Mountain.

Proposed Recreation Plan Features and Facilities: 15 mi (24 km) of primitive trail, 1 primitive campsite (2-4 capacity), 1 trailhead, and 10 parking spaces.

Recreation Opportunity Summary: Hiking, backpacking, photography, wildlife observation, botanical interest sites, and potential for trail development.

Accessibility: The proposed Denali Highway-Watana damsite access road and hiking from a proposed trail in the Tsusena Creek drainage.

2.1.11.2.4 Phase Four (Devil Canyon Operation)

DEVIL CREEK

This proposed recreation corridor corresponds with the Devil Creek drainage, which is confluent with the Susitna River at RM 161. Devil Creek meanders through upland tundra and then cascades southerly through steep canyons and narrow, brushy, and partially wooded valleys. Near the Susitna River, flows of Devil Creek and a small tributary plunge through narrow slots in the cliffs of the Susitna River gorge, creating two spectacular waterfalls. This setting is highly scenic and a major recreation resource.

Proposed Recreation Plan Features and Facilities: 9 mi (14.5 km) of primitive trail, 1 trailhead, 5 parking spaces, 1 bench, and signs.

Recreation Opportunity Summary: Hiking, nature observation, and photography.

Accessibility: The proposed Watana-Devil Canyon access road.

DEVIL CANYON DAMSITE

This proposed recreation site occurs in open forested uplands high above, and immediately to the south of the Susitna River at RM 152. Expansive views are observable to the west and north, as well as views of the steep walls of the Susitna River gorge below.

Proposed Recreation Plan Features and Facilities: One visitors center, 0.5 mi (0.8 km) of trail, 1 shelter, 1 single-vault latrine, 8 picnic sites, 15 parking spaces, 3 benches, and signs.

Recreation Opportunity Summary: Visitor information service, hiking, picnicking, nature observation, photography, ski touring, and snowshoeing.

Accessibility: The proposed Watana-Devil Canyon access road.

MERMAID LAKE

Located in an undulating upland tundra landscape, this proposed recreation site encompasses many medium-to-large lakes in shallow basins. This upland area is highly diverse in topographic character. The Chulitna Mountains are in the background to the north, and the Devil Canyon of the Susitna River parallels the southern boundary of the site.

Proposed Recreation Plan Features and Facilities: Eight campsites, 1 shelter, 2 single vault latrines, 1 water well, 1 bulletin board, 5 garbage cans, and signs.

Recreation Opportunity Summary: Car camping, snowshoeing, ski touring, nature observation, wildlife observation, fishing, and big game hunting.

Accessibility: The proposed Watana-Devil Canyon access road.

2.1.11.2.5 Phase Five (To be developed if the need is indicated by recreation demand.)

SOULE CREEK

The Soule Creek corridor extends westward from the proposed Denali Highway-Watana damsite access road paralleling the northern edge of the Brushkana Creek drainage. Vistas of the Alaska Range are observable to the east. Farther west, the corridor extends into a large basin within a broad valley of the Soule Creek drainage. A 2-mi (3.2-km) linear lake occurs within the basin. The surrounding terrain is a complex of often snow-covered mountaintops and ridges composed of multicolored rock. The basin is a strikingly scenic natural area.

Proposed Recreation Plan Features and Facilities: 8 mi (13 km) of primitive trail, 1 primitive campsite (5-6 capacity), 1 trailhead, and 5 parking spaces.

Recreation Opportunity Summary: Hiking, backpacking, wildlife viewing, primitive camping, photography, fishing, big game hunting, and potential for trail development.

Accessibility: Aircraft on the lake in the basin, and the proposed Denali Highway-Watana damsite access road.

SOUTHERN CHULITNA MOUNTAINS

The proposed recreation site consists of a small valley in the southeastern foothills of the Chulitna Mountains and is surrounded by rugged terrain. Vegetation of the valley floor is alpine tundra overlying a rocky base, causing very wet conditions in some places. A small lake created by an old moraine is located at the lower end of the valley, at which vantage points afford views of the Susitna River below.

Proposed Recreation Plan Features and Facilities: 3 mi (5 km) of primitive trail, 1 primitive campsite (3-4 capacity), 1 trailhead, and 3 parking spaces.

Recreation Opportunity Summary: Hiking, backpacking, nature observation, snowshoeing, and ski touring.

Accessibility: The proposed Denali Highway-Watana damsite access road.

FOG LAKES

Located within a partially wooded upland above the Susitna River, the proposed Fog Lakes recreation site encompasses a cluster of linear lakes in generally paralleling orientation, several of which exceed 1.5 mi (2.5 km) in length. Outfalls from several of the lakes coalesce into Fog Creek, which meanders westerly and then cascades through small canyons enroute to the Susitna River at RM 177. The rugged and scenic Talkeetna Mountains are in the background of vistas to the south.

Proposed Recreation Plan Features and Facilities: 15 mi (24 km) of primitive trail, 15-unit campground, 1 single-vault latrine, 15 parking spaces, 1 trailhead, and signs.

Recreation Opportunity Summary: Hiking, car camping, nature observation, wildlife observation, photography, and fishing.

Accessibility: Aircraft on Fog Lakes, and the access road across the proposed Watana dam.

STEPHAN LAKE

The proposed recreation site is within a wooded valley located in uplands south of the Susitna River. The valley encompasses the 3.5-mi (5.6-km) long Stephan Lake, which is a popular fly-in recreation area. The southern boundary of the valley landscape abuts the Talkeetna Mountains. Outfall from Stephan Lake (i.e., Prairie Creek) flows southerly enroute to the Talkeetna River.

Proposed Recreation Plan Features and Facilities: 5 mi (8 km) of primitive trail, 5 campsites (semi-primitive), signs, and a canoe boat ramp.

Recreation Opportunity Summary: Hiking, backpacking, kayaking-canoeing, wildlife observation, photography, fishing, and big game hunting.

Accessibility: Aircraft on Stephan Lake, and a proposed hiking trail from the Susitna River.

2.1.11.3 Recreation Monitoring Program

In addition to phased recreation development, the Applicant's proposed recreation plan includes provisions for a monitoring program to parallel the development program. The purpose of the monitoring program would be the collection of data relative to intensity and patterns of recreation use, as well as other information indicative of recreation demand. Such data would serve as the basis for adjustments in the recreation development program if required. Accordingly, the analysis of Phase One monitoring could result in modification in Phase Two, Three, and Four developments, as currently committed to by the Applicant (Exhibit E, Vol. 8, Chap. 7, Sec. 6.2). It should be noted that the Applicant is not committed to recreation development Phase Five, which would be implemented only if recreation demand data indicate a need (Exhibit E, Vol. 8, Chap. 7, Sec. 5.4.5).

The monitoring program and the Phase One recreation development would be initiated concurrent with beginning construction at the Watana dam site. At the time Watana facilities would become operational in 1994 (or ten years after completion of Phase One recreation development, whichever is earlier), Phase One monitoring data would be evaluated and Phase Two development would be verified or modified. Construction of the Phase Two recreation developments would be completed within three years of the joint determination of recreation need by parties involved; i.e., the Applicant, Alaska Division of Parks, U.S. Bureau of Land Management, Native Corporations, and/or other affected landowners (Exhibit E, Vol. 8, Chap. 7, Sec. 6.2). As noted in Section 2.1.11.2, community involvement would also be encouraged.

Phase Three of the recreation plan would be evaluated concurrent with beginning construction at Devil Canyon, and the Phase Three elements would be verified or modified based on monitoring experience related to development of Watana facilities. Phase Three developments would be constructed within three years of the joint determination of need. When Devil Canyon facilities became operational in 2002 (Exhibit C, Vol. 1, Fig. C.2) (or ten years after completion of Phase Three construction, whichever is earlier), Phase Four development would be verified or modified, as indicated by monitoring information. Following Phase Four implementation, the appropriate parties would jointly agree on need for additional development and/or major rehabilitation based on evaluations of monitoring data at ten-year intervals throughout the duration of the project license. It is currently anticipated that the Alaska Division of Parks and the Applicant would enter into an agreement whereby the Division would agree to perform the survey, evaluation, design, construction, operation, and maintenance of the recreation facilities on public lands, with the costs to be borne by the Applicant (Exhibit E, Vol. 8, Chap. 7, Sec. 6.2.1). Agreements of similar intent would be entered into with other agencies or individuals as appropriate.

2.1.12 Mitigative Measures Proposed by the Applicant

2.1.12.1 Land Resources

2.1.12.1.1 Geology and Soils

Although not all geologic- and soil-related impacts of the proposed Susitna project could be controlled, the mitigative measures proposed by the Applicant would be effective in minimizing the severity of such impacts to the extent possible given the Applicant's project requirements.

The proposed combination of access route and transmission corridors or transmission corridors and existing rights-of-way would minimize the total areas to be affected by access road construction impacts, such as soil erosion and compaction and permafrost thaw. Proposed geotechnical investigations of the substrate materials for transmission towers, access roads, and construction facilities would allow the Applicant to adapt construction techniques and designs to ensure structural stability and reduce possible impacts. Use of balloon-tired equipment for construction and hauling activities wherever possible would reduce soil compaction associated with those activities. Use of appropriate insulating gravel pads or rigid insulation, as well as installation of surface water drainage systems for any facility, road, or transmission tower structure constructed would minimize or prevent thaw in areas of permafrost. Additionally, selective removal of vegetation and avoidance of the stripping of surface organic litter would help reduce erosion losses as well as impacts related to permafrost thaw. Prompt revegetation of disturbed areas outside the reservoir and the use of surface water diversions and sediment-trap basins for all construction activities and borrow areas would also reduce erosion losses.

Slow and steady filling of the reservoirs would reduce the potential for reservoir-induced seismic activity and slow the rate of potential reservoir slope failures. Monitoring of seepage rates in high-risk areas is proposed, and installation of grouting or cutoff wells as needed would be effective in controlling these losses and reducing the risk of related failures.

2.1.12.1.2 Land Use and Ownership

Land use mitigative measures have been proposed by the Applicant for each of the major project features, including the dams and impoundment areas, construction camps and villages, planned recreation areas, access routes, and transmission line corridors (see App. F, Sec. F.4). In summary, these mitigative measures proposed by the Applicant include:

- Developing a land management plan in cooperation with the appropriate agencies;
- Confining land use activities to project construction areas;
- Posting and enforcing construction camp rules;
- Restricting use of private vehicles and providing transportation services;
- Siting of sewage treatment lagoons and landfills away from housing;
- Limiting road and outdoor recreation vehicle access;
- Restoring disturbed site areas;
- Developing a fire protection plan;
- Using existing transmission line rights-of-way where feasible; and
- Siting right-of-way away from private or special-use land.

2.1.12.2 Water Quantity and Quality

The Applicant has proposed to develop mitigative measures to protect, maintain, and/or enhance the water quantity and quality of the Susitna River. The first phase of the mitigative process involves identifying water quality and quantity impacts from construction, filling, and operation, and incorporating mitigative measures in the preconstruction planning, design, and scheduling where feasible. Three mitigative measures were incorporated into the engineering design: (1) establishing minimum flow requirements to provide the fishery resources with adequate flows and water levels for upstream migration, spawning, rearing, over-wintering, and out-migration while maintaining the economic viability of the project; (2) using fixed cone valves on the outlet facility to reduce the hydraulic momentum, thereby preventing nitrogen saturation in excess of the Alaska Department of Environmental Conservation (ADEC) statute of 110%; and (3) using multi-level intakes to improve downstream temperature control.

The second phase of mitigation would involve the implementation of environmentally sound construction practices and monitoring of those practices and the resulting impacts in order to identify and correct problems.

Water quality and water quantity-oriented mitigative measures proposed by the Applicant for the construction phase of the Susitna project are discussed in detail in Exhibit E, Chapter 2. Those mitigative measures include the scheduling of mining of borrow sites in and adjacent to surface waters to avoid periods when suspended solids in the Susitna River are at their annual minimum concentration, siting facilities away from streams, employing erosion-control measures (e.g., revegetation, buffer strips), treating and disposing of spoil from gravel washing and concrete processing plants in ways to avoid adverse effects on water quality, developing and implementing spill-prevention and containment procedures to minimize the impact on water quality from accidental spills of petroleum products, and processing of wastewater to meet necessary state and Federal wastewater and waste disposal permits and requirements.

Sustained high levels of sediment in a system can change the species composition and productivity of the system. Siltation can affect development of fish eggs and benthic food organisms. The primary mitigative measures that would be used by the Applicant to minimize construction erosion are: (1) siting facilities away from the clearwater fish streams; (2) employing erosion-control measures such as runoff control, stilling basins, and revegetation; (3) scheduling erosion-producing activities at biologically noncritical seasons; (4) minimizing the time necessary to complete the activity so that erosion is a short-term, non-reoccurring problem; and (5) maintaining vegetated buffer zones.

Removal of floodplain gravel can cause erosion, siltation, increased turbidity, increased ice buildup caused by groundwater overflow, fish entrapment, and alteration of fish habitat. These adverse impacts on aquatic habitats would be avoided or minimized. Before floodplain material (e.g., sand, gravel) sites were used, it would be determined that upland sources were inadequate to supply the needed material. Floodplain sites would be thoroughly explored to verify that they could supply the necessary quantities of material. Important habitats such as overwintering and spawning areas would be identified and avoided. Buffers would be retained between the sites and any active channels except when draglining in the active channel. Material would be stockpiled outside the floodplain to avoid backing flow at higher stages and to avoid the possibility of material being eroded into downstream reaches. Overburden would be disposed of in upland sites or returned to the area from which it was removed and contoured and planted. Material-washing operations would use recycled water and would not discharge into adjacent streams. Dredging in the river channel would be limited to the summer period when concentrations of suspended solids are at their annual maximum.

The Tsusena Creek material site (borrow site E) would be rehabilitated after mining ceased. The goal of rehabilitation would be to create productive aquatic habitat. The site would be shaped and contoured to enhance fish habitat, and all man-made items removed from the site. Exposed slopes would be graded and seeded. Rehabilitated areas would be monitored to ensure that grading, revegetation, and other mitigative measures were effective in preventing erosion. The Cheechako Creek and Susitna River borrow sites would be inundated and would not require rehabilitation beyond that needed to minimize erosion.

Spills of oil and other hazardous substances into streams are toxic to fish and their food organisms. A Spill Prevention Containment and Countermeasure Plan (SPCC) would be developed as required by the U.S. Environmental Protection Agency (USEPA). Equipment refueling or repair would not be allowed in or near floodplains without adequate provisions to prevent the escape of petroleum products. Waste oil would be removed from the site and be disposed of using ADEC/USEPA-approved procedures. Fuel-storage tanks would be located away from water bodies and within lined and bermed areas capable of containing 110% of the tank volume. Fuel tanks would be metered and all outflow of fuel accounted for; all fuel lines would be located in aboveground or ground-surface utilidors to facilitate location of ruptured or sheared fuel lines. State law requires that all spills, no matter how small, be reported to the ADEC. Personnel would be trained and assigned to monitor storage and transfer of oil and fuel and to identify and clean up spilled oil and other hazardous material. All personnel employed on the project, especially field personnel, would be trained to respond to fuel spills in accordance with an approved oil-spill contingency plan.

Vehicle accidents, although difficult to fully protect against, can be minimized by constructing the roads with properly designed curves to accommodate winter driving conditions. The roads would be provided with adequate signs; during the winter, difficult stretches would be regularly cleared and sanded. In summer, dust would be controlled with water.

Discharge of camp effluents could result in increased levels of metals and nutrient loading. Concrete batching plants release high alkaline effluents. Effluents would comply with ADEC/USEPA effluent standards. The concrete batching effluent would be neutralized and treated prior to discharge to avoid impacts related to pH and toxicity.

Adverse impacts associated with removing vegetation along streams are: (1) accelerated erosion into the streams; (2) altered temperature regimes; and (3) operation of equipment in perennial or ephemeral streambeds. Clearing would be scheduled as close to reservoir filling as is feasible. Control methods would be employed wherever needed to minimize erosion to streams. To the extent practicable, clearing would take place during the winter. Cleared vegetation would be dried for one season and burned in place.

The primary water quantity and water quality issues during filling and operation of the Watana and Devil Canyon would be the maintenance of minimum downstream flows for fishery resources and other instream flow needs, maintenance of an acceptable downstream thermal regime throughout the year, and control of downstream gas supersaturation below the dams.

Selection of appropriate flow regime for reservoir operations consistent with power needs is offered by the Applicant as a measure to avoid or minimize impacts. The Watana filling flow in the period October to April would reflect inflow to the reservoir; during operation, flows during this period would be 5,000 cfs (140 m^3/s). Because slough overtopping is expected in this period, with consequent temperature reduction in salmon incubation areas, the Applicant has proposed to heighten upstream berms. From May to the last week of July, the target flow would be 6,000 cfs (170 m^3/s) to allow mainstem fish movement. A brief flow peak proposed by the Applicant for this time period (of a magnitude to be specified following additional biological studies) would be generated to stimulate outmigration of juvenile salmon. During the last week of July, flows would be increased from 6,000 cfs to 12,000 cfs (170 to 340 m^3/s), in increments of 1000 cfs (28 m^3/s) and maintained through mid-September to provide access by sockeye and chum salmon to sloughs upstream of Talkeetna. To rectify anticipated difficulty with slough access, even at 12,000 cfs (340 m^3/s), the Applicant proposes to structurally modify the streambed profiles of eight sloughs. To rectify decreases in intragravel flow caused by lowered river elevations, the Applicant has suggested piping mainstem water through the berm and releasing it beneath the substrate. Compensation for anticipated loss of slough spawning habitat would be accomplished by gravel cleaning in side channels, mainstem areas, and currently unused sloughs in order to develop new spawning substrates. An estimated 432,315 ft^2 (38,902 m^2) of spawning habitat would be created, which is 187,000 ft^2 (16,830 m^2) greater than the estimated slough spawning habitat used by salmon upstream of Talkeetna in 1981 and 1982. As a last alternative for compensation, the Applicant has indicated that a hatchery for chum salmon could be developed.

The Applicant has proposed using multi-level water intakes on hydropower generating facilities at Watana and Devil Canyon dams as a measure to mitigate the unavoidable temperature changes associated with creation of a reservoir. The multi-level intake strucutres would be used to select temperatures within the stratified reservoir that most closely match the pre-project thermal regime. This sytem would not be operative during reservoir filling.

The Applicant's plan for mitigating nitrogen supersaturation downstream of the dams is to install fixed cone valves on the outlet facility. These fixed cone valves would be used during augmentation and excess flows. Nitrogen supersaturation of turbine flows would be mitigated by having subsurface discharge to minimize air entrainment.

2.1.12.3 Fisheries

The Applicant has provided a conceptual plan for mitigation of anticipated impacts to fishery resources. Details of the plan await further resolution of the aquatic resources to be impacted by the project.

The objective of fisheries mitigation planning for the project has been to "provide habitat of sufficient quality and quantity to maintain natural reproducing populations" wherever this is compatible with the hydroelectric project's power objectives. Artificial propagation is contemplated only as a last resort.

The priorities of the fisheries mitigation were determined by employing the hierarchical approach to mitigation contained in the Susitna Hydroelectric Project Application and U.S. Fish and Wildlife Service and Alaska Department of Fish and Game mitigation policies. The five basic mitigative actions, in order of priority, are:

- Avoiding impacts through design features or scheduling activities to avoid loss of resources.
- Minimizing impacts by carefully scheduling and siting operations, timing and controlling flow releases, and controlling impacts through best management practices.
- Rectifying impacts by repairing disturbed areas to provide optional fish habitat and reestablishing fish in repaired areas.
- Reducing or eliminating impacts over time through monitoring, maintenance, and proper training of project personnel.
- Compensating for impacts by conducting habitat construction activities that rehabilitate altered habitat or by managing resources on project or nearby public lands to increase habitat values.

The Applicant selected four species of Pacific salmon (chum, chinook, coho, and pink) in the Susitna River downstream of the project and the Arctic grayling in the impoundment reach as "evaluation species". These species currently have high regional visibility and their populations seemed most susceptible to project impacts. A major premise of mitigation planning for the Susitna River downstream of the project has been that improved conditions of flow (stabilized), water quality (reduced turbidity) and substrate (managed) in the mainstem would provide replacement habitat to mitigate for the potential loss of fish habitat zones in partially dewatered sloughs.

The Applicant's proposed mitigative measures for certain impact issues are described below. Staff comments on these plans, as well as a discussion of these plans and other potential mitigative measures, are provided in Section 5.1.1.

Mitigation of construction impacts would be achieved primarily by incorporating environmental criteria into pre-construction planning and design, and by good construction practices. A design criteria manual and a construction practices manual are to be prepared. The continuing aquatic studies program would be used to define sites, designs, and schedules so as to minimize impacts. Environmental staffs would maintain a high degree of communication and cooperation with personnel conducting design and construction. Monitoring of construction facilities and activities is planned to identity and correct impacts.

The following is a discussion of the impact issues and the mitigative measures that would be applied during and after construction. Those issues considered to have the greatest potential for adverse impact to the aquatic environment are discussed first. Avoidance, minimization, rectification, and reduction of impacts are discussed. There are presently no direct costs associated with these mitigative measures.

Improperly constructed stream crossings can block fish movements and increase siltation in the stream. Roads with inadequate drainage structure can alter runoff patterns of nearby wetlands and streams. Encroachments on stream courses can alter hydraulic characteristics and increase siltation of streams, thereby affecting fish habitat.

The objective of constructing stream crossings is to maintain the natural stream configuration and flow so that passage of fish is ensured. Alaska state law (AS-16.05.840) requires the maintenance of fish passage. Appropriate control measures would be undertaken as a part of routine maintenance to ensure that beaver dams do not interfere with fish passage needs. For the project area, the evaluation species used in developing criteria for stream crossings is Arctic grayling. In designing and constructing a crossing, consideration would be given to presence or absence of fish or fish habitat, location of crossing, type of crossing structure, flow regime, and method of installation.

The sport fishing pressure on the local streams and lakes would substantially increase. The access road and transmission line rights-of-way would allow fishermen to reach areas previously unexploited. To minimize this impact during the construction phase, access to the streams would be limited by closing roads to unauthorized project personnel and to the general public. The Alaska Board of Fisheries would be provided such information as they require to manage the fisheries. Some watersheds, such as the Deadman Creek/Deadman Lake system, would require modification of present seasons and catch limits if current stocks are to be maintained. These regulations might take the form of reduced seasons or catch limits, imposition of maximum size limits, or control of fishing methods.

Fish fry and juveniles can be impinged on intake screens or entrained into hoses and pumps when water is withdrawn from water bodies for miscellaneous uses during construction. If possible, surface water withdrawal would be from streams or lakes that do not contain fish. If water must be withdrawn from a fish-bearing water body, the Alaska Department of Fish and Game intake design criteria would be used for all intakes.

Blasting in or near fish streams can rupture fish swim bladders and damage incubating embryos. The Alaska Department of Fish and Game has standard blasting guidelines that establish the distance from water bodies at which charges can be detonated without harming fish. These guidelines would be used for blasting at project sites.

Fish passing downstream through the diversion tunnels are expected to be lost because of the high tunnel velocities. During summer, relatively few fish are present in the vicinity of the tunnel entrance. During winter, resident fish are expected to be entrained into the intake and passed downstream. The segment of the fish population lost in the diversion tunnel would be lost in any case due to reservoir filling, because of lost tributary habitat and the expected low habitat value in the reservoir. Mitigation for these losses would be achieved by the early initiation of grayling propagation.

For filling and operation impacts, the Applicant has proposed mitigative measures for four specific impact issues that affect fisheries: (1) flow regime downstream of the project, (2) temperature changes downstream of the project, (3) inundation impacts on mainstem and tributary habitats by reservoirs, and (4) nitrogen supersaturation (Table 2-3). These topics are also addressed above in Section 2.1.12.2 (Water Quantity and Quality).

Because there will be no way to avoid, minimize, or rectify inundation of grayling habitat in the reservoir zones, the Applicant proposes funding research on grayling propagation technology, developing hatchery facilities for grayling, and introducing rainbow trout into Devil Canyon reservoir as compensation measures.

2.1.12.4 Terrestrial Communities

2.1.12.4.1 <u>Plant Communities</u>

The Applicant's proposed plan for mitigation of impacts to botanical resources includes implementation of the following measures (listed in order of priority): avoidance, minimization, rectification, reduction, and compensation. This approach was adopted after consultation with resource agencies, including the Alaska Department of Fish and Game and the U.S. Fish and Wildlife Service. Removal of vegetation cannot be totally avoided during construction of many proposed project facilities; therefore, the Applicant has proposed implementation of the other mitigative measures.

Mitigative measures proposed by the Applicant to minimize impacts to vegetation generally consist of measures applied to the design or location of project facilities so as to reduce clearing requirements or effects on sensitive areas such as wetlands. The Applicant has already applied these mitigative measures to the proposed siting and design of major facilities, such as construction camps and villages, the Devil Canyon railhead facility, and general access and transmission line routing. However, these mitigative measures also would be applied on a more site-specific basis during detailed engineering and alignment studies for project facilities.

Proposed use of flexible speed designs as well as application of side-borrow and balanced cut-and-fill techniques for access road construction should reduce fill requirements and essentially eliminate the need for large borrow sites located some distance away from the access corridors, thereby minimizing impacts to vegetation. The Applicant also has proposed a plan to minimize vegetation loss associated with disposal of spoil created during construction activities and borrow excavations. This plan includes depositing most of the spoil within the impoundment area in such a way that fines do not become entrained in water flows. To minimize impacts to vegetation crossed by the transmission line corridors, the Applicant has planned only selective clearing of the rights-of-way and maximum use of existing roads for access to transmission lines.

The potential for impacts to vegetation as a result of increased access to the upper and middle Susitna Basin (e.g., off-road vehicle effects and increased incidence of fires) would be minimized during construction through restriction of public access. Policies concerning public access to the proposed project area after project construction would be developed with concurrence of land and resource management agencies and private landowners whose lands would be affected.

Mitigative measures to rectify impacts to vegetation generally would be applied once facilities used on a temporary basis during construction were no longer needed. Rehabilitation would be initiated by the first growing season following removal of facilities or equipment. Areas disturbed by either construction activities or nonessential activities would also require rectification. Proposed rehabilitation procedures include dismantling of structures, ripping land

Table 2-3. Impacts Issues and the Applicant's Proposed Mitigation Features for Anticipated Filling and Operational Impacts to Aquatic Habitats, Susitna Hydroelectric Project

Impact Issues	Occurrence				Mitigation Feature			
	Watana Development		Devil Canyon Development		Watana Development		Devil Canyon Development	
	Filling	Operation	Filling	Operation	Filling	Operation	Filling	Operation
Passage of adult salmon	X	X		X	- Downstream release	- Downstream release		- Downstream release
Adverse impacts to slough habitat	X	X		X	- Downstream release - Slough modification - Replacement habitat through modification of side channels	- Downstream release - Slough modification - Replacement habitat through modification of side channels		- Downstream release - Slough modification - Replacement habitat through modification of side channels
Loss of side-channel and mainstem salmon spawning areas	X	X		X	- Replacement habitat through modification of side channels	- Replacement habitat through modification of side channels		- Replacement habitat through modification of side channels
Altered thermal regime	X	X		X		- Multiple outlet		- Multiple outlet
Gas supersaturation	X	X			- Fixed cone valves			- Fixed cone valves
Inundation of tributary habitat	X		X		- Grayling propagation and Kokanee stocking program		- Grayling propagation and Kokanee stocking program	
Out-migration of juvenile anadromous fish	X	X		X	- Downstream release	- Downstream release		- Downstream release

surfaces and regrading to contour, replacement of mineral and/or organic layer soils salvaged during facility construction, application of fertilizers, scarification of replaced soils, and encouragement of reinvasion by native species from surrounding undisturbed areas. Seeding would be used only where necessary to provide erosion control or improve visual impact. Where seeding was required, native species, primarily fast-growing native grasses, would be used.

Mitigative measures planned by the Applicant to reduce impacts to vegetation would really be an extension of rectification in that these measures would mainly involve monitoring of project facilities and activities to ensure the most effective use and application of rehabilitation measures. Monitoring measures would be stipulated in the comprehensive restoration plans and would be intended to help focus and implement the plans. Monitoring would also be used to maintain awareness of the extent and location of disturbed areas, both planned and unplanned, so that rehabilitation could begin as early as feasible once activities in a given area diminished.

Vegetation losses associated with development of the proposed dam and impoundment sites could only be offset through compensation measures. The Applicant has proposed to compensate for losses by ranking lost vegetation types with respect to their value as wildlife habitat, and then selectively altering vegetation on acquired lands to replace or exceed lost areal coverages of high-priority vegetation types. This would allow compensation for high-priority vegetation (habitat) types while requiring acquisition of relatively smaller land areas. In identifying replacement lands for habitat enhancement, the Applicant would place the highest priority on state and Federal lands that can be acquired at minimal or no cost.

2.1.12.4.2 Wildlife

The Applicant's mitigation plan for wildlife was developed within the constraints of project needs in consultation with Federal and state resource agencies. As noted above, much of the plan involves recovery of plant communities. The plan is in a state of ongoing refinement and further definition and will be integrated with the Applicant's monitoring plan.

Avoidance of impacts would be implemented primarily in project design, and hence is constrained by the project goals. The avoidance of some impacts has been factored into the analysis of impacts in Section 4.1. Alternative project designs that might avoid impacts are discussed in Sections 4.2 to 4.7. Avoidance would also be achieved by scheduling and siting project activities such that they do not occur during periods or in locales important in the life history of a wildlife population. The Applicant proposes to schedule activities such that they would not interfere with nesting raptors, nesting trumpeter swans, overwintering bear, or calving moose. In addition, the Applicant proposes to relocate some activities (e.g., overflights) so that they would not interfere with raptor or swan nesting nor with sheep use of the Jay Creek mineral lick.

Impacts might be reduced by lessening the magnitude or extent, or altering the location, of project features. The minimum level to which impacts might be reduced would be limited by project design goals. The Applicant proposes to reduce impacts in several areas. For example, use of borrow material areas would be minimized to the extent possible while excavating sufficient fill material. In addition, selective clearing of rights-of-way would be implemented to maintain as much vegetation cover as possible while allowing safe operation of transmission facilities.

Restoration would be most effective in recovering browse productivity on lands requiring temporary disturbance during project construction. As discussed above, the Applicant proposes to revegetate areas of borrow sites, temporary villages, construction laydown areas, and similar features. Recovery of these areas would be feasible, although complete recovery could require more than 50 years. However, for 1 to 20 years after initiation of revegetation, productivity of browse might be enhanced to a level similar to that found in early stages of plant succession.

Replacement activities proposed by the Applicant would principally be used to replace raptor nesting locations that would be lost to the project. Replacement lands for lost habitat might also be used.

Compensation through habitat enhancement is the major action by which the Applicant proposes to mitigate for loss of habitat carrying capacity. The Applicant proposes to convert mature growth forest into early successional vegetation communities. Early successional vegetation tends to provide higher productivity of forage for moose, bear, and other wildlife. The Applicant has proposed using fire, vegetation crushing, and forest clearing to achieve its goals.

2.1.12.5 Threatened and Endangered Species

The only threatened or endangered species that could be impacted would be the American peregrine falcon (Falco peregrinus anatum) (see Secs. 3.1.6 and 4.1.6). North of Nenana the proposed transmission line would pass near peregrine nesting habitat in the hills overlooking the Tanana River to the south. Several historical peregrine nesting sites are located within these hills. Two of these locations are within 1 mi (1.6 km) of the proposed route. However, the proposed route does avoid prime habitat. Because the nests are inactive, the only applicable mitigative action would be the avoidance of permanent or long-term alteration of high-quality peregrine habitat. If nesting locations near the proposed route did become active, further steps would be implemented to avoid disturbance.

2.1.12.6 Recreation Resources

The Applicant's recreation plan (see Sec. 2.1.11) constitutes proposed mitigation for losses of recreation resources and opportunities due to the development of the proposed project and provides means for accommodating recreation demand generated by the construction and operation of project facilities. Consistent with phased development of the entire project, the Applicant proposes to implement the recreation plan in phases (Exhibit E, Vol. 8, Chap. 7, Sec. 6.1), each phase intended to mitigate specific aspects of the overall project as follows:

Phase One Objectives (Watana Construction)

- To mitigate for loss of recreation opportunities because of construction activities and associated land closures;
- To provide recreation opportunities for project construction workers;
- To provide the public with some early recreation benefits derived from the public investment in Watana.

Phase Two Objectives (Watana Operation)

- To mitigate for loss of recreation opportunities due to the operation of Watana facilities;
- To provide for the recreation use potential of the project;
- To accommodate project-induced recreation demand;
- To allow public access to project lands and waters;
- To protect the environmental values of the project area.

Phase Three Objectives (Devil Canyon Construction)

- To mitigate for loss of recreation opportunities due to Devil Canyon construction;
- To provide recreation opportunities for construction workers.

Phase Four Objectives (Devil Canyon Operation)

- To mitigate for loss of recreation opportunities due to the operation of Devil Canyon facilities;
- To provide for the recreation use potential of the project;
- To accommodate project-induced recreation demand;
- To allow public access to project lands and waters;
- To protect the environmental values of the project area.

Concurrent with initial construction, the Applicant proposes to initiate a program to monitor recreation use and demand continuously throughout the life of the project license.

2.1.12.7 Socioeconomic Factors

The Applicant has proposed, in general terms, to reduce the speed, magnitude, and distribution of project-induced population growth by adjusting timing of labor needs and leave and shift schedules to avoid extreme monthly, seasonal, and annual peaks; and by providing transportation incentives and services to encourage workers to reside in large population centers remote from the site and discourage settlement in the small communities nearby. However, no specific scheduling or transportation plans have been developed. The Applicant has also proposed, as part of the project plan, development of onsite housing for single workers; some temporary and permanent single-family housing for construction engineers, managers, and their families; and a permanent village for households of operation workers. These plans include recreation facilities, a school, community services, and a health facility.

2.1.12.8 Visual Resources

The Applicant's visual resource mitigation plan is designed to reduce or eliminate adverse impacts due to project development. The emphasis of the plan is on (1) avoidance of critical environments, including ongoing site refinements throughout the design phase, (2) use of best development practices and site-sensitive engineering, and (3) rehabilitation. The Applicant has identified four major categories of mitigation: (1) additional studies, (2) best development practices, (3) creative engineering design, and (4) the use of form, line, color, and texture (Exhibit E, Vol. 8, Chap. 8, p. E-8-47). Additional mitigative measures that would reduce visual resource impacts include vegetation impact mitigative techniques described in Section 2.1.12.4.1.

During the Phase II detailed design process, additional studies to resolve the visual impacts would be performed by an interdisciplinary design team. Potential aesthetic impacts would be further ameliorated through site-specific design analysis and development. Visual resource impacts would be mitigated through siting studies (e.g., avoidance of thaw-susceptible areas) and alternative solutions (e.g., project design changes). Additional measures that would be implemented would include best development practices through construction techniques (e.g., construction equipment would be confined to gravel roads and construction zone areas), rehabilitation techniques (e.g., grading to contour and reseeding), and operation policies (e.g., restricting off-road vehicle use). Where project facilities would not be compatible with the surrounding landscape character, creative engineering design measures would be taken (e.g., minimizing road profile elevations to blend with existing natural contours). Finally, the use of form, line, color, or texture could reduce visual impacts caused by project features (e.g., painting buildings an appropriate color to blend with the surrounding natural landscape).

2.1.12.9 Cultural Resources

The Applicant has recommended the investigation of all significant cultural resource sites (i.e., those eligible for inclusion in the National Register of Historic Places) that would be subject to unavoidable direct or indirect impacts resulting from project development. Preservation by avoidance (combined with a monitoring program) is recommended for significant sites that would be exposed to potential impacts during either the construction or operation phases of the project.

2.2 SUSITNA DEVELOPMENT ALTERNATIVES

2.2.1 Alternative Facility Designs

2.2.1.1 Applicant's Studies

The design of the proposed facilities at the Watana and Devil Canyon developments are the result of detailed studies during which the design of each major component was evaluated relative to increasingly refined criteria. The criteria for design included economics, environmental and geotechnical constraints, load forecasts, and engineering considerations. A detailed discussion of the various components and methodology for the screening and review of alternative general arrangements of the components is presented in the Application (Exhibit B, Sec. 2). A summary of these studies follows.

2.2.1.2 Alternative Watana Facilities

Main Dam. The Applicant selected the elevation of the Watana dam crest based on consideration of the value of the hydroelectric energy produced from the associated reservoir, geotechnical constraints on reservoir levels, and freeboard requirements. Three crest elevations were studied, 2240, 2190, and 2140 ft (682.8, 667.5 and 652.3 m). The dam type was selected based on a comparison of embankment, concrete arch, and concrete-faced rockfill dams for Watana. Comparison criteria considered economics, availability of suitable construction materials, and expected performance of the dam based on the seismic, climatic, and geotechnical conditions at each site.

Diversion Facilities. The topography of the site generally dictates that diversion of the river during construction be accomplished using diversion tunnels with upstream and downstream cofferdams protecting the main construction area. A design flood with a recurrence frequency of once in 50 years was selected for the design of the cofferdams based on experience and practice with other major hydroelectric projects.

Concrete-lined and unlined rock tunnels were compared. The reliability of an unlined tunnel is more dependent on rock conditions than is a lined tunnel, particularly given the extended period during which the diversion scheme is required to operate. Based on these considerations, given a considerably higher cost, together with the somewhat questionable feasibility of four unlined tunnels with diameters approaching 50 ft (15 m) in the type of rock expected at the site, the unlined tunnels were eliminated. The lined tunnel schemes examined were (1) pressure tunnel with a free outlet, (2) pressure tunnel with a submerged outlet, and (3) a free flow tunnel.

Spillway Facilities. Discharge of the spillway design flood would require a gated service spillway on either the left or right bank. Three basic alternative spillway types were examined: chute spillway with flip bucket, chute spillway with stilling basin, and cascade spillway. Consideration was also given to combinations of these alternatives with or without supplemental facilities, such as valved tunnels and an emergency spillway fuse plug for handling the PMF discharge.

Power Facilities. Selection of the optimum powerplant development involved consideration of the following:

- Location, type and size of the power plant;
- Geotechnical considerations;
- Number, type, size, and setting of generating units;
- Arrangement of intake and water passages; and
- Environmental constraints.

Studies were also made to compare the construction costs of both surface and underground powerhouses.

Preliminary studies were undertaken during the development of conceptual project layouts at Watana to investigate both right and left bank locations for power facilities. The location on the southern bank was rejected because of economics and indications that the underground facilities would be located in relatively poor quality rock. The underground powerhouse was therefore located on the northern bank such that the major openings lay between the two major shear features ("The Fins" and the "Fingerbuster").

General Arrangement. Preliminary alternative arrangements of the Watana project were developed and subjected to a series of review and screening processes. The layouts selected from each screening process were developed in greater detail prior to the next review and, where necessary, additional layouts were prepared combining the features of two or more of the alternatives. Assumptions and criteria were evaluated at each stage and additional data incorporated as necessary.

Four arrangement schemes were developed during the preliminary review stage (Exhibit B, Figs. B.27 through B.32), and two schemes evolved out of these for review in the final stage. The proposed scheme (scheme WP3A) was adopted based on economics and fewer potential geotechnical problems.

2.2.1.3 Alternative Devil Canyon Facilities

The methodology used by the Applicant to develop the designs of the various components of the Devil Canyon development were similar to those used to evolve the Watana design.

2.2.2 Alternative Access Corridors

2.2.2.1 Applicant Studies

The objective of alternative access studies conducted by the Applicant was to provide a transportation system that would support construction activities and allow for the orderly development and maintenance of the site facilities, while considering the relative environmental impacts of the various alternatives. Three general corridors leading from the existing transportation network to the proposed dam sites were identified (Fig. 2-13). A detailed discussion of these corridors is provided in the Application (Exhibit E, Chap. 10, Sec. 2.3) and a summary of the studies follows.

2.2.2.2 Corridors Studied

The three corridors identified were:

Corridor 1 - From the Parks Highway to the Watana dam site via the northern side of the Susitna River.

Corridor 2 - From the Parks Highway to the Watana dam site via the southern side of the Susitna River.

Corridor 3 - From the Denali Highway to the Watana dam site.

Within these corridors, a total of 18 plans were developed by laying out routes on topographical maps in accordance with accepted road and rail design criteria.

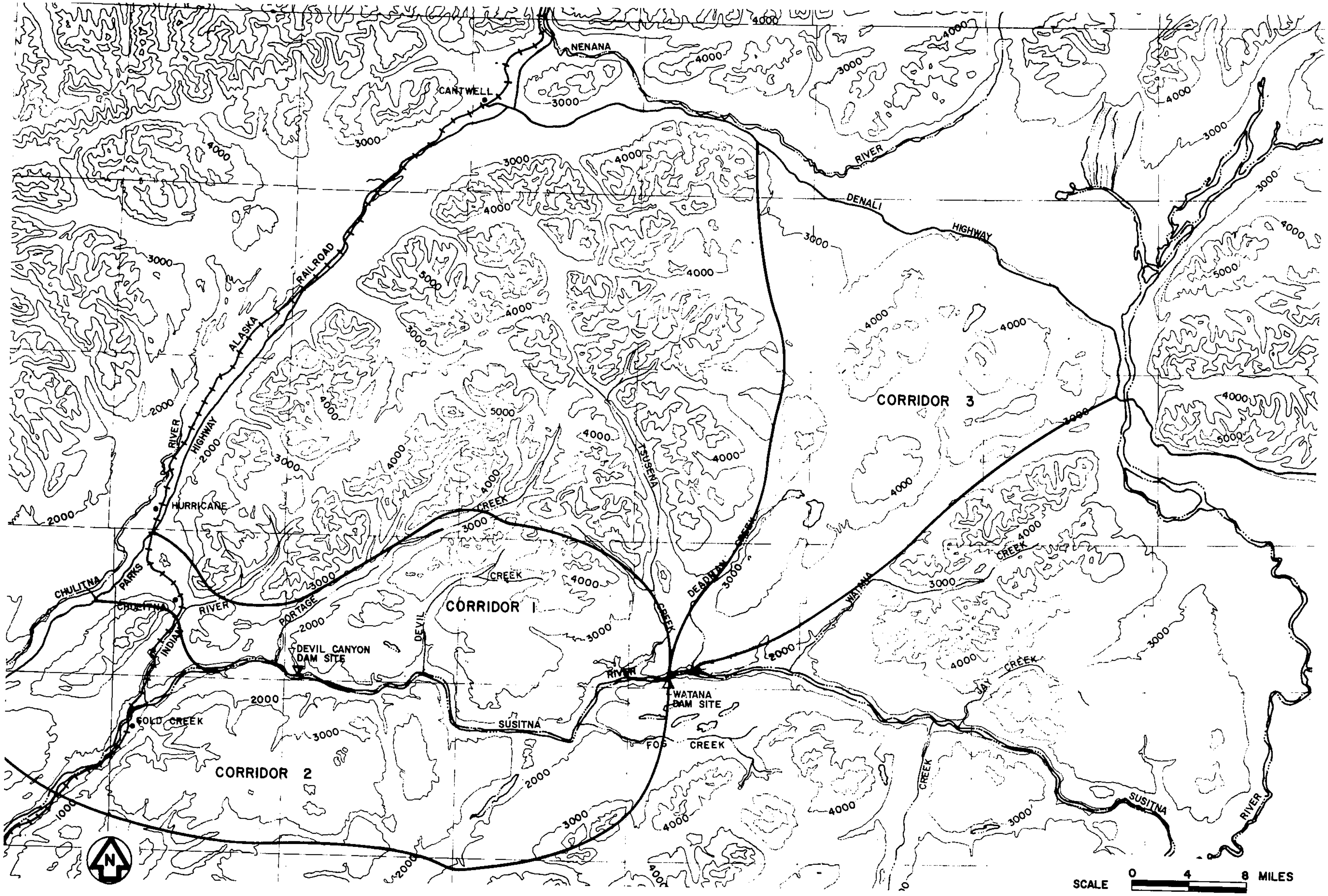

Figure 2-13. Alternative Access Corridors. [Source: Application Exhibit B, Fig. B.42]

2.2.2.3 Development of Plans

Once the basic corridors were defined, alternative routes that met the selected design parameters were established and evaluated against technical, economic, and environmental criteria. Within each corridor, the most favorable alternative route in terms of length, alignment, and grade was identified. These routes were then combined with each other and/or with existing roads or railroads to form the various access plans.

These plans were screened using the following criteria:

- Minimizing impacts to the environment;
- Minimizing total project costs;
- Providing transportation flexibility to minimize construction risks;
- Providing ease of operation and maintenance; and
- Pre-construction of a pioneer road.

This led to the development of eight alternative access plans. Three additional plans were added at the suggestion of the Susitna Hydroelectric Steering Committee.

Studies of these 11 access plans culminated in the recommendation of Plan 5 as the route that most closely satisfied the selection criteria. Plan 5 starts from the George Parks Highway near Hurricane and traverses along the Indian River to Gold Creek. From Gold Creek the road continues east on the southern side of the Susitna River to the Devil Canyon dam site, crosses a low-level bridge and continues east on the northern side of the Susitna River to the Watana dam site. For the project to remain on schedule, it would have been necessary to construct a pioneer road along this route prior to the FERC license being issued. This plan was, however, eventually eliminated due to comments received from the public, agencies, and organizations. Seven additional access alternatives then were developed using refined evaluation criteria. All 18 plans were evaluated using the refined criteria to determine the most responsive access plan in each of the three basic corridors.

2.2.2.4 Description of Most Responsive Access Plans

The proposed plan, Plan 18 "Denali-North", is described in Section 2.1.7. The most responsive plan for the two other corridors are described below.

Plan 13 "North". This plan would utilize a roadway from a railhead facility adjacent to the George Parks Highway at Hurricane to the Watana dam site following the northern side of the Susitna River. A spur road 7 mi (11 km) long would be constructed at a later date to service the Devil Canyon development. Travelling southeast from Hurricane, the route would pass through Chulitna Pass, avoid the Indian River and Gold Creek areas, then parallel Portage Creek at a high elevation on the northern side. After crossing Portage Creek the road would continue at a high elevation to the Watana dam site. Access to the southern side of the Susitna River at the Devil Canyon dam site would be over a high-level suspension bridge approximately 1 mi (1.6 km) downstream from the Devil Canyon dam. This route would cross mountainous terrain at high elevations and include extensive sidehill cutting in the region of Portage Creek. Construction of the road, however, would not be as difficult as Plan 16, the southern route.

Plan 16 "South". This route would generally parallel the Susitna River, traversing west to east from a railhead at Gold Creek to the Devil Canyon dam site, and continue following a southerly loop to the Watana dam site. To achieve initial access within one year, a temporary low-level crossing to the northern side of the Susitna River would be required approximately 12 mi (19 km) downstream from the Watana dam site. This would be used until completion of a permanent high-level bridge. In addition, a connecting road from the George Parks Highway to Devil Canyon, with a major high-level bridge across the Susitna River, would be necessary to provide full road access to either site. The topography from Devil to Watana is mountainous and the route would involve the most difficult construction of the three plans, requiring a number of sidehill cuts and the construction of two major bridges. To provide initial access to the Watana dam site, this route would present the most difficult construction problems of the three routes, and would have the highest potential for schedule delays and related cost increases.

2.2.3 Alternative Transmission Line Corridors

The Applicant's initial choice of transmission line corridors for further study depended upon certain environmental selection criteria, and, to a lesser extent, technical and economical analysis. Three areas with 22 corridors were defined and selected for final study. Four corridors were chosen for consideration in the northern area to transmit project power from the Healy substation to Fairbanks; three corridors were chosen for the southern area to transmit project power from the Willow substation to Anchorage (Cook Inlet); and 15 corridors were chosen in the central area to carry project power from the Watana and Devil Canyon sites to the Willow-Healy Intertie. One transmission corridor was then selected in each area, with the environmental factors and technical and economic ratings being considered. Additionally, the choice of the access route for the Susitna development affected the choice of the transmission line corridor in the central area.

The four corridors studied by the Applicant in the northern area varied in length from 85 to 115 mi (136 to 185 km). Only two route segments from Healy are practical because of topography, with one along an existing transportation route being preferred.

The 15 corridors studied by the Applicant in the central area were reduced to seven because of technical or economic unacceptability [i.e., mountain crossings over 4,000 ft (1,200 m)]. The selection of the access route in September 1982 narrowed the corridors to four, all connecting the Watana dam site, the Devil Canyon dam site, and the proposed Gold Creek substation on the Intertie. The final selection amounted to a choice between two parallel corridor segments connecting the two dam sites and two parallel corridor segments connecting the Devil Canyon site with the Intertie substation. These four corridors are about 40 mi (64 km) long each.

The three corridors studied by the Applicant in the southern area included two connecting the Willow substation and Point MacKenzie and one connecting Willow to Anchorage via Palmer. The corridor via Palmer is the longest at 73 mi (117 km), but the preferred route from Willow to Point MacKenzie via Red Shirt Lake is 38 mi (61 km) in length.

Figures 2-14 through 2-16 show routes of the proposed and alternative transmission-line segments considered by the Applicant when selecting a preferred route.

2.2.4 Alternative Susitna Development Schemes

2.2.4.1 General

As indicated in Section 1.4.1, the FERC Staff has considered three alternative development schemes for the Susitna River Basin: Watana I with Devil Canyon; Watana I with Modified High Devil Canyon, and Watana I with a reregulating dam. The locations of these developments are illustrated in Figure 2-17.

2.2.4.2 Watana I-Devil Canyon Development

Facilities. This development would be identical to the proposed project, with the exception that Watana dam would be scaled down to have a crest elevation of 2,125 ft (648 m) and a normal reservoir level of 2100 ft (640 m) [versus 2,210 ft (674 m) and 2,185 ft (666 m), respectively, for the proposed dam].

Operation. This project would operate in the same manner as the proposed project, i.e., Watana I would operate as a baseload plant until completion of Devil Canyon. After completion of Devil Canyon, Watana I would operate as a peaking plant and Devil Canyon would be operated to maintain a constant tailwater elevation at Watana I and to regulate Watana I discharges to meet downstream fishery requirements.

2.2.4.3 Watana I-Modified High Devil Canyon Development

Facilities. The Watana I development would be as described in Section 2.2.4.2. The High Devil Canyon development would be located approximately at RM 157, or about 5 mi (8 km) upstream from the proposed Devil Canyon site. The dam would be constructed of similar materials and designs as the High Devil Canyon Dam studied by the Applicant (Exhibit B, Fig. B.9). It would be of earth and rockfill construction with an impervious core, and a crest elevation of 1,495 ft (456 m). It would have a normal maximum water surface elevation of 1,470 ft (448 m) and a maximum height of approximately 595 ft (181 m). The south abutment spillway and north abutment underground powerhouse would be similar in concept to High Devil Canyon.

Operation. This development would be operated in the same manner as the Watana I-Devil Canyon Project.

2.2.4.4 Watana I-Reregulating Dam Development

Facilities. This development would incorporate a reregulating dam located approximately 16 mi (24 km) downstream of Watana I. The Reregulating dam would be of earth and rockfill construction, with a crest elevation of 1,500 ft (457 m) and a maximum height of approximately 250 ft (76 m). A spillway would be located on the northern abutment and a 200-MW powerhouse would be downstream of the dam on the southern bank. This development would be similar in design to the Tunnel No. 3 Reregulation dam scheme considered by the Applicant in development plan E3 of

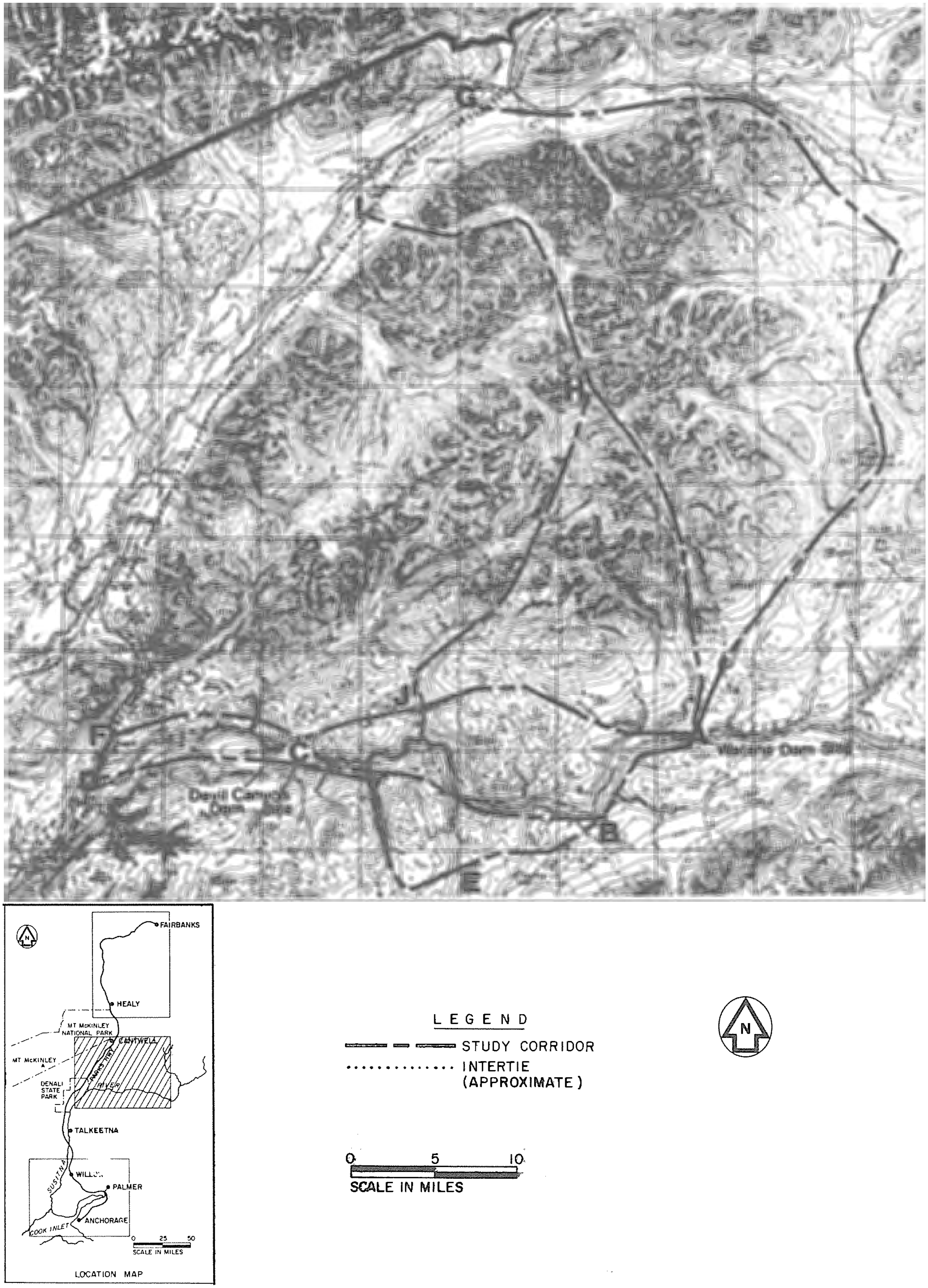

Figure 2-14. Alternative Transmission Line Corridors--Central Study Area. [Source: Application Exhibit B, Fig. B.48]

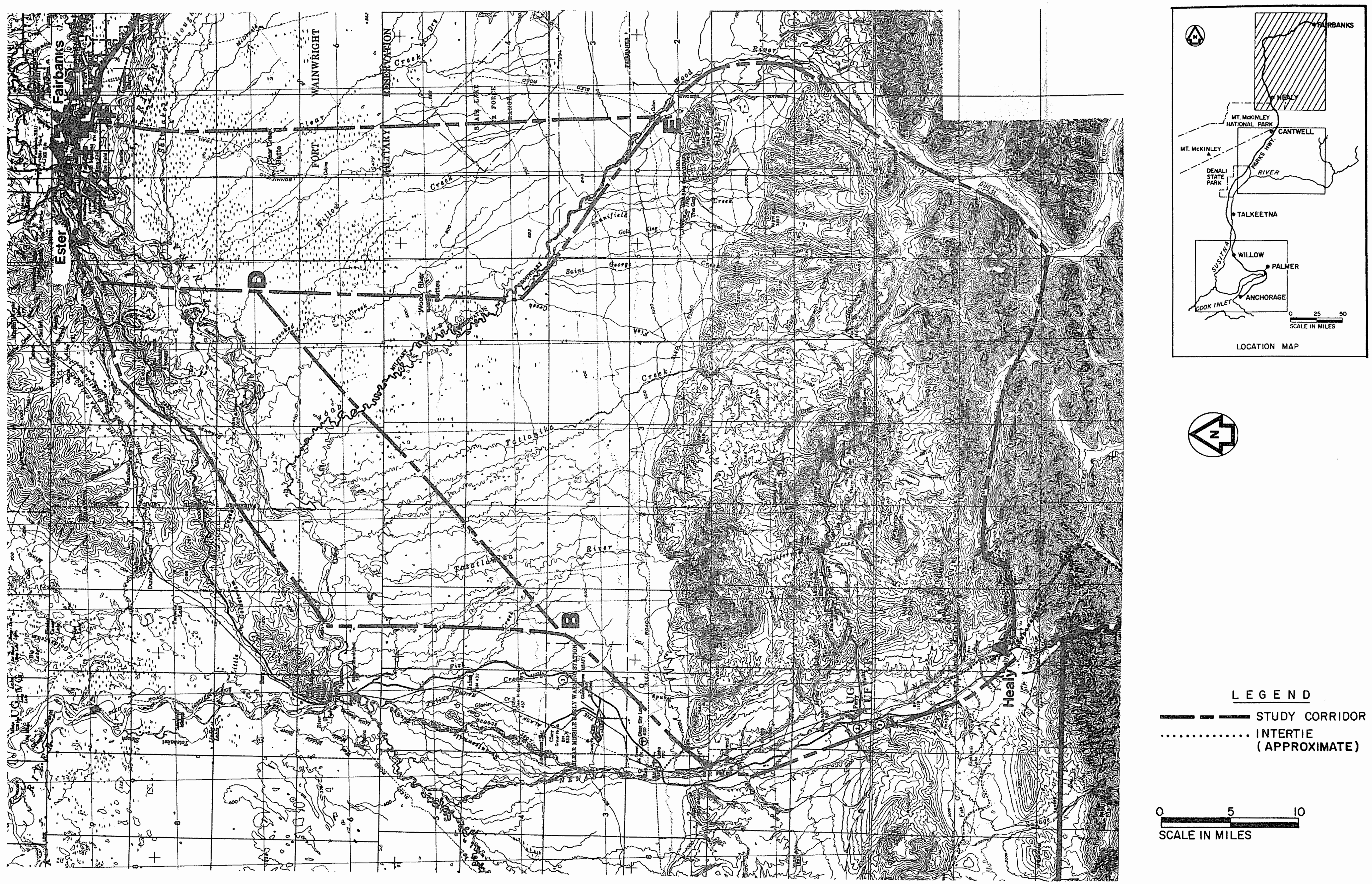

Figure 2-15. Alternative Transmission Line Corridors--Northern Study Area.
[Source: Application Exhibit B, Fig. B.49]

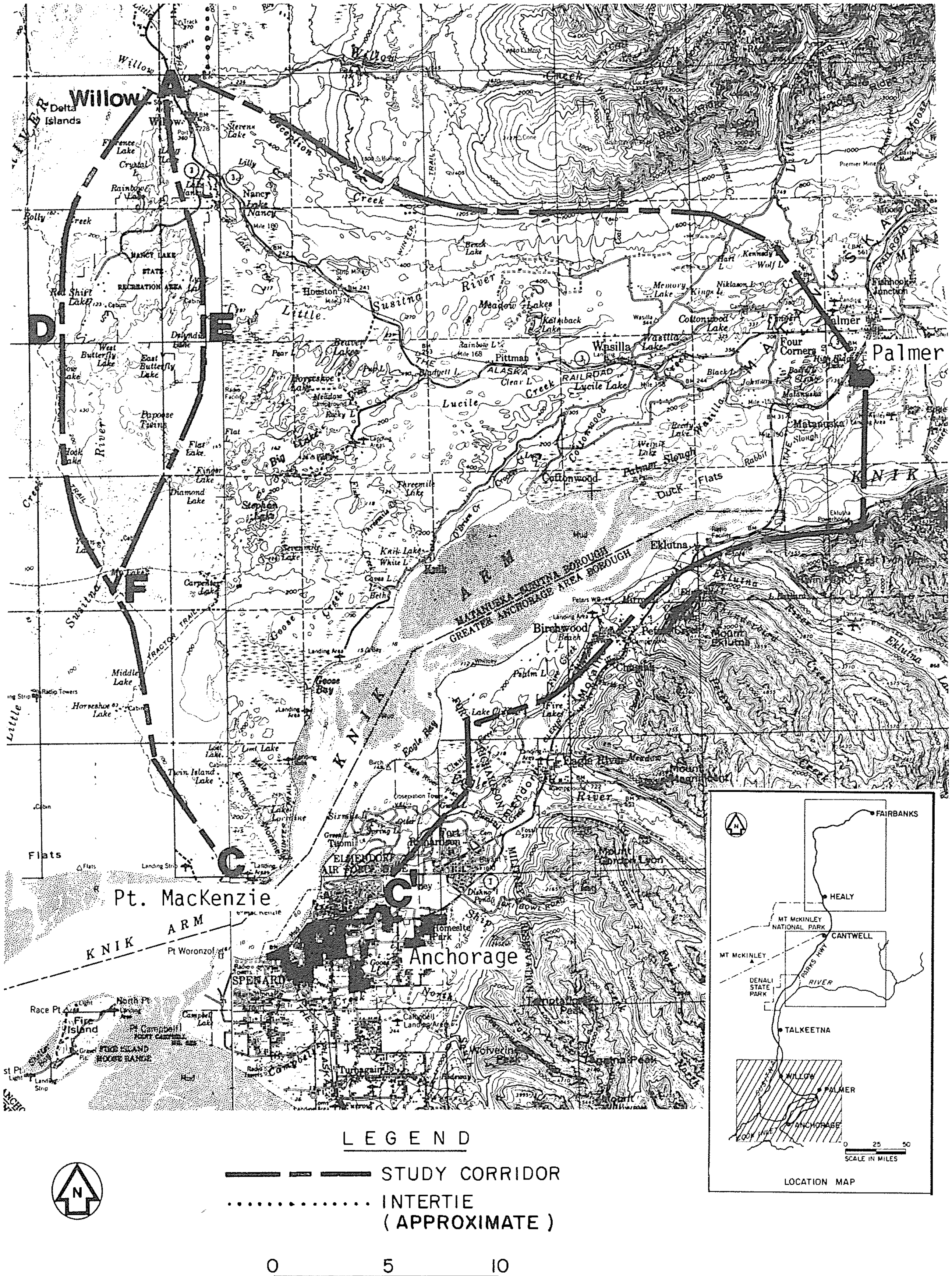

Figure 2-16. Alternative Transmission Line Corridors--Southern Study Area.
[Source: Application Exhibit B, Fig. B.47]

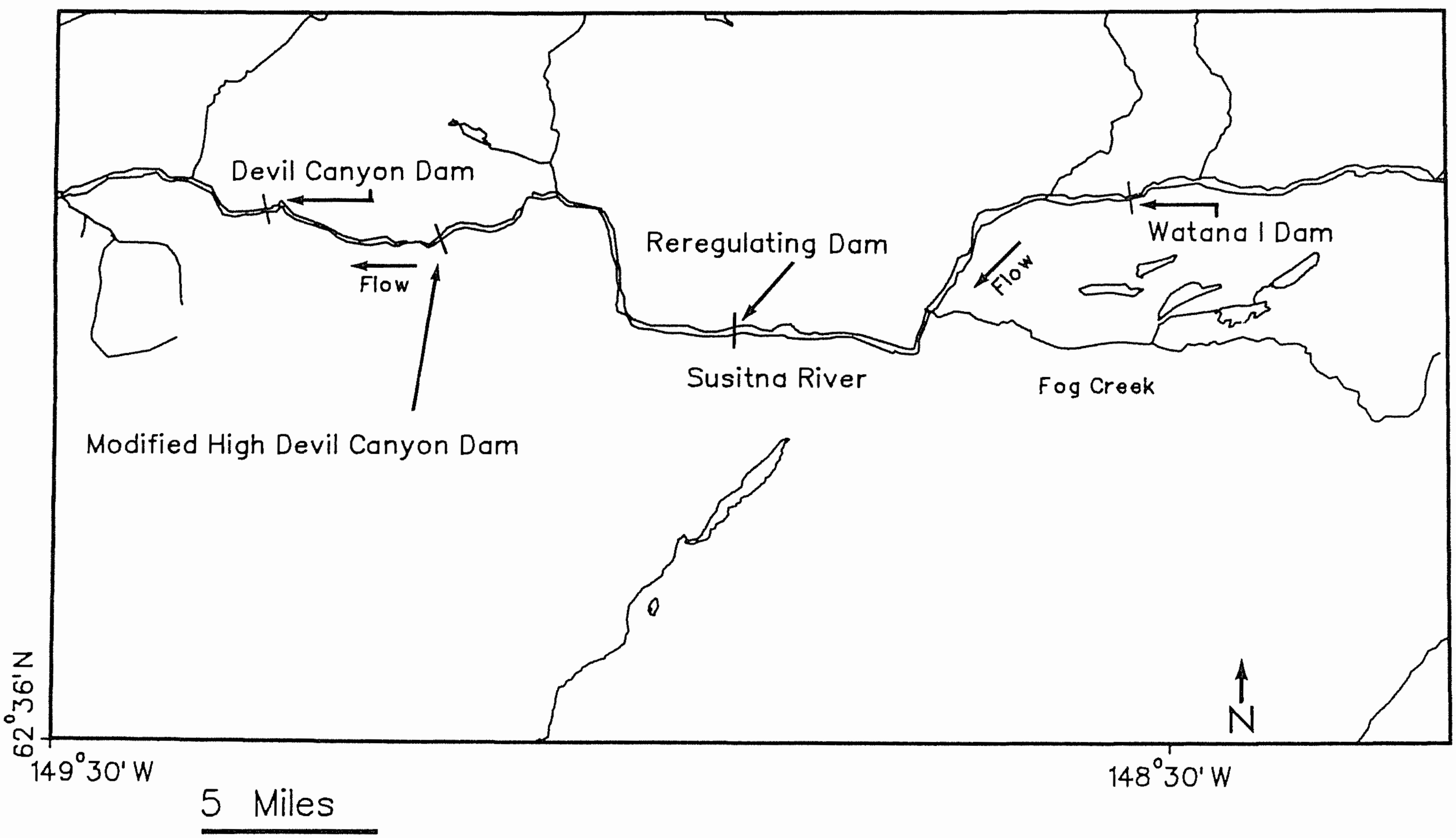

Figure 2-17. Locations of Alternative Susitna River Developments.

Exhibit B, except the 15-mi (24-km) long power tunnel between the Reregulating dam and Devil Canyon would not be constructed. The tunnel and a powerhouse at Devil Canyon could be added in the future. However, if further study indicates that the tunnel is an economically feasible alternative, the Reregulating dam powerhouse construction could be staged to avoid installing capacity which could not be used if water was diverted to the tunnel powerhouse.

Operation. The project would be operated in the same manner as the two previously discussed developments.

2.3 NATURAL-GAS-FIRED GENERATION SCENARIO

2.3.1 Alternative Facilities

For its natural-gas generation scenario, the Staff assumed that eight state-of-the-art 200-MW gas-fired baseload combined-cycle plants and two 70-MW gas-fired combustion-turbine peaking units would be installed. The assumed combined cycle plants each include two combustion-turbine generator units, a heat recovery boiler using the exhaust gases of that combustion turbines to produce superheated steam, and a steam turbine generator. Additional details regarding the assumed design and operating parameters of the combined-cycle plants are given in Appendix G, Table G.5. The combined-cycle substantially improves power generation efficiency. A plant with two combustion turbines can be operated at partial load with one of the gas turbines out of service. The combustion-turbine peaking units assumed for this scenario (as well as all other thermal scenarios) are simple-cycle facilities using natural gas as fuel.

The technical parameters and economic assumptions used for units in the gas scenario are listed in Table 2-4.

Table 2-4. Plant Addition Technical Parameters and Economic Assumptions--Combined-Cycle and Combustion-Turbine Units

Parameter	Combined Cycle	Combustion Turbine
Technical		
Unit Size (MW)	200	70
Heat Rate (Btu/kWh)	8,000	12,200
Planned Outages (%)	7	32
Forced Outages (%)	8	8.0
Economic		
Unit Capital Cost†[1] ($/kW)	1,107	636
O&M Costs		
Fixed ($/kW-yr)	7.25	2.7
Variable (mills/kWh)	1.69	4.8
Economic Life (years)	30	30

†[1] Including interest during construction at 0% escalation and 3% interest.

Source: Adapted from Applicant's Revised Table D.18.

2.3.2 Location

The Staff assumed that the combined-cycle and combustion-turbine units would be sited in proximity to natural gas distribution pipelines in the Anchorage-Cook Inlet areas. Because of the greater volume of gas required by the combined cycle units, it is expected that they would be concentrated in the western Cook Inlet area and on the Kenai peninsula. For purposes related to impact analysis, Staff assumed the 200-MW combined-cycle plants would be located as follows: two on the lower Beluga River, three on the lower Chuitna River, two on Cook Inlet near Kenai, and one southeast of Anchorage. General site locations are shown in Figure 2-18. The two 70-MW gas turbines were not specifically sited, but it was assumed they would be located in close proximity to the Anchorage load center.

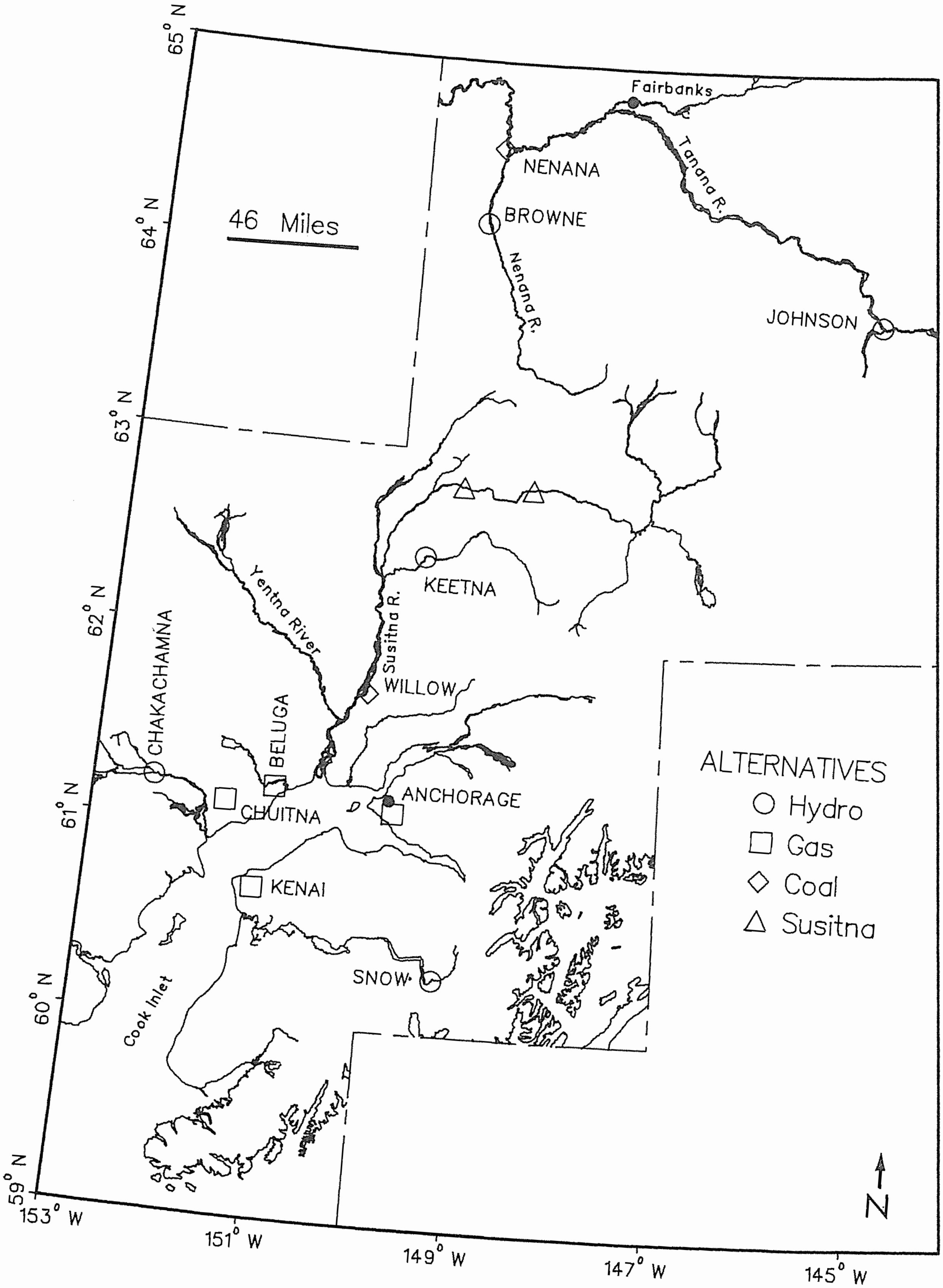

Figure 2-18. Location of Thermal and Hydroelectric Alternatives.

2.3.3 Construction Requirements

The Staff's gas scenario analysis indicated eight 200-MW combined-cycle units and two combustion-turbine units would be required to meet Railbelt power requirements through the year 2042. Construction requirements for the combustion turbines are identical to those indicated in the coal scenario. The personnel required for construction of a 200-MW combined-cycle plant would vary over a 32-month construction period and peak at about 400 people in the second year.

The services needed to support construction of a combined-cycle plant would include access roads; a complete water supply, storage, and distribution system; power lines to provide electric power for construction activities; and camp facilities, including sewage treatment facilities, a waste incinerator and garbage compactor, sleeping recreation and dining quarters, and an airstrip for personnel transport, the transport of perishable goods, and medical emergencies.

Installation of combustion-turbine units can require from less than one year to about two years. Only limited construction is required because most of the installation consists of prefabricated modules. A relatively small work force of about 30 people would be required, and site services would vary depending on site location.

Transmission line connections would be required to tie the combined cycle plants into existing transmission networks. It was assumed that two 345-kV lines would connect the Beluga River and Chuitna River plants to existing transmission facilities at the nearby Beluga gas plant. Upgrading of the Beluga to Anchorage lines might be necessary. The Kenai and Anchorage plants would be located adjacent to existing lines.

2.3.4 Operation and Maintenance

A combined-cycle unit would require 10-15 operating and 18 maintenance personnel. An operating staff of about 12 people would be needed for the combustion-turbine facilities.

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

The operation and maintenance costs assumed in the Staff's analysis are listed in Table 2-4.

2.4 COAL-FIRED GENERATION SCENARIO

2.4.1 Alternative Facilities

For the coal scenario, the Staff assumed that five 200-MW baseload coal-fired units and ten 70-MW combustion-turbine peaking units would be installed as needed to meet the projected Railbelt power requirements. The coal units were assumed to be of conventional state-of-the-art design and to be provided with dry flue-gas desulfurization scrubbers for the removal of sulfur oxides, baghouse particulate removal, wet/dry mechanical draft cooling towers for heat rejection, and pulverized coal for combustion. A more detailed description of the assumed coal unit design and operating parameters is given in Appendix G, Table G.8. The assumed capital cost was deemed to reflect the state-of-the-art with regard to environmental safeguards and an ability to meet established performance standards. The combustion-turbine peaking units were assumed to be simple-cycle machines using natural gas as fuel. The technical parameters and economic assumptions for capital cost, operation and maintenance costs, and economic life are listed in Table 2-5.

2.4.2 Location

In its analysis, the Staff assumed that coal-fired generation facilities would be located in the Nenana and Willow areas of the Railbelt. Staff assumed siting of three units near Nenana and two near Willow (see Figure 2-18). Coal delivery to the generating stations was assumed to be by unit train from the vicinity of the Usibelli Mine in the Nenana coal fields. The ten combustion turbines were not specifically sited, but it was assumed they would be dispersed throughout the Anchorage-Cook Inlet area as necessary to optimize delivery of electric power. Fuel for the combustion turbine installations was assumed to be available from gas distribution pipelines.

2.4.3 Construction Requirements

The coal scenario analysis indicated that five 200-MW coal-fired units and ten combustion turbines would be required to serve anticipated load growth through the year 2022. Construction of a single coal unit would require about five years. The number of construction workers

Table 2-5. Plant Addition Technical Parameters and Economic Assumptions--Coal-Fired and Combustion-Turbine Units

Parameter	Coal-Fired Steam	Combustion Turbine
Technical		
Unit Size (MW)	200	70
Heat Rate (Btu/kWh)	10,000	12,200
Planned Outages (%)	8.0	3.2
Forced Outage (%)	5.7	8.0
Economic		
Unit Capital Costs†1 ($/MW)	2,309	636
O&M Cost		
Fixed ($/kW-yr)	16.83	2.7
Variable (mills/kWh)	0.6	4.8
Economic Life (years)	30	30

†1 Including interest during construction at 0% escalation and 3% interest.

Source: Adapted from Applicant's Revised Table D.18.

required would vary, but would peak at about 500 by the end of the second year and fall off dramatically near the end of the fourth year.

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

The ultimate transmission construction requirement for transmission of power from generating units in the Nenana area to the load centers was assumed to be similar to that required for transmission of the power output from the proposed Watana development. This includes construction of a second 100-mi (160-km) 345-kV line from Healy to Willow, paralleling the proposed 345-kV Intertie; a double-circuit, 345-kV extension from Willow to the University station in Anchorage; and a 100-mi (160-km) long, double circuit, 345-kV extension of the Intertie from Healy to the Ester substation in the Fairbanks area. The Staff assumed that two 345-kV outlets from the Nenana coal plant would interconnect with the Healy-to-Ester 345-kV transmission line at a switching station in the vicinity of the Nenana coal fields, between Healy and Nenana, and that transmission outlets from the coal plant would be shorter than the 37-mi (59-km) long outlets from Watana to the Intertie right-of-way. The transmission arrangements for two coal units in the Willow area would probably involve connection of the Willow area generation at the Willow substation via one 345-kV line.

2.4.4 Operation and Maintenance

Operation and maintenance of a single 200-MW coal unit has an estimated staff requirement of about 100 persons to support a three-shift, 24-hour-a-day operation. Operation and maintenance staffing requirements for the gas turbines would be the same as described for the gas scenario.

Periodic maintenance would be performed by the coal plant staff on all pipes, valves, rotating machinery, heat-sensitive equipment, and other items subject to wear, leaks, corrosion or other deterioration. In addition, the maintenance programs would provide for monitoring of the revegetation and erosion prevention programs initiated during the cleanup phase of construction. In general, major equipment replacement or overhauls would be performed during the plant's annual scheduled outages, sometimes involving the temporary assignment of specialized personnel. On the average, scheduled outages are estimated to require approximately four weeks per year for plants ranging in size from 100 MW to 300 MW, corresponding to a scheduled outage rate of 8%. The operation and maintenance costs assumed in the Staff analysis are listed in Table 2-5.

2.5 COMBINED HYDRO-THERMAL GENERATION SCENARIO

2.5.1 Hydro Units

The hydroelectric sites considered in the combined hydro-thermal scenario are Browne, Chakachamna, Johnson, Keetna, and Snow (Fig. 2-18). The Chakachamna area has been studied previously for hydroelectric development and is currently under study by the Applicant; therefore, fairly detailed site informaton is available. Browne, Johnson, Keetna, and Snow, however, have not been intensively studied, and information on those areas is limited primarily to non-specific inventory data and resource maps.

2.5.1.1 Browne

The Browne site is located on the Nenana River near Healy, about 75 mi (120 km) southwest of Fairbanks. The site layout for the Browne project is shown in Figure 2-19. The Browne dam would be either a concrete gravity or a concrete-faced rockfill structure. It would have a crest elevation of 995 ft (303 m) and a maximum height of approximately 235 ft (71.6 m). A diversion tunnel and flip-bucket spillway would be constructed on the northern abutment, and a power tunnel and surface powerhouse would be built on the southern abutment.

2.5.1.2 Chakachamna

Chakachamna Lake is located in the Alaska Range about 80 mi (130 km) west of Anchorage. The lake is drained by the Chakachatna River, which runs southeasterly out of the lake and eventually into Cook Inlet. The site layout for the Chakachamna development is shown in Figure 2-20. The development would be a lake tap of Chakachamna Lake with a diversion tunnel [approximately 23 ft (7 m) in diameter] to the McArthur River basin. An underground powerhouse would be located on the McArthur River near the base of the Blockade Glacier.

2.5.1.3 Johnson

The Johnson site is located on the Tanana River, approximately 120 mi (190 km) southeast of Fairbanks and has a drainage area of 10,450 mi^2 (27,066 km^2). The Johnson dam would be a concrete gravity structure with earthen dikes and would have a maximum height of about 140 ft (43 m). The reservoir would have a maximum water surface elevation of 1,470 ft (448 m) and would have an active storage of about 5,300,000 ac-ft (6.5 billion m^3).

2.5.1.4 Keetna

The Keetna site is located on the Talkeetna River, approximately 70 mi (110 km) north of Anchorage. The Talkeetna River, with headwaters in the Talkeetna Mountains, flows southwesterly to its confluence with the Susitna River. The dam site has a drainage area of 1,260 mi^2 (3,263 km^2). Streamflow records indicate the yearly average discharge at the site to be 1.7 million ac-ft (2.1 billion m^3). Power development would include a dam with a diversion tunnel (Fig. 2-21). The dam would be of earth and rockfill construction and would have a crest elevation of 965.0 ft (294.1 m) with a maximum height of approximately 365 ft (111 m). The spillway and power facilities would be located south of the dam.

2.5.1.5 Snow

The Snow site is located on the Snow River in the Kenai Peninsula. Power development would include a dam with diversion through a tunnel approximately 7,500 to 10,000 ft (2,300 to 3,000 m) long. An earth and rockfill dam with a crest elevation of 1,210 ft (369 m) and a maximum height of approximately 310 ft (94 m) would be constructed. The diversion and power tunnel would be located on the southern abutment and a spillway would be constructed at the southern end of the reservoir [approximately 1 mile (0.6 km) from the dam] (Fig. 2-22).

The Snow River at the proposed dam site flows in a deep narrow gorge cut into bedrock on the floor of a glacial valley. Graywacke and slate are exposed and this overburden is evident. The river flows west and north into the southern end of the Kenai Lake. The average annual streamflow at the dam site is estimated at 510,000 to 535,000 ac-ft (629 to 660 million m^3). The dam site would be fed by 105 mi^2 (222 km^2) of the river's 166-mi^2 (430-km^2) drainage area.

2.5.2 Thermal Units

2.5.2.1 Facilities

The thermal portion of a combined hydro-thermal scenario would consist of the same types of thermal resources considered in the coal, gas, and mixed coal and gas thermal scenarios discussed previously. These would include the 200-MW, conventional coal-fired units discussed in the coal

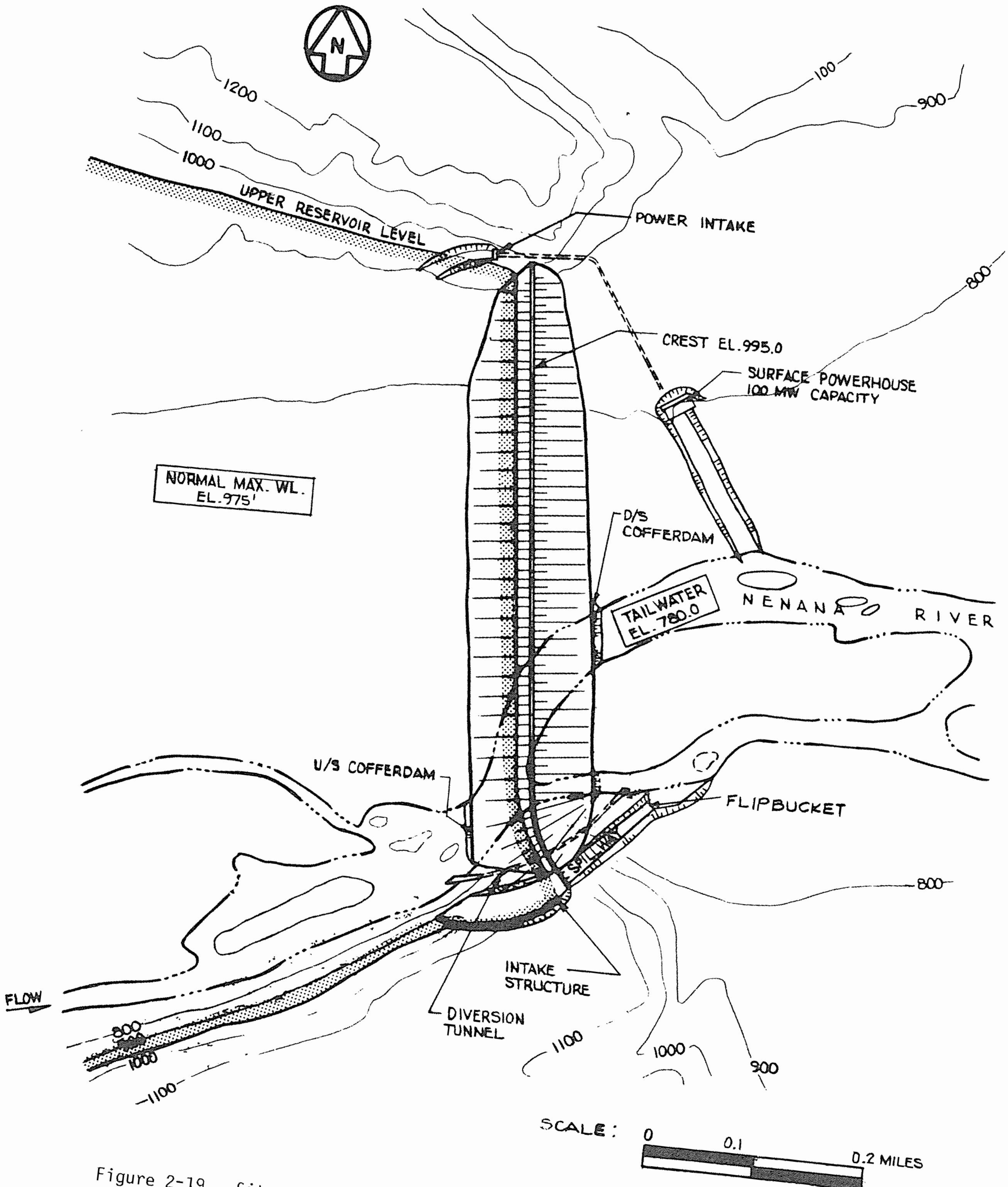

Figure 2-19. Site Layout--Browne Development. [Source: Applicant, Task 6 Design Development, Fig. C.6 (December 1981)]

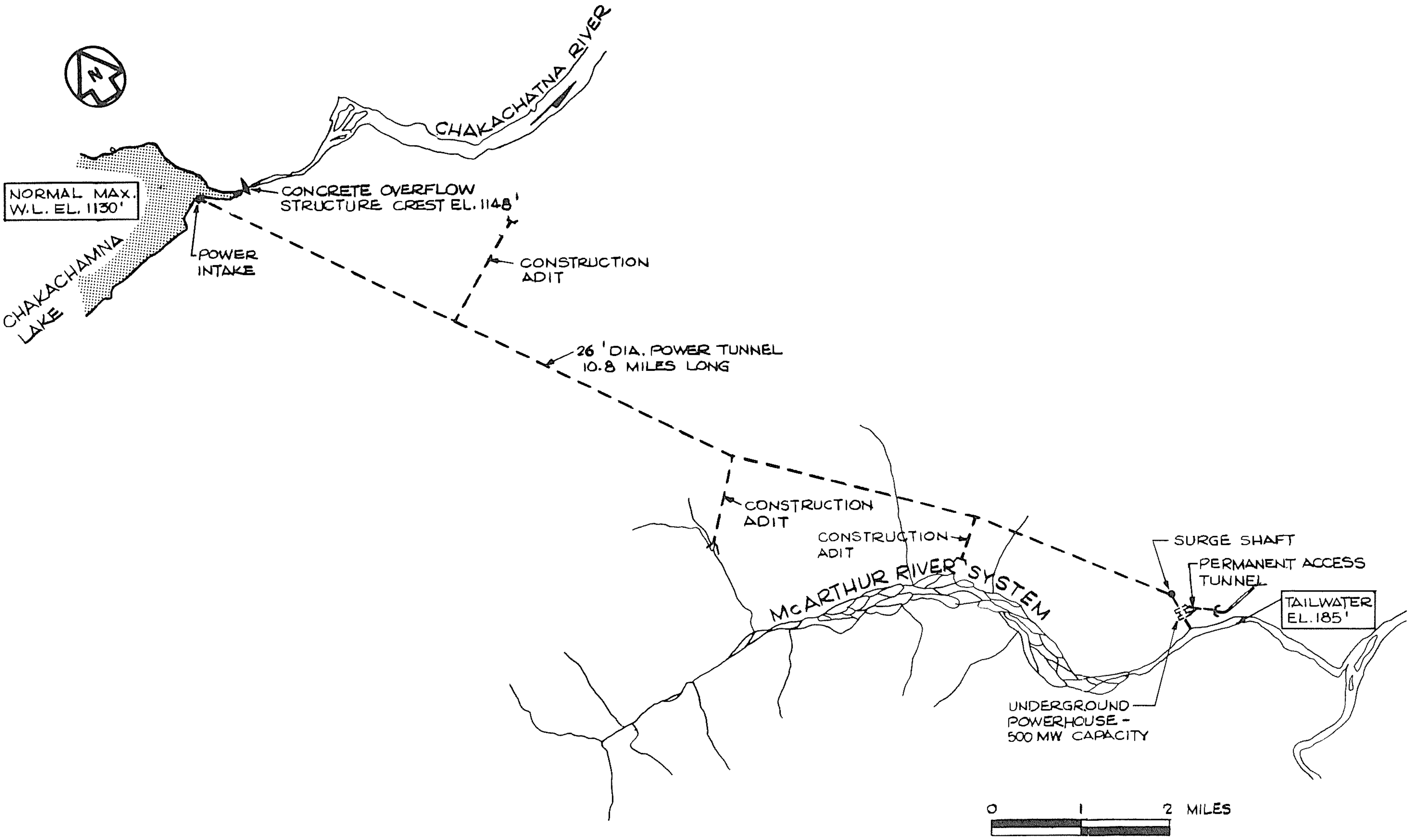

Figure 2-20. Site Layout--Chakachamna Development. [Source: Applicant, Task 6 Design Development, Fig. C.9 (December 1981)]

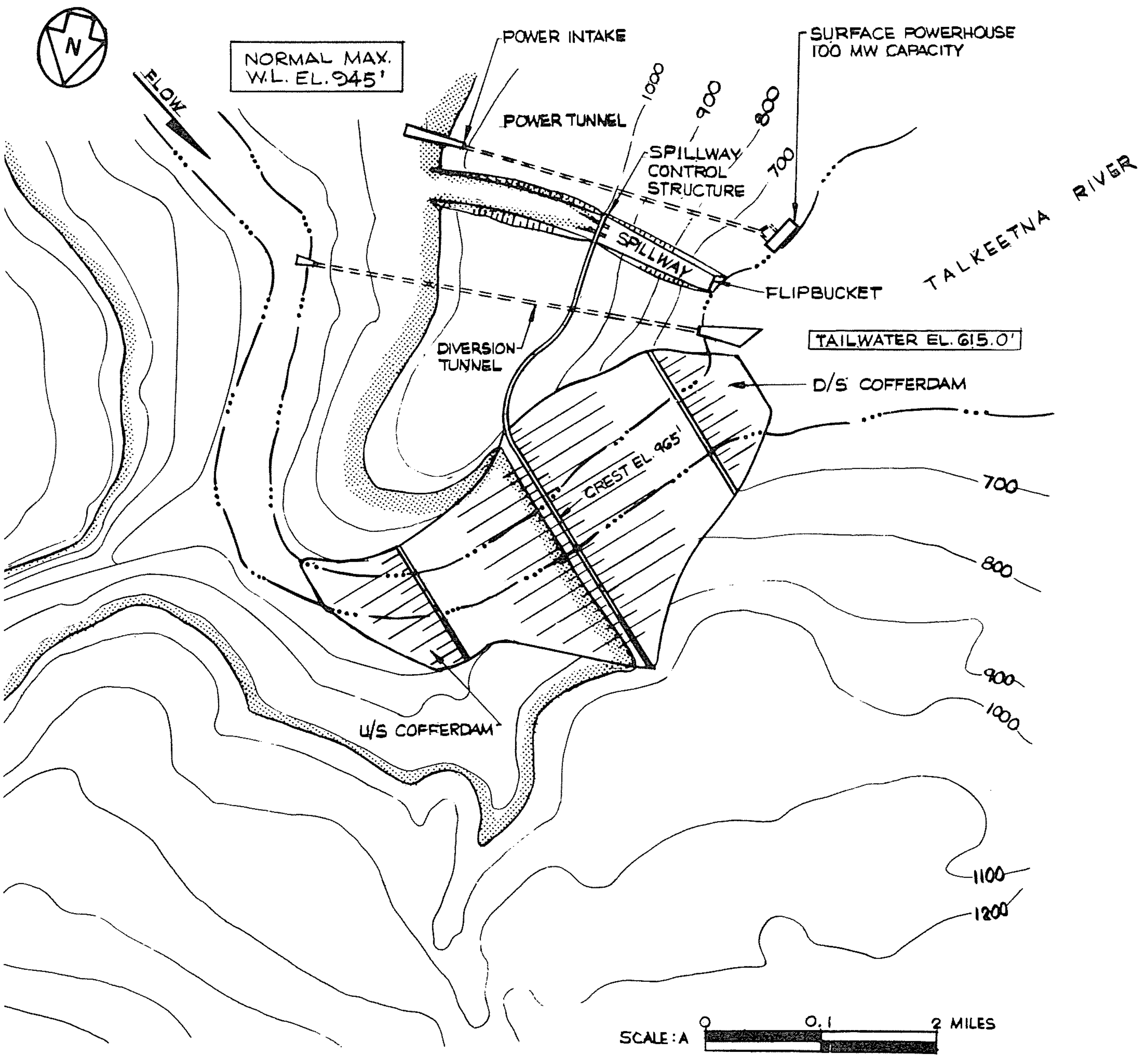

Figure 2-21. Site Layout--Keetna Development. [Source: Applicant, Task 6 Design Development, Fig. C.4 (December 1981)]

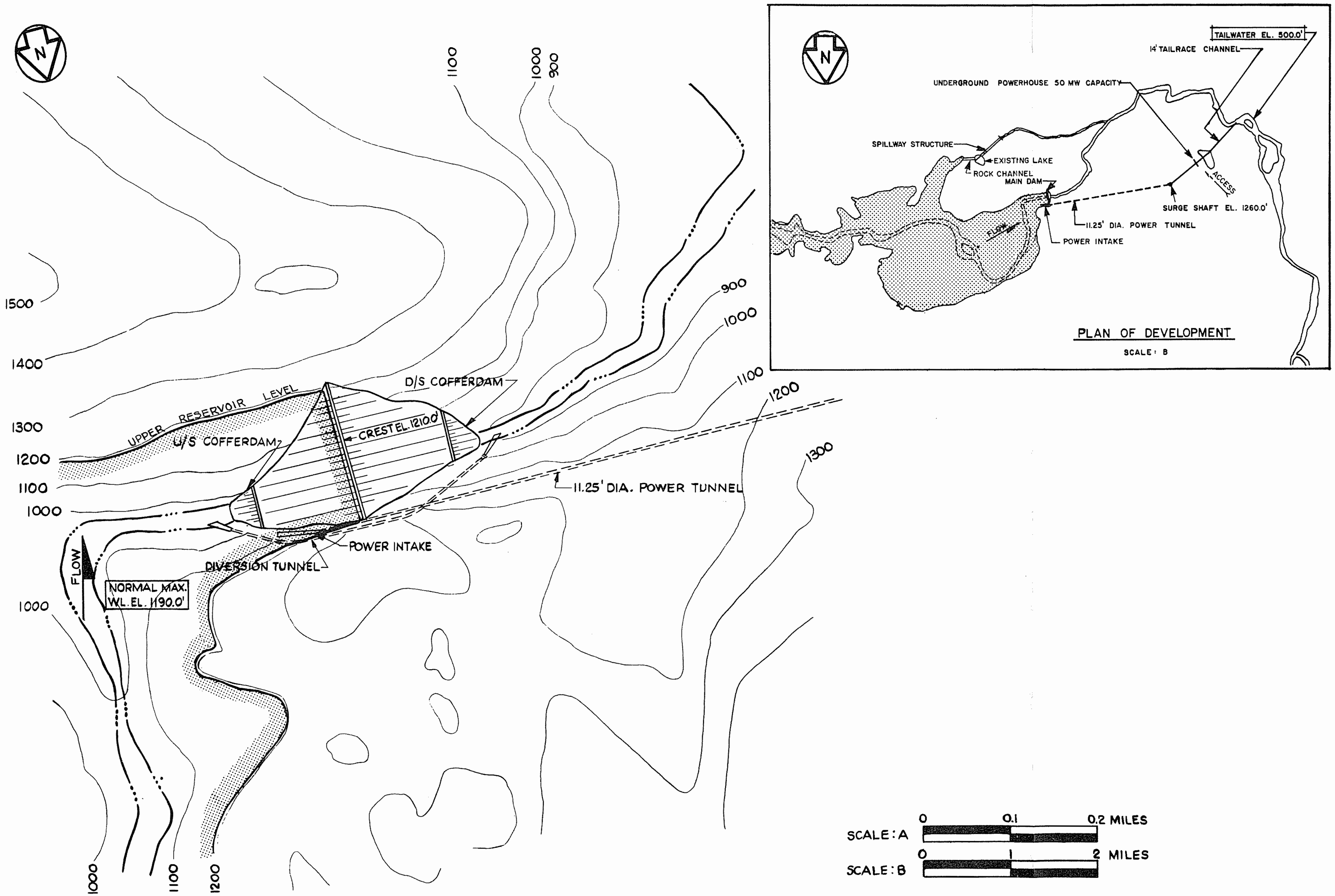

Figure 2-22. Site Layout--Snow Development. [Source: Applicant, Task 6 Design Development, Fig. C.3 (December 1981)]

and mixed scenario, the 200-MW combined-cycle units discussed in the gas and mixed scenario and the gas-fired combustion turbines discussed in all of the thermal scenarios. Utilizing the lower cost hydropower resources in the combined scenario reduces the number of thermal units required to meet power requirements through the 30 years of operation, as compared to all-thermal scenarios. The thermal plant requirements for the thermal and mixed hydroelectric/thermal scenarios are listed in Table 2-6 for a medium load-growth rate.

Table 2-6. Required Thermal Resources--
Medium Load Growth

	Number of Units		
Scenario	70-MW Combustion Turbine	200-MW Combined Cycle	200-MW Coal-Fired
Coal	10		5
Gas	2	8	
Coal/Gas	5	4	3
Hydro-thermal			
With Chakachamna†[1]	3	3	1
Without Chakachamna†[2]	3	4	1

†[1] Johnson, Chakachamna, Keetna, Snow, Browne.

†[2] Johnson, Keetna, Snow, Browne plus one 200-MW combined cycle unit.

2.5.2.2 Location

The single coal generating unit in the combined hydro-thermal scenario was again assumed to be in the Nenana area of the Railbelt, taking advantage of the expansion capability of the Usibelli Mine. Gas-fired combined-cycle units were again located in the Kenai Peninsula and on the western side of the Cook Inlet (the Beluga area) in proximity to natural-gas fuel supplies. Required natural-gas-fired combustion-turbine units for peaking were again assumed to be located in proximity to natural-gas distribution pipelines.

2.5.2.3 Construction Requirements

The thermal resource components of the combined hydro-thermal development plan as required by load growth through the year 2022 are shown in Table 2-6. The construction requirements associated with each type of plant have been described previously in connection with the coal and gas scenarios.

2.5.2.4 Operation and Maintenance

Baseload operation of coal-fired units and gas-fired combined-cycle units would be coordinated with the firm and peaking capability of the hydro resource development, and the gas-fired combustion turbines would provide additional peaking capability as required. Operation and maintenance aspects of the individual plant types would be as described in the previous discussions of thermal scenarios.

2.5.3 Transmission

The dispersed locations of the generating plants in the hydro-thermal scenario would result in a transmission system somewhat different from that described for the proposed project. Less generation would be located along the Fairbanks-Anchorage Intertie, requiring less strengthening of the Intertie. However, longer lines at lower voltage levels would be needed for the three hydropower plants located beyond the extremities of the Intertie.

The 100-MW Browne and Keetna hydro plants, between Anchorage and Fairbanks, could each be connected to the Intertie with separate pairs of 138-kV lines of about 5 and 20 mi (8 and 32 km) length; respectively. The 200-MW coal plant in the Nenana area could connect to a strengthened Intertie using 138-kV twin outlet lines, probably less than 10 mi (16 km) long.

The Chakachamna 300-MW hydro plant, west of Anchorage, could connect with the existing Beluga substation using twin 230-kV transmission lines about 50 mi (80 km) long. The 100-MW Snow hydro plant, south of Anchorage, could be integrated with the Anchorage load area by construction of two 115-kV lines to existing substations, one about 30 mi (48 km) long and the other about 60 mi (97 km) long. The Johnson 210-MW hydro plant, southeast of Fairbanks, could be integrated with the Fairbanks load area by twin 138-kV lines extending about 45 mi (72 km) to an existing substation and doubling an existing 138-kV line 73 mi (117 km) long from the substation to Fairbanks.

The gas-fired combined-cycle and combustion-turbine units of this scenario would be located in the load center areas and would not require significant amounts of high-voltage transmission.

While these general possibilities are evident, the optimum voltage levels and numbers of lines for connecting the generating plants and strengthening the Intertie can only be determined by detailed load flow and reliability studies.

2.6 NO-ACTION ALTERNATIVE

The no-action alternative would constitute a denial of a license to construct, operate, and maintain the Susitna Hydroelectric Project, as proposed by the Applicant. This alternative would result in the non-utilization of potential electric energy that could be derived by developing the portion of the Susitna River between the Oshetna River and Devil Canyon. The Applicant would then need to develop one or more alternative power sources in order to meet projected future load-growth requirements.

2.7 MITIGATIVE MEASURES FOR ALTERNATIVE SCENARIOS

2.7.1 Land Resources

2.7.1.1 Geology and Soils

Mitigative measures for construction of the alternative access and transmission routes and the alternative hydropower sites would be similar to those described for the proposed project (see Sec. 2.1.12.1). Conventional construction practices designed to control erosion losses and soil disturbances would be adequate in controlling impacts arising from the construction of the individual coal- and gas-fired plants under the alternative scenarios. Conventional coal-storage and -handling procedures would be sufficient to minimize or control erosion losses from storage and ash disposal areas. Coal mine practices such as drainage diversion, use of sediment traps, restoration of topography, soil stripping/storage, and revegetation would be required to control surface mining impacts.

2.7.1.2 Land Use and Ownership

Many of the land use mitigative measures described in Section 2.1.12.1 would also be applicable for the alternative dam facilities and power-generation scenarios. Specific siting criteria for the gas-fired and coal-fired plants would be required to minimize the potential for land use conflicts with surrounding natural, recreational, residential, or commercial lands. Plans for the Browne and Johnson hydropower facilities would have to incorporate engineering design measures that would mitigate the inundation of portions of the Nenana River Valley (including the George Parks Highway and Alaska Railroad) and the Johnson River valley (including the Alaska Highway and an above-ground pipeline).

2.7.2 Climate, Air Quality, Noise

No climate, air quality, or noise mitigation would be required for the combined-cycle natural gas units or gas turbines. These plants, as proposed in the various alternative generating scenarios, should satisfy all applicable air quality standards. The same is true of up to two coal-fired units at Nenana and for the two at Willow.

If three, four, or five coal-fired units were to be sited at Nenana, potential problems would arise involving visibility impairment at Denali National Park (Class I area), exceedence of the PSD Class I increment for SO_2 at Denali (four and five units only), and exceedence of the PSD Class II increment at the elevated terrain northeast of Nenana. These potential air quality problems were revealed upon application of EPA-approved screening analyses to the determination of air quality impacts. These potential violations should be confirmed using more sophisticated analyses (and site-specific meteorological data) involving more complex EPA-approved models. The visibility impairment problem might be mitigated to some degree by employing NO_x controls (more efficient combustion) at the Nenana plants. It is primarily the NO_x emission that would lead to visibility impairment in the observation of plume contrast with the sky. The two PSD problems are attributable solely to the SO_2 emissions and could be mitigated to some degree by additional scrubbing beyond the minimum required, i.e., 70% reduction in sulfur.

Model calculations would be required to determine if such pollutant emission reductions would lead to compliance with EPA and Alaska air quality standards.

2.7.3 Water Quantity and Quality

Minimum flows to reduce impacts on fish migration and spawning activities are assumed. Although the actual flow requirements are unknown, reasonable estimates based on historical flows and typical minimum flow requirements are possible. Table 2-7 contains the minimum flow requirements at each of the hydro sites for the critical summer months as well as for the remainder of the year. These values are based on a minimum flow in June, July, and August of the maximum of the historical Q_{90} value, while the remainder of the year the minimum flow is 30% of the mean annual flow. For comparison, the values for the Susitna at Devil Canyon are also included in Table 2-7. The Susitna flows appear realistic, which indicates that some confidence in the values is warranted. These minimum flows are input to the economic models to determine the generation costs for each hydro site.

Table 2-7. Minimum Flows for the Alternative Hydro Sites

	Minimum Flow (cfs)	
Site	Summer	Other Months
Bradley Lake	1,200	180
Lake Chakachamna	9,900	1,100
Browne	9,300	1,400
Snow	740	210
Johnson	24,000	3,200
Keetna	5,000	720
Susitna (Devil Canyon)	18,000	2,700

Conversion: To convert cubic feet per second to cubic meters per second, multiply by 0.0283.

For all thermal alternatives, mitigative techniques to minimize water consumption are assumed. These techniques include wet/dry cooling systems, maximum water recycling, and best available controls on water-consuming devices, such as dry scrubbers on the coal facilities. The techniques assumed presently exist, but may add some cost to the facilities, which is included in the cost analyses.

2.7.4 Fisheries

Among alternatives considered for the Susitna project, fisheries mitigation would appear necessary for the Susitna Basin alternatives and for the Keetna and Chakachamna projects. The Susitna Basin alternatives each would require mitigation similar to, but at different scales than, the proposed project. A project at the Keetna site on the Talkeetna River would disrupt upstream fish migrations, which would require mitigation. Until the size and composition of these migrations are determined, no mitigation plan can be developed beyond the conceptual outline discussed in Section 2.1.12.3. At the Chakachamna site, mitigation would be required for potential losses of about 40,000 spawning sockeye that pass through Chakackamna Lake and whose young use the lake for rearing. Important salmon spawning areas downstream of the water diversion would also require some mitigation for probable losses. A fish ladder for upstream migrants has been suggested, but no firm plans for mitigation have been made.

2.7.5 Terrestrial Communities

2.7.5.1 Plant Communities

Alternative Susitna dam designs and locations, access and transmission line routes, and borrow sites would require mitigation similar to that described for corresponding proposed facilities (Secs. 2.1.12.4.1 and 5.3.5). Measures necessary for mitigation of impacts to vegetation caused by construction of the non-Susitna hydropower alternatives also would be similar to those described for the proposed project. Mitigative measures necessary for natural-gas-fired units would include (1) siting of facilities such as buildings, transmission line stubs, and pipeline spurs to avoid sensitive vegetation types or wetlands, and (2) rehabilitation of areas disturbed by construction of such facilities. Mitigative measures necessary for coal-fired power plants would include those measures indicated for natural-gas-fired units, plus rehabilitation of solid-waste disposal sites and land disturbed by surface mining.

2.7.5.2 Wildlife

Mitigative measures for alternative actions would be similar to those described in Section 2.1.12.4.2, although the extent of mitigation would vary with the magnitude of impacts to wildlife. Specific measures cannot be presented here without more site-specific data on potential impacts.

2.7.6 Threatened and Endangered Species

Mitigative measures such as those outlined in Section 2.1.12.5 would be required for alternative transmission lines that pass near Nenana. No other alternatives would likely require mitigative measures for threatened and endangered species.

2.7.7 Socioeconomic Factors

The primary mitigative measures for all alternatives located farther than about 40 mi (64 km) from Anchorage or Fairbanks would be the same as those for the proposed project, including:

- Provide construction camps (with recreation facilities) for single workers;
- Develop leave and shift schedules (based on past experiences in Alaska) to discourage inmigration to small communities and rural areas;
- Provide low-cost transportation (e.g., air or bus travel to Anchorage and/or Fairbanks, commuter buses to bus or train stations) for workers to travel easily to permanent residences or for vacations outside the project area, and to discourage conflicts between project-related traffic and local and tourist traffic;
- Provide training programs for local labor and hire local workers;
- Provide advance funding or loans to finance expansion of community services (e.g., water and sewer systems, schools) and for development of housing prior to the influx of workers; and
- Maintain ongoing communication with state, borough, and community officials on community and area plans and impacts, on proposed and actual construction schedules, and on any schedule changes and similar matters.

2.7.8 Visual Resources

In general, many of the mitigative measures described in Section 2.1.12.8 and Section M.4 (App. M) that would be implemented to lessen impacts on visual resources for the proposed project also would be applicable to the alternative dam facilities and power generation scenarios. These measures include conducting additional studies; implementation of proper development practices and creative engineering design; and the use of form, line, color, and texture to make project facilities more visually compatible with surrounding natural features. In particular, gas- and coal-fired generation plants should be sited away from highways, residential areas, and recreation areas. If the power plants are located near visually sensitive areas, wet-dry cooling towers or dry cooling towers should be used to limit the amount of vapor plumes emanating from the plants. Additionally, state-of-the-art emission controls should be used to limit the amount of haze that could develop downwind from the coal-fired plants.

2.7.9 Cultural Resources

Cultural resource mitigative measures for the Susitna development alternatives are essentially the same as those recommended for the proposed project. Investigation would be required for significant sites exposed to direct or indirect impacts, while preservation by avoidance (with monitoring) would be necessary for potentially impacted significant sites. For the non-Susitna power generation alternatives, surveys would be required in the affected areas in order to inventory and evaluate cultural resources. For significant sites that would be directly or indirectly impacted by the construction of dams and associated facilities or reservoir areas, investigation is recommended. Significant sites in areas that would be impacted by non-hydropower generation facilities would probably be mitigable by avoidance.

REFERENCES FOR SECTION 2

Electric Power Research Institute. 1982. Transmission Line Reference Book, 345 kV and Above. 2nd ed.

American National Standards Institute. 1984. National Electrical Safety Code. Institute of Electrical Electronics Engineers, Inc. New York.

3. AFFECTED ENVIRONMENT

3.1 PROPOSED PROJECT

3.1.1 Land Resources

3.1.1.1 Geology and Soils

The proposed Susitna project is located in the middle Susitna River Basin of Southcentral Alaska (Fig. 2-1). This area is bordered on the north and west by the Alaska Range, to the east by the Copper River Lowlands and to the south by the Talkeetna Mountains.

At both of the proposed dam sites the topography is dominated by scoured bedrock knobs and ridges. At the Devil Canyon site a thin veneer of glacial deposits covers the Cretaceous graywacke and argillite rocks that form the steep valley walls. Upland from the broad V-shaped Susitna River Valley at the Watana dam site, up to 80 feet (ft) [24 meters (m)] of glacial till cover the underlying diorite bedrock. The construction camps and project villages would be located on level terrain--north of the Susitna River at Watana and south of the river at Devil Canyon. All proposed borrow pits would be located on relatively flat terrain adjacent to the Susitna River or within broad valleys of tributaries to the Susitna.

Following the Denali Highway, the proposed access route would cross the thick glacial and alluvial deposits of the Nenana River Valley from Cantwell to Brushkana Creek; from there it would extend south across the relatively flat terrain of the Brushkana and Deadman creeks to the Watana dam site, and thence across the sloping uplands between the Devil Canyon and Watana dam sites. A rail line connecting the Devil Canyon camp area to the Alaska Railroad at Gold Creek would cross relatively level terrain south of the Susitna River.

The proposed transmission line corridor would follow the access corridor between Gold Creek and the Watana dam site. From Gold Creek to Anchorage, the transmission line would cross thick glacial and alluvial deposits in the Susitna River Valley along the edge of the Talkeetna Mountain foothills to the swampy Cook Inlet lowlands at Point MacKenzie. North of Gold Creek the line would extend through the Alaska Range via the Chulitna and Nenana river valleys, crossing the extensive and swampy outwash deposits north of the Alaska Range foothills to the broad Tanana River Valley and extend northwest to Ester across loess-covered ridges and hills.

Spodsolic soils, or soils containing a thin organic layer overlying a mineral horizon, are present throughout the middle Susitna River Valley in the vicinity of the proposed reservoir sites, construction camps, and access routes. The transmission line would cross Spodsolic soils throughout its length north to Cantwell. North of Cantwell, the transmission line would cross Inceptisols, or young, horizonless, incompletely formed soils. Permafrost is absent south of Willow and becomes discontinuous to the north.

No mineral resources are known to be present in the vicinities of the sites of most of the proposed project features. The transmission line would pass near or through subbituminous and lignite coal fields in the Healy area.

Southcentral Alaska is identified as a seismically active area. The major potential sources of seismic ground motion for the proposed project include the Castle Mountain Fault system, the Denali Fault system, and the Benioff interplate and intraplate regions.

3.1.1.2 Land Uses and Ownership

3.1.1.2.1 Existing and Future Uses

Existing land uses and development within the upper and middle Susitna River Basin are scattered and of low intensity (see Fig. 3-1). There are essentially no major areas of agriculture, timbering, or large-scale mining, nor of significant residential, commercial, or industrial development within the area. At present, the primary land use within the basin is dispersed recreation (see Sec. 3.1.7). To date, the area has not met the criteria required for inclusion in any of the following programs: National Park-Preserve System, National or Historic Landmark Status, Wilderness Preservation System, National Forest System, or State Park System. The

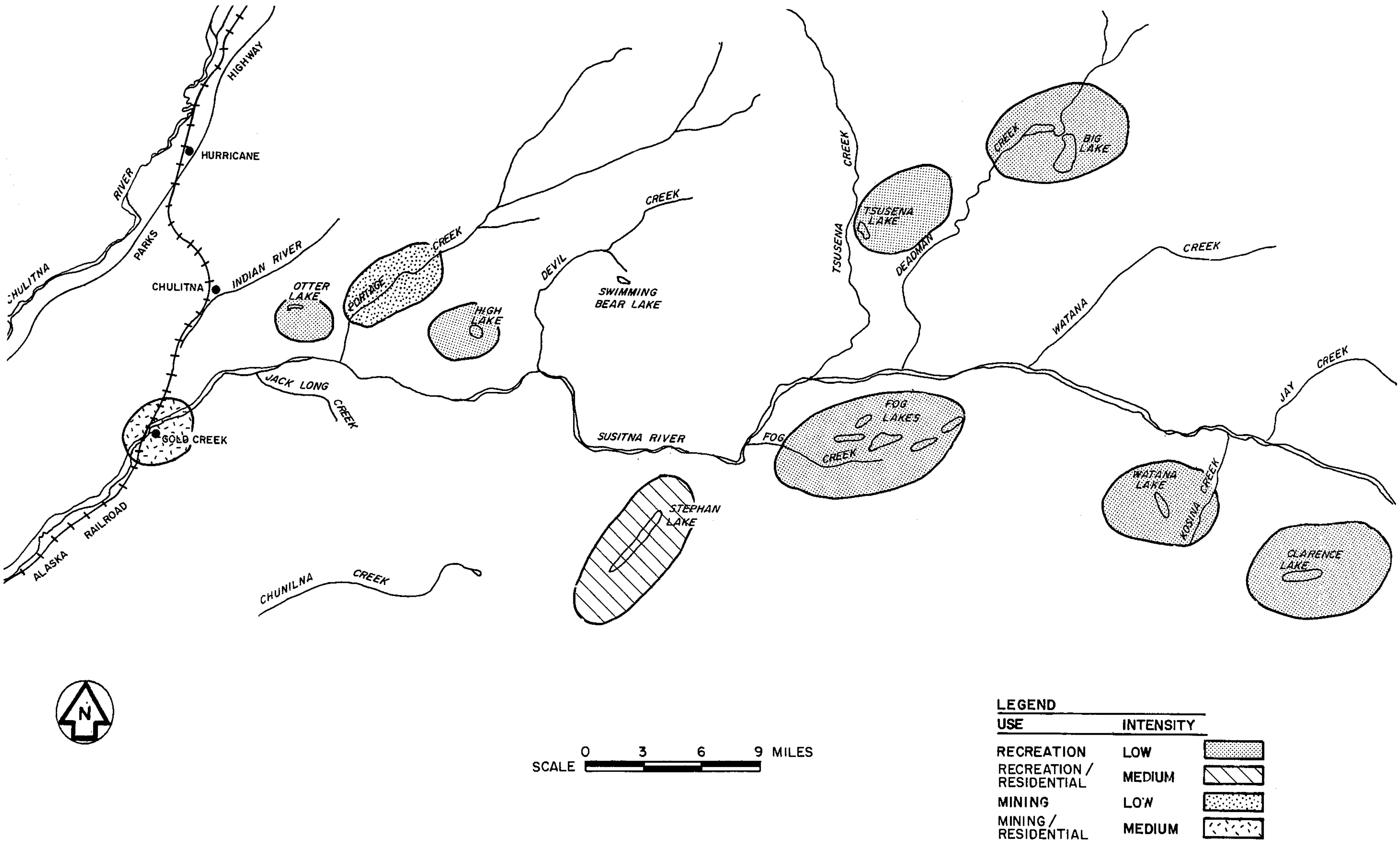

Figure 3-1. Land Use Patterns within the Upper and Middle Susitna River Basin.
[Source: Application Exhibit E, Vol. 8, Chap. 9, Fig. E.9.8]

Susitna River has not been studied for inclusion in the National and Wild Scenic River System (Exhibit E, Vol. 8, Chap. 7, p. E-7-16).*

The U.S. Soil Conservation Service has determined that there are no prime or unique farmlands or rangelands located within the middle Susitna River Basin (Exhibit E, Vol. 8, Chap. 9, p. E-9-27). Mineral exploration and mining activities have been limited, and only scattered claims have been operated in the area on an intermittent basis. Few highway or major utility corridors exist within the upper and middle Susitna River Basin. Ground access into the area is extremely limited and essentially consists of a network of connecting trails. The major mode of access into the basin is by aircraft. Because of this limited access, little development has taken place, and that which has occurred generally consists of single and small clusters of cabins. No special use lands (such as military reservations, firing ranges, testing, or training areas) have been identified within the upper and middle Susitna River area.

The proposed 330-mile (mi) [530-kilometer (km)] transmission line corridor between Fairbanks and Anchorage would extend through portions of the Tanana, Nenana, Chulitna and Susitna river valleys. The corridor would parallel portions of the George Parks Highway and Alaska Railroad. This region is commonly referred to as the Alaska Railbelt.

Along this proposed corridor, agricultural lands are located near Fairbanks, along the Parks Highway and the Alaska Railroad between the communities of Dunbar and Nenana, north of Healy, in the vicinity of Talkeetna, at the Delta Island agricultural disposal tract southwest of Willow, at the Fish Creek Management Unit south of Red Shirt Lake, and at the Point MacKenzie agricultural sale northwest of Point MacKenzie.** A preliminary analysis by the state has indicated that forested areas along both sides of the George Parks Highway have high to moderate value as forestry lands (Alaska Dep. of Natural Resources, 1982). Commercial use of wood resources has been limited to small logging operations along the Susitna River floodplain in the lower basin of the river. Wood is used by local residents as a building material and as a heating fuel. Only limited mineral exploration and mining activities have occurred within the area of the proposed transmission line corridor. Coal mining areas in the vicinity of the proposed corridor are west of Fairbanks, east of Dunbar, in the vicinity of Nenana, and an extensive area east of Healy. Coal is also located in the Broad Pass area (Commonwealth Associates, 1982).

Significant natural and recreation areas (including Denali National Park and Preserve, Denali State Park, and the Nancy Lake State Recreation Area) are located both to the east and west of the corridor. The proposed route does not extend through a national park-preserve system, national historic landmark area, designated wilderness area, or national forest system. However, the corridor does parallel a portion of the Denali State Park for more than 10 mi (16 km) and extends through about 5 mi (8 km) of the Susitna Flats State Game Refuge near Anchorage. Portions of the transmission line corridor would essentially parallel the George Parks Highway and the Alaska Railroad. The corridor would be crossed by the Denali Highway (Route 8) near the community of Cantwell. Numerous landing strips and floatplane landing sites are located along the proposed route of the transmission corridor.

An existing Golden Valley Electric Association transmission line extends from Fairbanks to Healy, and right-of-way is being cleared for the Anchorage-Fairbanks Intertie between Healy and Willow. An existing Chugach Electric Association transmission line extends east from the Knik Arm near Anchorage. Between Fairbanks and Anchorage, the proposed Susitna transmission line corridor would extend past a number of small communities and developed lands. The U.S. Air Force Clear M.E.W.S. Military Reserve is located in the vicinity of Anderson, and lands managed by the U.S. Army (Fort Richardson) and U.S. Air Force (Elmendorf Air Force Base) are located along the proposed transmission line corridor route near Anchorage. The numerous small settlement areas and special use lands are discussed in detail in Section F.1.2.2.1 (App. F).

Relative to future land use development and activities, no significant change in current types or intensity of land use is anticipated for the upper and middle Susitna River Basin unless the proposed project is developed. In the future, significant changes in land use in the basin would occur only with the development of a road system. Along the proposed route of the power transmission line corridor, the extent and intensity of land use activities and development will likely continue to increase along the George Parks Highway and Alaska Railroad corridors (even without project development) as greater demands are placed on existing land resources for planned recreational, agricultural, utility, and mineral resource development within the Railbelt region.

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*Throughout this document, references to specific "Exhibits" are to the exhibits submitted to FERC as part of Alaska Power Authority's Susitna Hydroelectric Project License Application. References to specific "Appendices" (App.) are to the appendices provided in Volumes 2 through 7 of this Draft Environmental Impact Statement.

**Land ownership and classification terminology is provided in Appendix F, Table F-2.

3.1.1.2.2 Existing and Future Ownership Status and Management

Enactment of the Alaska Statehood Act of 1958, the Alaska Native Claims Settlement Act of 1971, and the Alaska National Interest Lands Conservation Act of 1981 has placed much of the land in Alaska, including lands within the upper and middle Susitna River Basin area and along the proposed Fairbanks to Anchorage transmission line corridor, in a state of transition of ownership and management.

Most of the land in the upper and middle Susitna River Basin is now owned by the U.S. Government and managed by the Bureau of Land Management. However, much of the Federal land is in the process of being transferred to the state and to the Cook Inlet Region, Inc. (CIRI), the Native regional commission for the area (see Fig. 3-2). Native selected lands in the project area generally occur along both sides of the Susitna River and around the Stephan Lake area. There are two state land disposal areas west of the proposed project sites and some small private parcels and Native-conveyed lands in the basin area. It is unlikely that the Matanuska-Susitna (Mat-Su) Borough, within which the project area is located, would select any lands in the vicinity of the proposed dam sites, reservoirs, or access road areas.

Most of the land along the proposed route of the transmission line corridor is currently owned by the state and managed by the Alaska Department of Natural Resources. The U.S. Government owns only scattered parcels of land within the corridor. Native selected lands are located near Dunbar and in the vicinity of Anderson, and are being applied for in the Talkeetna area. The only Fairbanks-North Star Borough approved or patented lands along the transmission line corridor area are west of Fairbanks. The Mat-Su Borough is concentrating its selection of lands in the lower Susitna Basin near existing highways and west of the Susitna River. Private land ownership is scattered along the entire proposed route of the transmission line corridor.

3.1.1.2.3 Existing and Future Land Values

Complete and accurate data on values of land in the Watana, Devil Canyon, and transmission line corridor areas are not available. This is due primarily to the on-going changes in land ownership and to the current lack of development and use of land in the Susitna River Valley area that would indicate or assign a value for a specific piece of property. Market values are available only for state, borough, Native, or private lands that have been, or are about to be, sold. Specific land values for required project lands would not be established until the actual project land acquisition process was started. Although it is difficult to accurately predict future land values, it is anticipated that these values will increase over time. This is especially true for the Railbelt Region of Alaska because of existing and planned human development and activities, presence of road and utility corridors, and potential for resource development.

3.1.2 Climate, Air Quality, Noise

3.1.2.1 Climate

The climate of Alaska is divided into four major climatic zones on the basis of temperature and precipitation: Arctic, Continental, Transition, and Maritime. The proposed Susitna project features would be located mainly within the Continental Zone, although the lower portion of the transmission line corridor would extend into the southern Transition zone near Anchorage. The Continental climate in Alaska is characterized by extreme daily and seasonal temperature variations and low precipitation.

Eight meteorological stations were installed within the upper and middle Susitna River Basin as part of the studies conducted for the proposed project. Most representative of the study area are the Watana measurements reported from April 8, 1980, through September 30, 1981. At Watana, winds were rarely more than 22 miles per hour (mph) [10 meters per second (m/s)], with directions typically from the southwest or northeast over the year. Data from other stations reveal the same range in wind speed but with the predominant wind direction altered by the topographical features. The range of temperatures was typically -58°F to 95°F (-50°C to 35°C) at all stations.

3.1.2.2 Air Quality and Noise

No data on existing air quality in the project area have been presented by the Applicant. Some general comments can be made, however, on the basis of data from nearby regions. The existing air quality should be excellent since there are no urban or industrial complexes within about 100 mi (160 km). In fact, the air quality in most of Alaska is generally very good because there are few large industrial complexes or population centers within the state. The large industrial and urban pollution sources that do exist, e.g., the large number of industrial, residential, and automobile sources in Anchorage and Fairbanks, are isolated by distance and precipitous mountain ranges into separate air basins. Thus, it is expected that all pollutants are at extremely low concentrations in the project site vicinity. Total suspended particulate

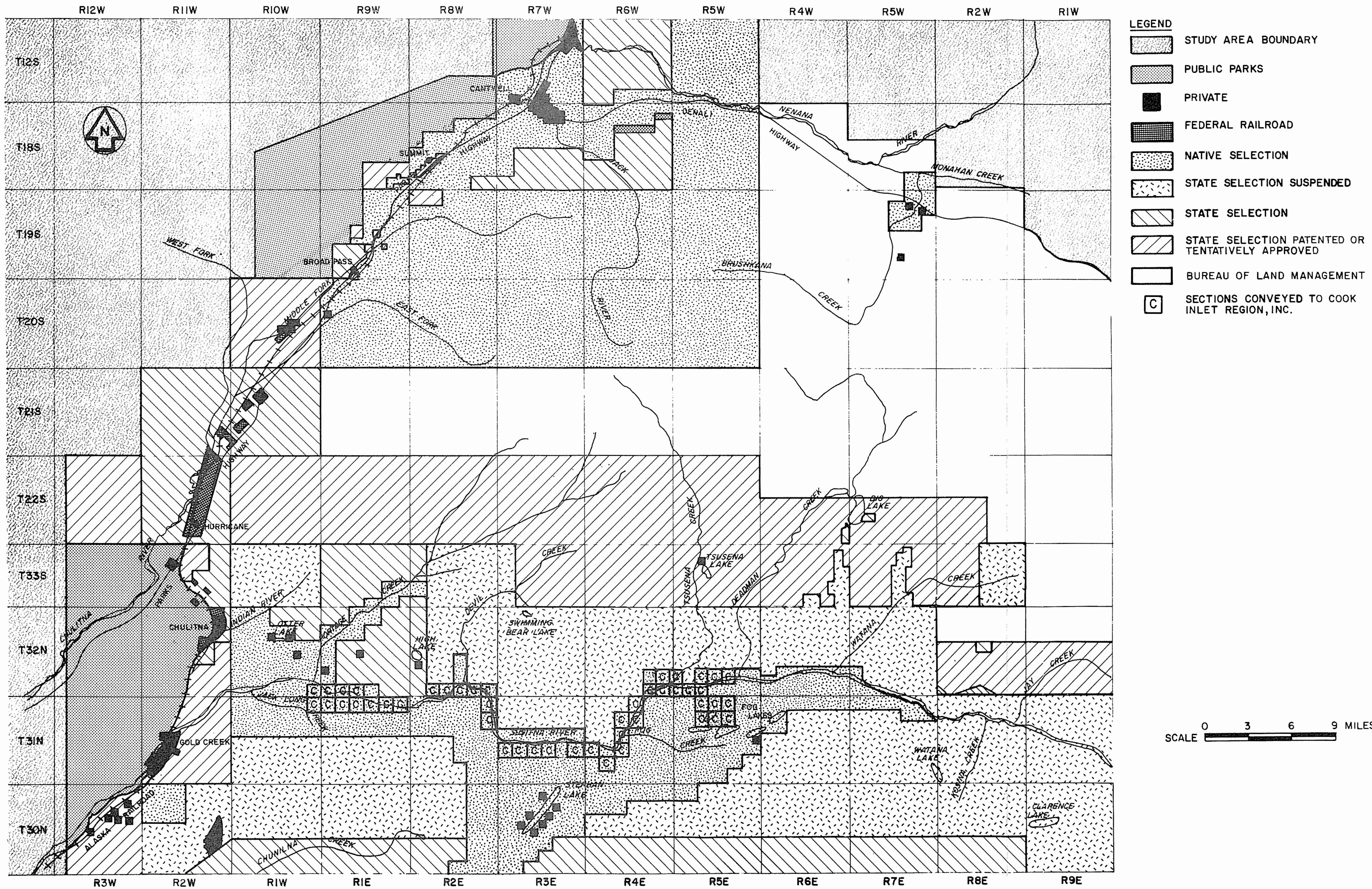


Figure 3-2. Land Ownership and Management Patterns in the Upper and Middle Susitna River Basin. [Source: Application Exhibit E, Vol. 8, Chap. 9, Fig. E.9.3]

(TSP) measurements throughout the State of Alaska have been found to exceed the 24-hour particulate matter standard due to fugitive emissions only near human activities.

No ambient noise measurements were made at the proposed project site, which is situated in an isolated rural area. Very few ambient noise measurements have been made in rural areas, but of those made, typical A-weighted sound levels range from 27-45 dBA. Nighttime values are most representative of the true noise residual and generally measure approximately 30 dBA.

3.1.3 Water Quality and Quantity

3.1.3.1 Surface Water Resources

The Susitna River Basin is the sixth largest river basin in the State of Alaska, covering an area of 19,400 square miles (mi^2) [50,250 square kilometers (km^2)], which is about equivalent to the size of Vermont and New Hampshire. The mainstem of the Susitna River flows 320 mi (515 km) from its headwaters in the Alaska Range to Cook Inlet (Fig. 3-3). Three different physiographic regions can be identified within the basin. The upper basin extends from the outwash plains of numerous glaciers in the Alaska and Talkeetna mountains down to the confluence with the Tyone River. In this sub-basin the river meanders through a broad valley draining many swampy lowlands. In the middle basin, the river turns west and flows through a narrow, steep-walled canyon. The proposed hydroelectric dams [Watana dam at River Mile (RM) 184, Devil Canyon dam at RM 152] are located in this middle section of the river basin. River gradients in the canyon section are high, averaging 10 to 30 ft/mi (5 to 15 m/km). The channel pattern here is relatively straight and entrenched, with occasional midchannel islands. The rapids in the vicinity of Devil Canyon are rated among the most violent in North America (U.S. Dept. of the Interior, 1980). Below the Devil Canyon dam site, the Susitna Valley gradually widens and the river changes from a single channel configuration to a split channel with intermittent, well-vegetated islands, side bars, and backwater sloughs. Bottom substrate in the main channel below Devil Canyon consists primarily of gravel, with a well-developed cobble armor. The sloughs in the middle basin are overflow channels behind side bars or islands that convey clear water from small tributaries and/or upwelling groundwater at intermediate and low main-channel flows. Bottom substrates in the sloughs grade from sand and gravel at their mouths to cobble and boulder at their upstream ends. These sloughs are considered important habitat for salmon spawning (see Sec. 3.1.4).

Farther downstream, at the confluence of the Chulitna, Talkeetna, and Susitna rivers (RM 1D4 to 95) near the town of Talkeetna, another dramatic change occurs in the river. Below this three-river confluence, the valley broadens again, gradients become much less, and the river takes on a braided pattern with multiple channels, islands, and a well-developed floodplain. Although the Susitna and Chulitna rivers contribute approximately the same proportion of flow to the lower basin (respectively, 43% and 39% of the mean annual flow at Susitna Station), sediment yield from the Chulitna River has been estimated to be 15 times greater than from the Susitna River (Bredthauer and Drage, 1982). This difference can be attributed to the proximity of the three-river confluence to the glaciers in the Chulitna drainage and to the relatively high sediment-trap efficiency of the upper Susitna Basin.

Six distinct types of aquatic habitat can be identified that are important to salmon in the Susitna River (Fig. 3-4). Physical conditions in these habitat types are often related to mainstem flow. For example, side sloughs undergo three hydraulic regimes as main-channel flow changes. The first regime occurs while flows are high enough to overtop berms at the sloughs' upper ends; here the sloughs act as side channels directly linked to the mainstem. When mainstem flow drops below the point where the upstream berms are overtopped, water levels in the side sloughs are determined by the backwater effect of the mainstem at the sloughs' downstream ends. At very low flows in the mainstem, water levels in the mainstem fall to the point were no water backs up into the mouths of the side sloughs. During this low-flow condition, the sloughs are entirely dependent on groundwater upwelling and surface runoff.

The Susitna River is typical of northern, glacially fed rivers with high flows in late spring and summer and low flows in the winter. Maximum discharge generally occurs during June, July, and August (Fig. 3-5). Early floods (May and June) are more severe and are generated primarily by snowmelt and ice breakup. Later floods (August and September) caused by rainfall are usually less severe. Low flows occur throughout the winter and early spring (November-April) while ice cover persists. The variation between mean monthly summer and winter flows exceeds 10:1. The upper basin contributes by far the greatest proportion of streamflows to the lower reaches of the Susitna River; annual water yield from the Upper Basin is 3.1 cubic feet per second per square mile (cfs/mi^2) [D.23 cubic meters per second per square kilometer ($m^3/s \cdot km^2$)], while the yield from the middle basin is only 1.2 cfs/mi^2 (0.09 $m^3/s \cdot km^2$). The mean annual streamflows at the Watana and Devil Canyon dam sites have been estimated at 7,986 cfs and 9,084 cfs (257 and 266 m^3/s), respectively (Exhibit E, Vol. 5A, Chap. 2, Table E.2.4).

The longest historical flow records within the basin (1949 to the present) come from the U.S. Geological Survey (USGS) gaging station at Gold Creek (RM 137). This station will be used as a point of reference for evaluating the effects of flow regulation in Section 4. At Gold

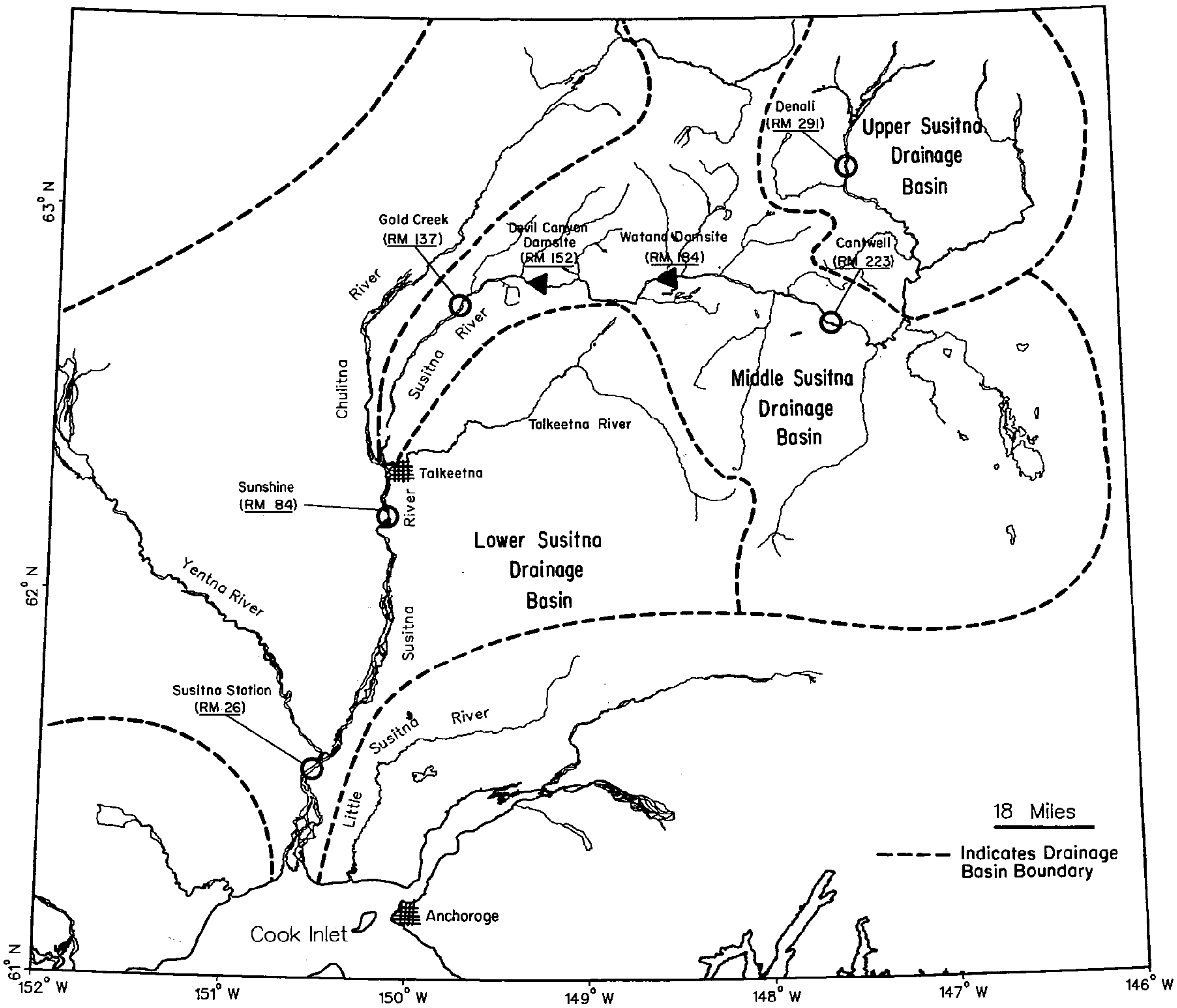


Figure 3-3. Map of the Susitna River Drainage Basin Showing the Locations of U.S. Geological Survey Gaging Stations.

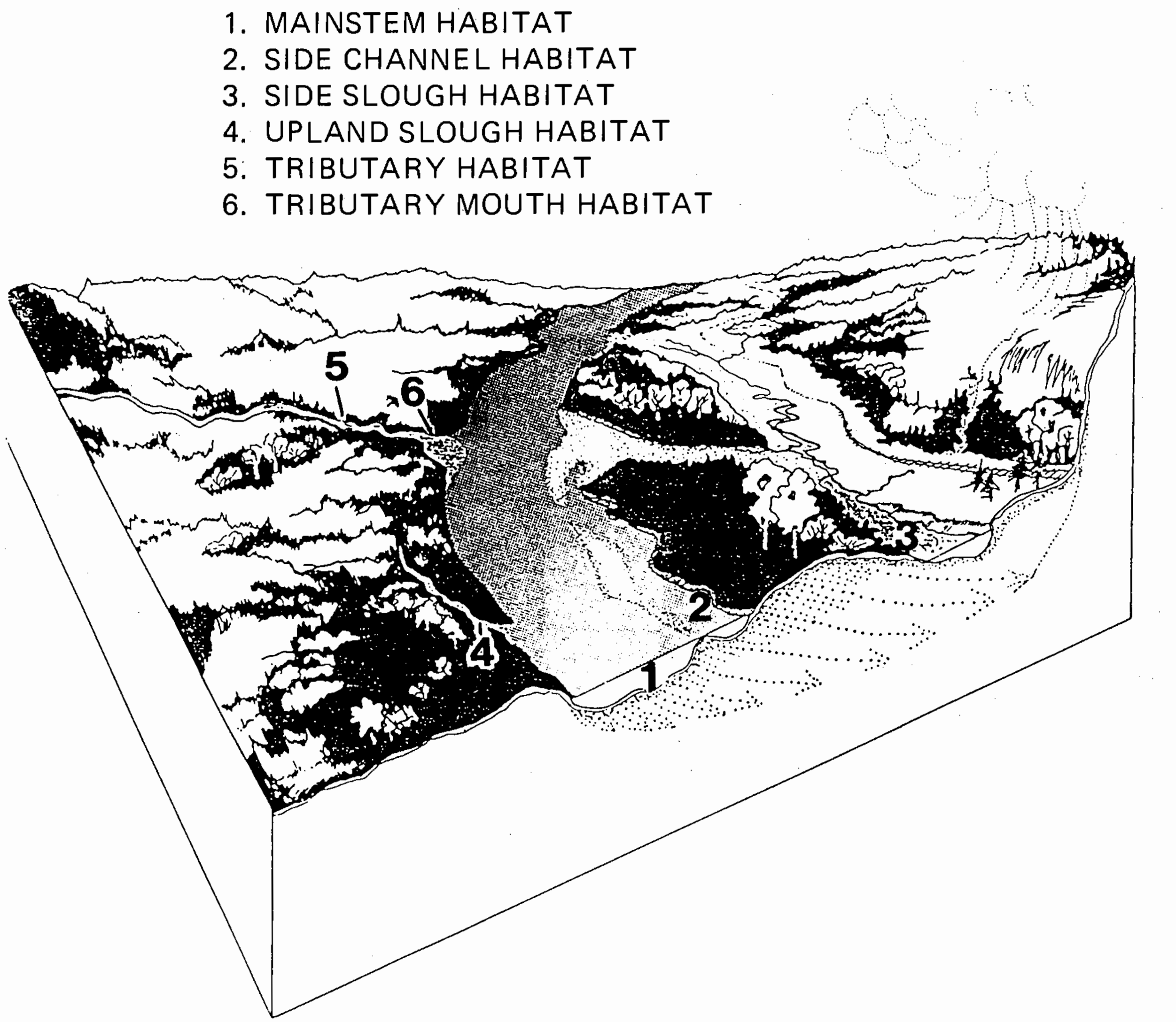


Figure 3-4. Generalized Aquatic Habitat Types Important to Salmon in the Susitna River. [Source: Alaska Dept. of Fish and Game, 1983]

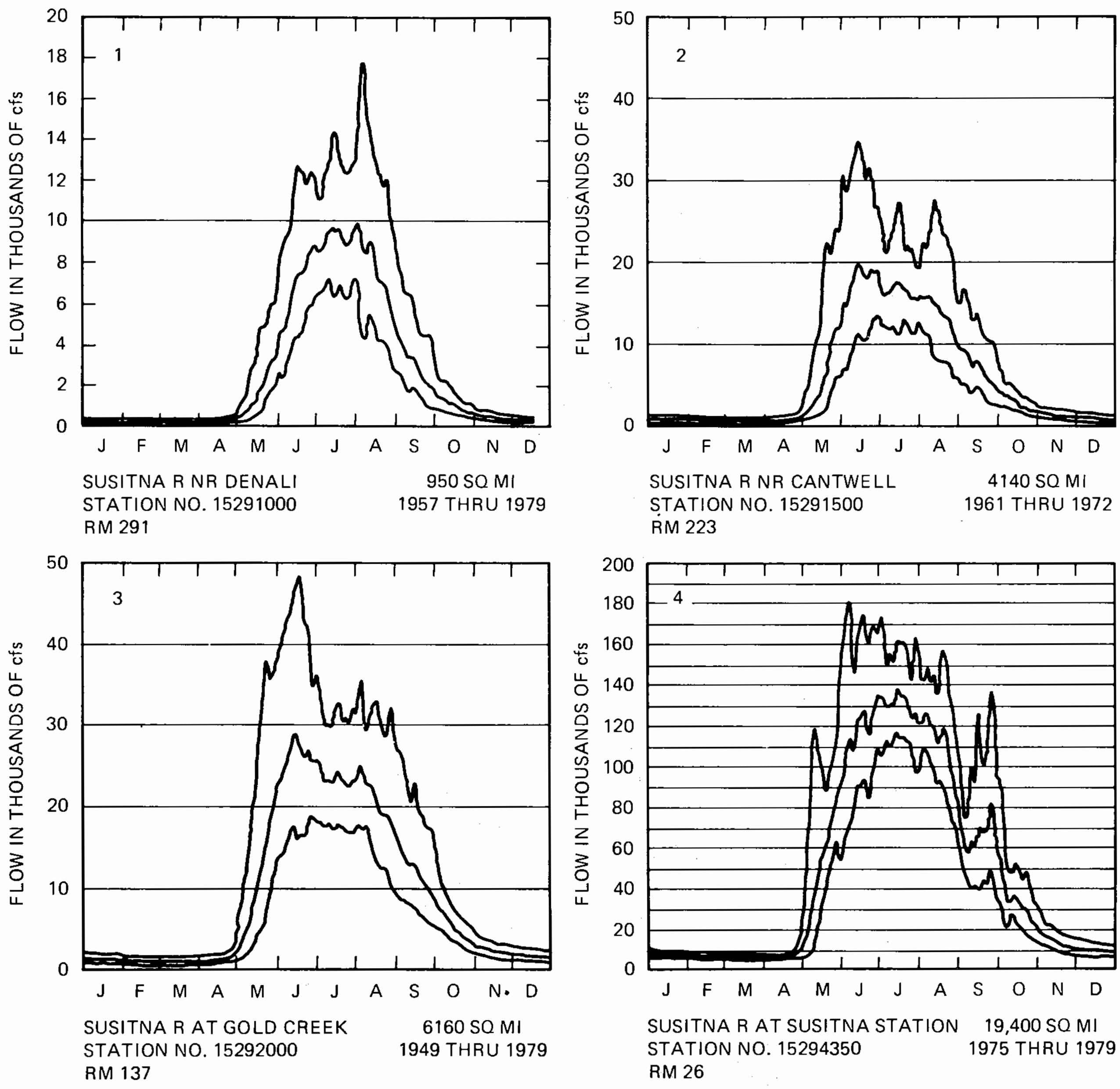


Figure 3-5. Annual Hydrographs for Mean Daily Flows and Estimated 10% and 90% Daily Exceedence Flows at Four USGS Gaging Stations on the Susitna River. [Source: Modified from Chapman, 1982]

Creek, 88% of the mean annual streamflow occurs between May and September. The minimum and maximum monthly flows observed at Gold Creek both occurred in 1964 (Exhibit E, Vol. 5A, Chap. 2, Table E.2.8): 713 cfs (20 m^3/s) in March and 50,580 cfs (1,432 m^3/s) three months later in June. The dominant or bankfull discharge (annual flood with a recurrence interval of 1.5 years) is approximately 40,000 cfs (1,133 m^3/s) (Exhibit E, Vol. 5A, Chap. 2, Table E.2.29). The maximum instantaneous peak flow at Gold Creek was 90,700 cfs (2,570 m^3/s) on June 7, 1964 (Exhibit E, Vol. 5A, Chap. 2, Table E.2.11).

Existing uses of water resources within the Susitna River Basin include domestic and municipal water supply, placer mining, navigation, fisheries, waste assimilation, recreation, riparian habitat, and freshwater recruitment to the Cook Inlet Estuary. Because of the undeveloped nature of the basin, existing downstream water rights that might be affected by the proposed project are relatively insignificant (Dwight, 1981). The most significant water uses that might conflict with dam operation are instream uses for maintaining aquatic and riparian habitat and for navigation or other forms of transportation. Sloughs, tributaries, side-channels, and the mainstem of the Susitna River provide important habitats for salmon spawning, egg incubation, rearing of sub-adults (see Sec. 4 for more details). Commercial navigation (i.e., barge and tow traffic) does not occur on the Susitna River (Trihey, 1982). Recent studies of the recreational access to the Susitna River have indicated that recreational traffic on the river is increasing at a high annual rate (Dwight, 1981). Major boat landings are located at Talkeetna (RM 97), Sunshine Bridge at the Parks Highway (RM 84), Kashwitna Landing (RM 61), and Willow Creek (RM 49). When frozen, the river also provides an important access corridor for ground transportation (e.g., snowmobiles and dogsleds).

Ice is formed first in the upper reaches of the Susitna River as a result of subfreezing air temperature and near 32°F (0°C) water temperatures. This initial phase of ice formation occurs in late October or early November. No ice is formed in the lower reaches of the river since air temperatures are still above freezing at this time. This frazil ice, formed upstream, flows downstream, creating ice jams at natural lodgement points such as areas with boulders, logs, or small islands. As downstream air and water temperatures diminish, ice begins to form along the river banks until ice cover closure occurs. With the ice supplied by upstream reaches, ice cover thickens and progresses upstream to Devil Canyon (RM 152). This progression occurs over a three- to five-week period. During ice front progression, upstream water levels may increase by 2 to 4 ft (0.6 to 1.2 m). Tributaries contribute only a small fraction of the total ice in the Susitna River; 70% to 80% of the ice in the lower Susitna River originates in the Susitna rather than in tributaries. By the time of ice breakup, ice thickness on the Susitna River averages 4 ft (1.2 m). Thicknesses in excess of 10 ft (3 m) have been observed near Vee Canyon.

As air temperatures rise during the spring, the ice cover weakens. The increased runoff due to melting of the snowpack and rainfall causes an increased river discharge. This greater river flow provides the necessary force to initiate ice movement and breakup. First ice movement begins about the first of May, with the mainstem being generally ice free within a week following ice movement. Ice on river banks and backwater areas will decay in place and remain for about two weeks after the mainstem becomes ice free. The precise timing and duration of the breakup process varies slightly from year to year as a function of spring climatic conditions and the extent of upland snow cover. Breakup is a violent process characterized by flooding and extensive erosion of the river banks.

3.1.3.2 Surface Water Quality

Except where indicated, the baseline description of surface water quality in the Susitna River presented below is based on data provided in Exhibit E (Vol. 5A, Chap. 2, Secs. 2.3 and 2.6) and on reports by the Alaska Department of Fish and Game (1983). Water quality for the smaller tributaries of the Susitna River, including those along the proposed access routes and transmission corridors, would not be expected to differ substantially from that of the mainstem Susitna River in terms of most water quality parameters. The major difference in water quality is likely to be suspended solids, with tributary streams draining watersheds without glacial sediment sources having a lower concentration during peak flow (spring-summer) periods than the mainstem Susitna. The following description of water quality thus focuses on the mainstem Susitna River, emphasizing those water quality parameters that could be affected by construction and operation of the Susitna project. The baseline salinity of water in Cook Inlet is also described because of the influence of freshwater inputs from the Susitna River on salinity in the upper Cook Inlet.

Concentrations of suspended (particulate) and dissolved constituents in the Susitna River are within the range characteristic of natural waters, including other glacially fed subarctic rivers in Southcentral Alaska (U.S. Geological Survey, 1979). Although the concentration of some constituents in the Susitna River, including aluminum, cadmium, copper, manganese, mercury, zinc, and total dissolved gases, occasionally exceed water quality statutes (Exhibit E, Vol. 5A, Chap. 2, Table E.2.17) or guidelines for the protection of aquatic organisms, these concentrations are most likely the result either of natural processes or of sample contamination caused by incomplete separation of the soluble and particulate materials in water prior to analysis.

Water quality of the Susitna River is typical of northern, glacially fed rivers, undergoing seasonal variations as a result of glacial melt, snowmelt, and rainfall, all of which tend to dilute soluble nutrients derived from bedrock and soil weathering, while increasing the concentration of nutrients in particulate phases, particularly those derived from glacial scouring. Susitna River water is of the calcium bicarbonate type, with calcium (Ca^{++}) being the major cation and bicarbonate (HCO_3^-) the major anion in solution. The concentration of these two ions range annually from approximately 10 to 50 parts per million (ppm) (mg/L) and 17 to 160 ppm (mg/L), respectively (Exhibit E, Vol. 5A, Chap. 2). Concentrations of both ions tend to decrease downstream due to dilution from inflowing tributaries that drain watersheds with a geology different from that in the upper Susitna drainage (Fig. 3-6).

Concentrations of the other major nutrient ions in the Susitna River essential for algal production are typical of streams draining similar geologic terrain in Southcentral Alaska. Nitrate nitrogen (NO_3-N) occurs in moderate concentrations, averaging less than 300 parts per billion (ppb) (µg/L) at all gaging stations on the river (Exhibit E, Vol. 5A, Chap. 2). Levels of ammonia nitrogen (NH_4-N) appear to be less than those for NO_3-N, averaging less than 100 ppb (µg/L) at Gold Creek (Exhibit E, Vol. 5A, Chap. 2). Dissolved organic nitrogen levels are comparable to those for nitrate, ranging from 150 to 340 ppb (µg/L) at Gold Creek.

Concentrations of soluble reactive phosphorus, reported as orthophosphorus (Exhibit E, Vol. 5A, Chap. 2), are low at all gaging stations on the Susitna River, averaging less than 50 ppb (Alaska Dept. of Fish and Game, 1983). Levels of total phosphorus, which includes soluble plus particulate P, are generally less than 100 ppb at all gaging stations, except during the high-flow period in summer, when particulate phosphorus concentrations are at their annual maximum. Silica (reported as SiO_2) concentrations in the Susitna River are within the range reported for most surface waters, ranging from 6 to 13 ppm at Gold Creek (Exhibit E, Vol. 5A, Chap. 2).

Dissolved oxygen concentrations generally remain high at all gaging stations on the Susitna River. Winter values average 11.6 to 13.0 ppm (mg/L), while summer concentrations average between 11.5 and 12.0 ppm (Fig. 3-7). During the summer, oxygen levels are at or near saturation at all gaging stations. Although saturation levels of dissolved oxygen decline during the low-flow period in winter, average saturation levels do not fall below 80% at any of the gaging stations. Thus, the severe winter dissolved oxygen depressions observed in some arctic and subarctic streams and rivers in Alaska (Schallock and Lotspeich, 1974) have not been observed in the Susitna River.

Total dissolved gas (nitrogen) concentrations have been monitored in the Devil Canyon, where extremely turbulent flow from standing waves results in air entrainment, causing nitrogen supersaturation. Above Devil Canyon, total dissolved gas is approximately 100% of saturation. Levels of dissolved gas immediately upstream and downstream of the proposed Devil Canyon dam site range from 105% to 117%, with the level of saturation generally increasing with increasing discharge (Fig. 3-8). Alaska water quality statutes (Alaska Dept. of Environmental Conservation, 1979) allow a maximum total dissolved gas concentration of no greater than 110% of saturation. This statute is thus exceeded naturally in Devil Canyon during high flows.

Dissolved and suspended solids in the Susitna River exhibit a contrasting seasonal pattern in concentration, with total dissolved solids (TDS) at a maximum during the low-flow period in winter when the concentration of suspended solids and turbidity are at an annual minimum (Fig. 3-9). Most of the suspended solids in Susitna River water consist of glacial flour produced by glacial scouring. Concentrations of both dissolved and suspended solids tend to decrease downstream due to both dilution from inflowing, clearwater tributaries and settling of suspended solids from the water.

Suspended solids increase with spring breakup from a winter value of 10 ppm (mg/L) to a summer maximum value in excess of 1,000 ppm (Exhibit E, Vol. 5A, Chap. 2). Concentrations of suspended solids in excess of 5,000 ppm have been measured at Denali during periods of peak flow. Particle size analysis of suspended solids indicates that the median size of suspended solids is generally less than 0.002 inch (in) [50 micrometers (µm)] (Exhibit E, Vol. 5A, Chap. 2).

The Susitna River is typically clear during winter months, with turbidity values at or near zero [as measured in Nephelometric Turbidity Units (NTU)]. When snowmelt and breakup commences in the spring, turbidity increases, reaching a maximum in the summer when inputs of suspended solids from glacial scouring are at their annual maximum. As would be expected, turbidity exhibits a longitudinal trend identical to that of suspended solids, decreasing downstream due both to settling of suspended solids from the water column and to dilution of the Susitna River water from inflow of clear-water tributaries.

The Susitna River is a major contributor of fresh water to Cook Inlet, with the measured flow at Gold Creek accounting for approximately 19% of the measured flow at Susitna Station near Cook Inlet (Exhibit E, Vol. 5A, Chap. 2). As such, the Susitna River has a major influence on the salinity in the upper Cook Inlet. At Node 27 near the Susitna River mouth, salinity ranges annually from approximately 6 parts per thousand (ppt) (g/L) to 21 ppt. As one proceeds down

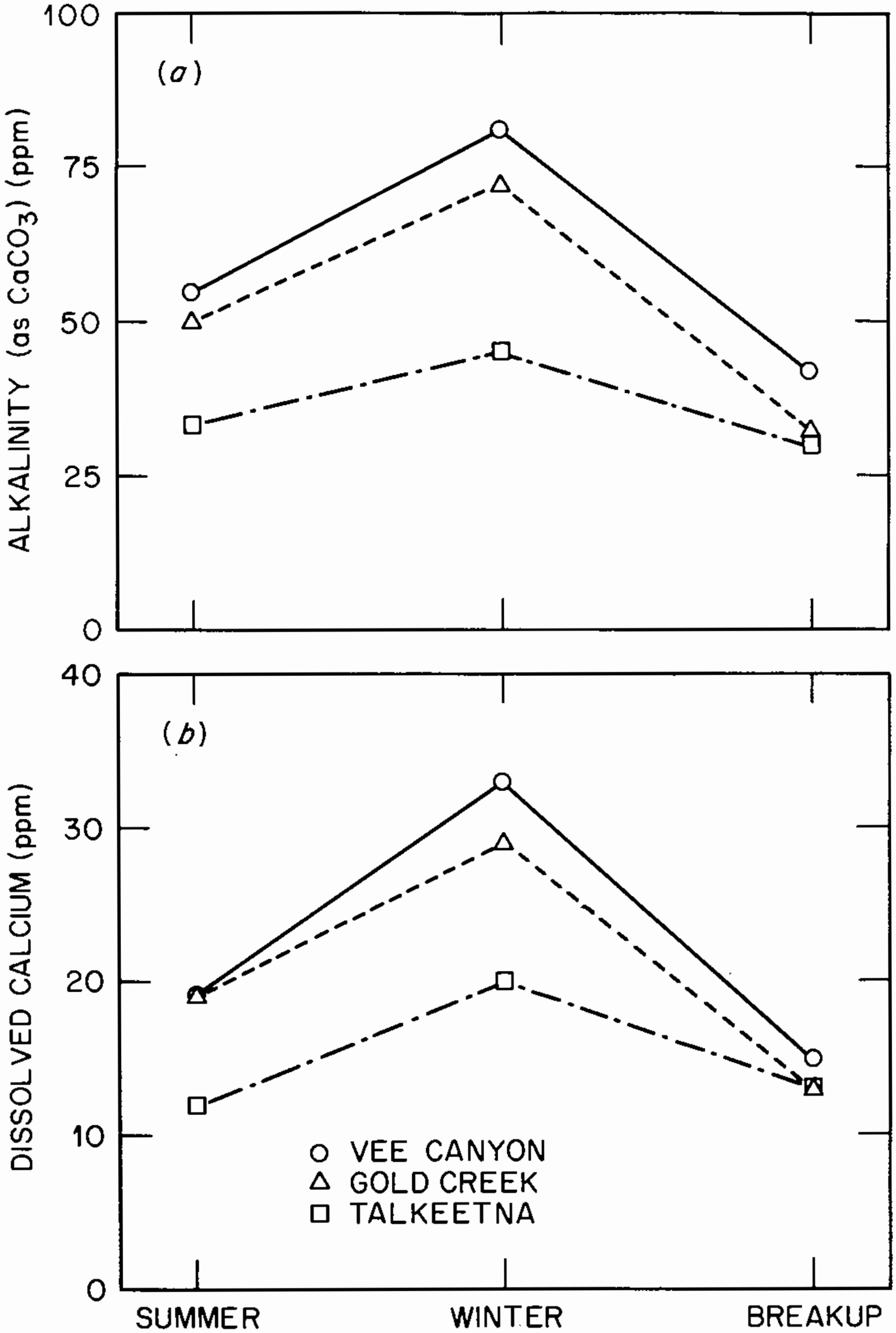


Figure 3-6. Seasonal Patterns in the (a) Mean Alkalinity (expressed as $CaCO_3$) and (b) Mean Calcium (Ca^{++}) Concentrations in Solution in the Susitna River at Vee Canyon, Gold Creek, and Talkeetna. [Source: R&M Consultants, 1981, 1982]

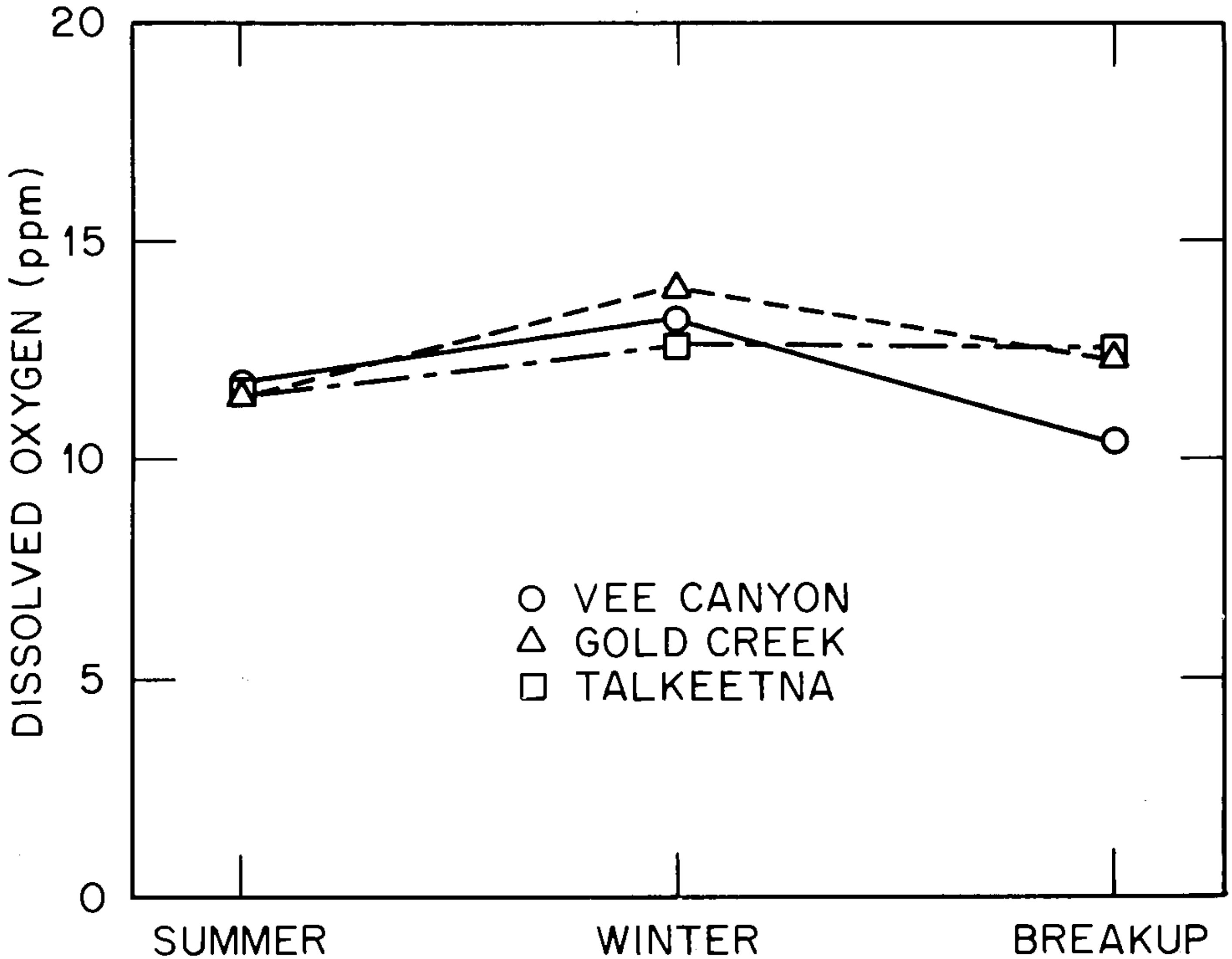


Figure 3-7. Seasonal Patterns in the Mean Dissolved Oxygen Concentrations in the Susitna River at Vee Canyon, Gold Creek, and Talkeetna. [Source: R&M Consultants, 1981, 1982]

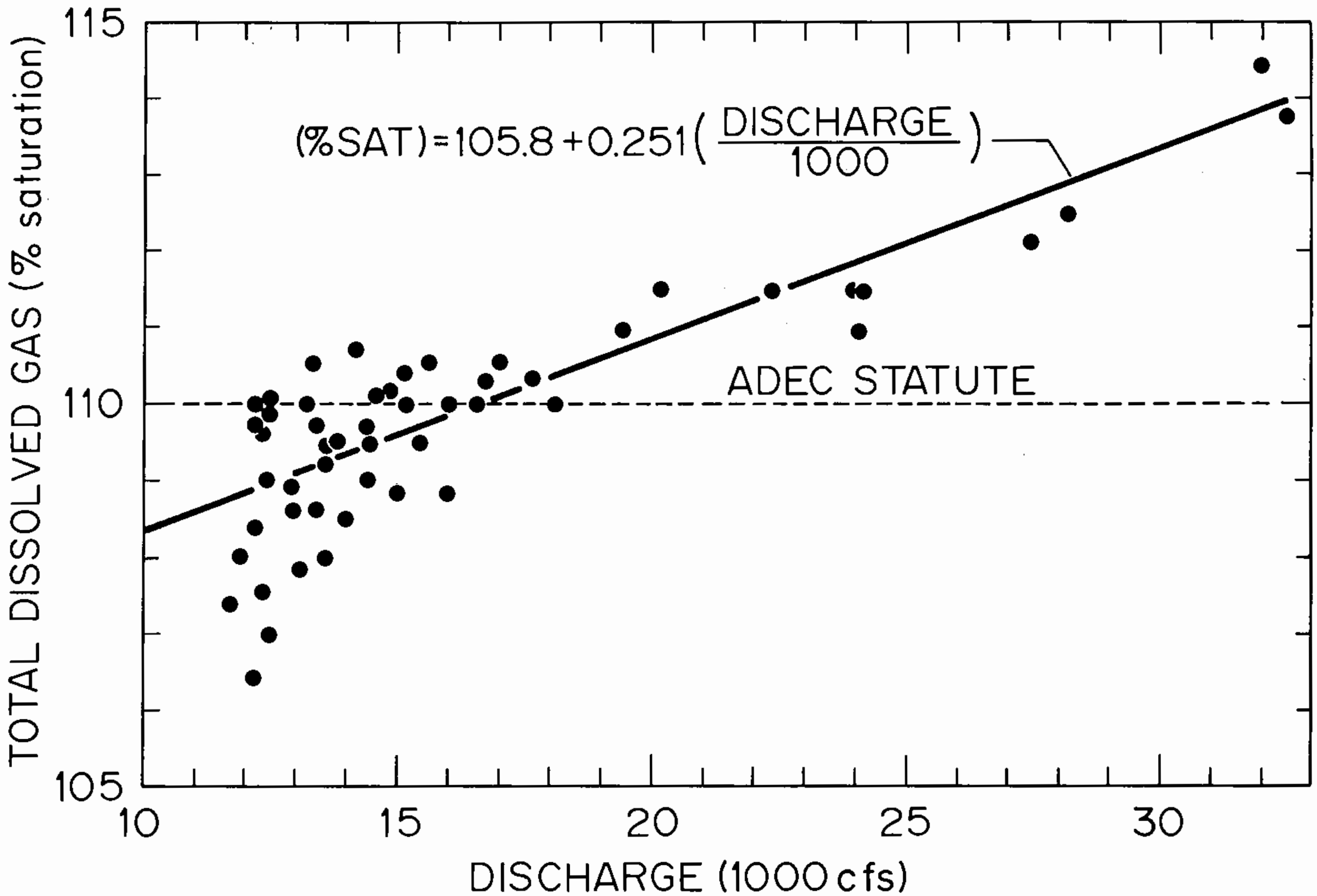


Figure 3-8. Relationship in the Susitna River at Devil Canyon Between Total Dissolved Gas (nitrogen), Expressed as Percent Saturation, and Discharge. (Also shown is the Alaska water quality statute for dissolved gas, demonstrating that under some natural flow conditions, the statute is exceeded in Devil Canyon. [Source: Application Exhibit E, Vol. 5A, Chap. 2]

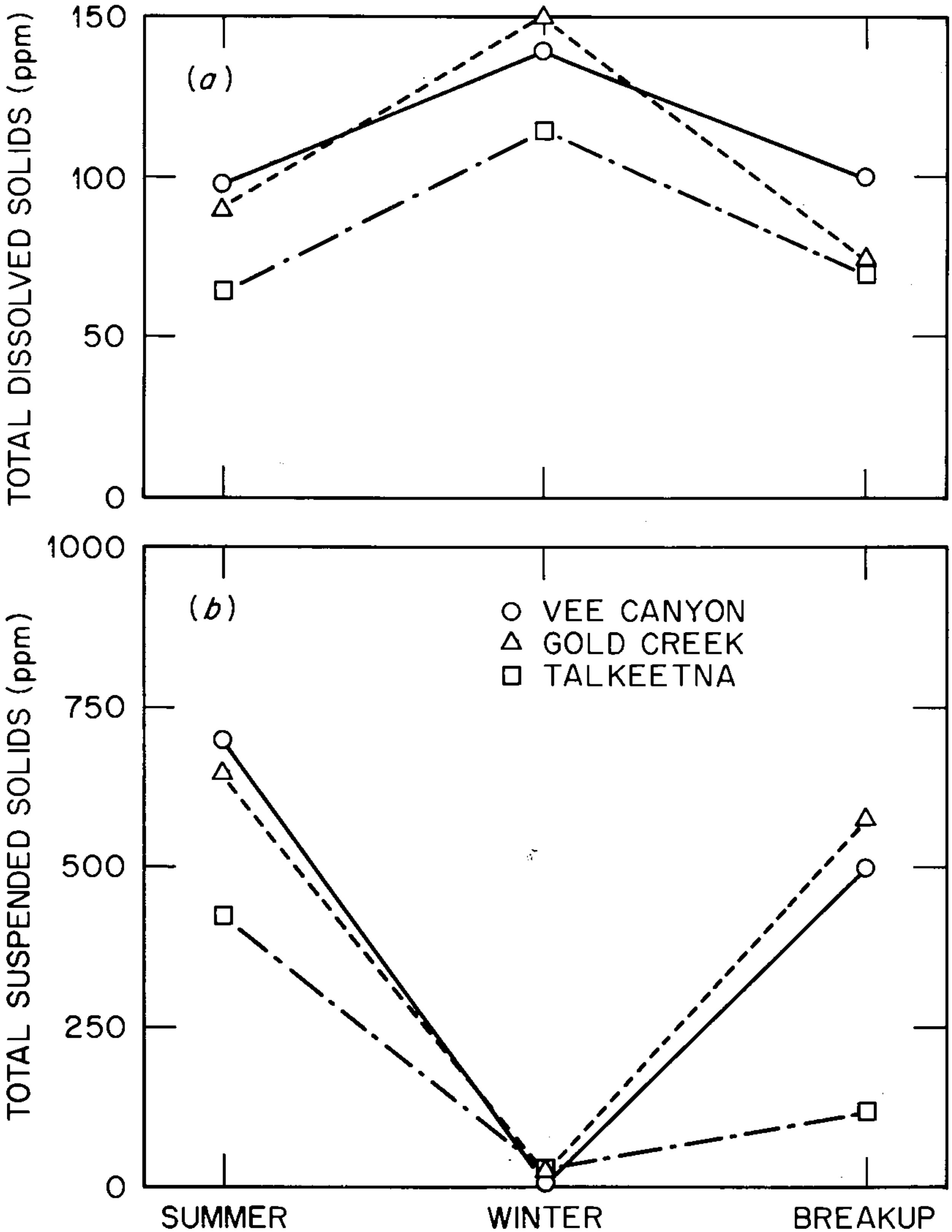


Figure 3-9. Seasonal Patterns in the Mean Concentrations of (a) Dissolved Solids and (b) Suspended Solids in the Susitna River at Vee Canyon, Gold Creek, and Talkeetna. [Source: R&M Consultants, 1981, 1982]

Cook Inlet toward the Gulf of Alaska, the salinity increases, approaching that of seawater, and the annual variation in salinity decreases, due to the declining influence of freshwater inputs to Cook Inlet.

During the winter, Susitna River mainstem water temperatures are approximately 32°F (0°C). Locally areas of warmer water, about 36°F (2°C) may occur in regions of groundwater discharge.

During the summer, upstream water temperatures (above Denali) will remain near 32°F (0°C) as a result of glacial melt. Mainstem water temperatures will progressively warm with both time and downstream distance as a result of solar heating. For example, during July 1980, a downstream gradient of approximately 0.16°F per mile (0.06°C per km) was observed between Denali (RM 291) and Vee Canyon (RM 244). During the same time, the downstream temperature gradient between Vee Canyon and Susitna (RM 26) was observed to be approximately 0.015°F per mile (0.005°C per km). Maximum recorded water temperatures at the Watana dam site (RM 184), Gold Creek (RM 137), and the Susitna Station (RM 26) are 57.2°F (14°C), 59°F (15°C), and 61.7°F (16.5°C), respectively. In August, Susitna River water begins to cool, reaching a minimum of about 32°F (0°C) between late September and October.

During the summer months, the mainstem of the Susitna River shows little diurnal temperature variations (less than 4°F, or 2°C) vertical temperature gradients. This is a result of the large volume flux and high flow velocities.

Slough water temperatures may vary significantly from the mainstem water temperatures and exhibit diurnal temperature variations of 18°F (10°C) or more. During the high-flow regime of the spring and summer, when the sloughs are overtopped, slough water temperatures are close to the local mainstem temperature. However, during other times of the year, slough water temperatures may be influenced by solar heating during the day, back radiation at night, and groundwater discharge. There are two components associated with groundwater discharge to the sloughs: (1) mainstem water moving through the coarse gravel between the mainstem and sloughs driven by stage differences, and (2) discharges from alluvial aquifers with recharge sources in the upland areas of the watershed. In order to distinguish between these two subsurface sources, the former will be referred to as mainstem infiltration and the latter as groundwater discharge. Measurements of subsurface water temperatures between the mainstem and sloughs reveal a strong correlation with adjacent mainstem temperatures. Measured slough intergravel temperatures (Alaska Dept. of Fish and Game, 1983) indicate near isothermal conditions in some areas, ranging only from about 35.6°F to 37.4°F (2°C to 3°C), while in other areas intergravel temperatures paralled local surface water temperatures. These data suggest that the relative importance of mainstem infiltration and groundwater discharge varies from slough to slough, as well as varying with location within a given slough.

These factors influencing slough water temperatures result in a thermal structure considerably different than the mainstem. Unlike the mainstem, sloughs demonstrate significant temporal and vertical structure. Short-term surface temperature fluctuations in slough 21 as compared with mainstem temperatures taken at Portage Creek are provided in Figure 3-10. This figure clearly shows the strong diurnal character of slough water temperature. Measurements of vertical thermal structures in sloughs have shown differences between surface and intergravel temperatures of about 9°F (5°C).

During the summer months, tributaries generally exhibit somewhat lower water temperatures than the Susitna River, producing locally lower water temperatures in the Susitna near the areas where these tributaries enter. During the winter, tributary water temperatures are about 32°F (0°C) and warm during summer in the same manner as in the Susitna.

3.1.3.3 Groundwater

Geohydrologic studies of the Susitna River Basin have focused on investigation of the conditions at the proposed Watana and Devil Canyon dam sites. The understanding of the groundwater regime within the projected areas of the reservoirs and downstream of the proposed dams is largely based on photo interpretation and regional geology.

Groundwater is commonly found in unconfined aquifers associated with alluvium or other unconsolidated sediments. The characteristics of these aquifers have been quantified at the dam sites and sloughs 8A and 9. The water table in the unconfined aquifers has been interpreted to be a subdued replica of the surface topography. No significant bedrock aquifers have been identified. However, drilling investigations at the dam sites have located joint and fracture systems within the bedrock which convey water. Artesian conditions have been identified in holes drilled in bedrock at the Watana dam site.

Perched aquifers are commonly found in the upper Susitna Basin overlying permafrost formations. Permafrost is abundant in the upper Susitna Basin, with a thickness of up to 300 ft (100 m), and commonly occurs as discontinuous formations on the southern side of the river channel. The permafrost, which has a temperature of approximately 30°F (-1°C), tends to reduce the permeability of the soil and the apparent availability of groundwater.

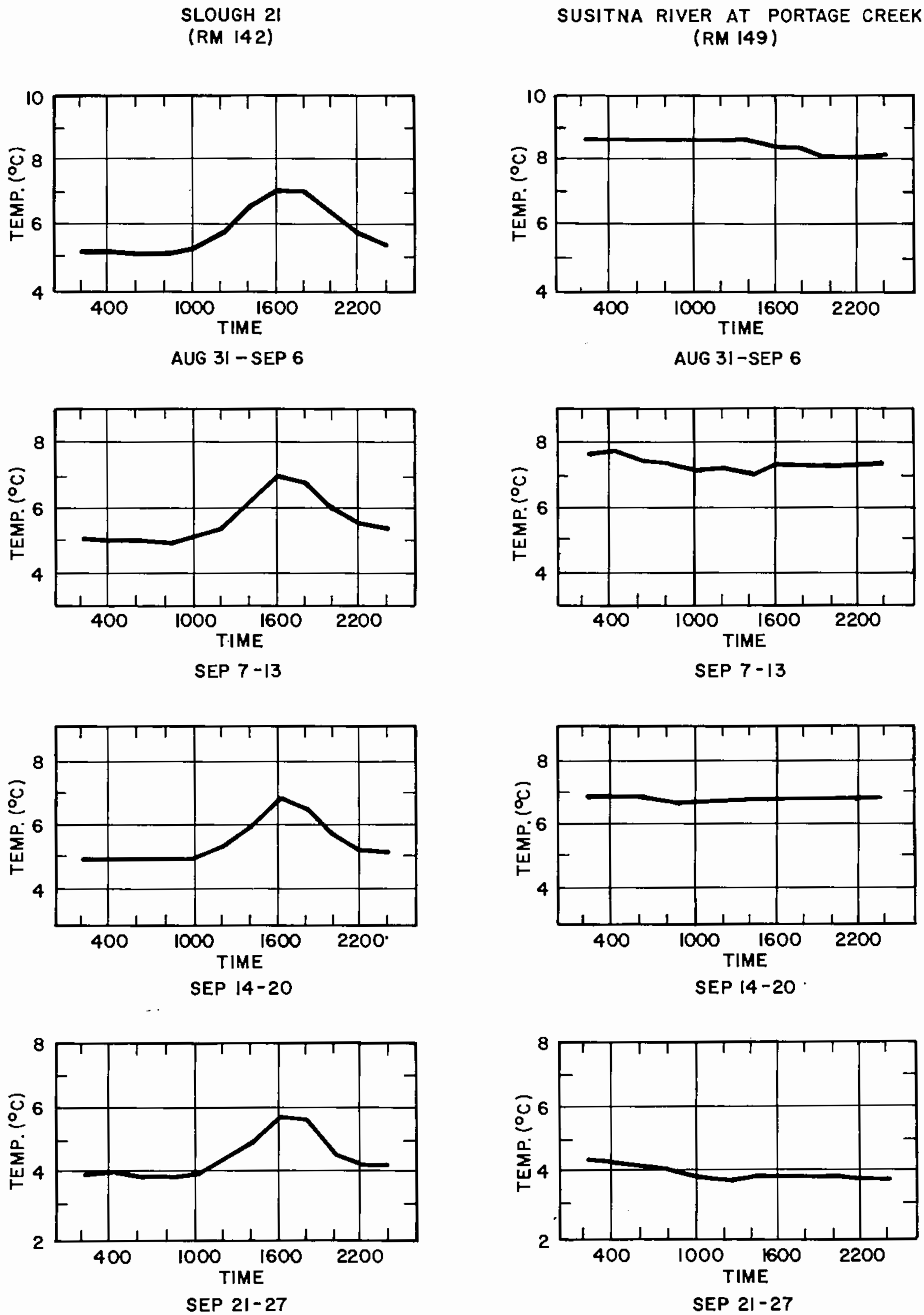


Figure 3-10. Comparison of Averaged Diurnal Temperature Fluctuations in the Mainstem and Slough 21 During September 1981. [Source: Application Exhibit E, Vol. 5B, Chap. 2, Fig. E.2.73]

The groundwater regime is recharged by snowmelt, glacial runoff, and precipitation. Discharges of groundwater to surface water typically occur in the valley bottoms and alluvial fans. Springs or artesian flows have not been identified but may exist.

Relict channels of the Susitna River or its ancestors exist in several locations in the upper basin. Two relict channels have been identified in the area near the Watana dam site, and one has been identified near the Devil Canyon dam site. These relict channels could be affected by project completion and are the subject of ongoing investigation.

Downstream of the Devil Canyon site, groundwater discharges to the sloughs throughout the year. The quantity of groundwater discharged to the sloughs and the description of the effect of groundwater discharges on the hydrology of sloughs 8A and 9 is being investigated.

3.1.4 Fish Communities

The Susitna River fish communities constitute one of the major exploited (or potentially exploited) resources of the project environs (Appendix I). All five species of Pacific Salmon (pink, Oncorhynchus gorbuscha; chum, O. keta; coho, O. kisutch; sockeye, O. nerka; and chinook, O. tschawytscha) use the Susitna River system for spawning (Figs. 3-11 and 3-12), and they are harvested in commercial, sport, and subsistence fisheries. Other anadromous species also occur (Fig. 3-13), and there is an assemblage of resident fishes that includes valued sports species. Four major zones can be distinguished: (1) the potentially inundated zones above Devil Canyon, (2) the Susitna River between Devil Canyon and the confluence of the Susitna, Talkeetna, and Chulitna rivers, (3) the Susitna downstream of Talkeetna, and (4) tributary and upland areas to be affected by access facilities or transmission lines.

3.1.4.1 Watershed Above Devil Canyon

Upstream of the lower reaches of Devil Canyon (RM 150), the Susitna River fish fauna is composed of year-round resident species (Fig. 3-11). Adult salmon are prevented from passing through the canyon by the steep gradient [31 ft/mi (5.9 m/km)], rapid water flow, and turbulent rapids. Although adult chinook salmon have been documented as far as RM 156.8 in the low-flow year 1982, no other anadromous species has been reported in the impoundment reach.

Seven resident fish species have been reported in the impoundment reach: Arctic grayling (Thymallus arcticus), Dolly Varden (Salvelinus malma), burbot (Lota lota), humpback whitefish (Coregonus pidschian), round whitefish (Prosopium cylindraceum), longnose sucker (Catostomus catostomus), and slimy sculpin (Cottus cognatus) (listed in general decreasing value to fisheries). Few resident fish occupy the turbulent Devil Canyon, whereas significant populations are found in the less severe gradient [13 ft/mi (2.4 m/km)] and multiple channels of the reach from Devil Creek to the approximate upstream limit of impoundment, Oshetna River (RM 233). The reaches near the less turbid tributary mouths are most highly populated, with burbot, round whitefish, and longnose sucker being captured exclusively there. Arctic grayling and Dolly Varden are tributary species that use the mainstem for overwintering and as a migration route among tributary streams, although Dolly Varden may be a more permanent river resident.

Tributaries, such as Oshetna River and Kosina Creek, provide optimal habitat for Arctic grayling. Rainbow trout, Dolly Varden and several species of smaller fishes, principally cottids, also occur there. These tributary streams are characterized by habitats with large numbers of pools, moderate streamflow velocity, and low turbidity. Lakes in the area contain lake and rainbow trout and northern pike.

There is little knowledge about benthic invertebrate fauna or algae or other primary producers of organic matter in the impoundment reach. The benthic aquatic ecosystem almost certainly is fed by detritus from surrounding terrestrial habitats and is limited in the mainstem by high turbidity. Fishing pressure is extremely light due to limited access, although Arctic grayling, Dolly Varden, lake and rainbow trout, and burbot have the potential for valuable sports fisheries.

3.1.4.2 Devil Canyon to Talkeetna

Numerous islands, gravel bars, and sloughs of the relatively stable but often split channel of the Susitna River downstream of Devil Canyon to its confluence with the Chulitna River make this reach especially suitable for salmon migration, spawning, and rearing. The main channel is often bedrock or firm cobble, and glacial silt clogs interstices of most gravel bars; thus, most spawning occurs in the looser gravels of side channels, sloughs, and tributary mouths. These habitat types intergrade with little distinction. Tributaries and sloughs have the clearest water, and thus support the largest numbers of rearing juveniles.

Adult salmon of all five species migrate upstream into this reach of the Susitna River from late spring through early fall (Figs. 3-11 and 3-12), a period that corresponds with high summer runoff. Each species has a somewhat characteristic migration period (Fig. 3-14). Chinook arrive first, migrating from mid-June through July; pink migrate from late July through August;

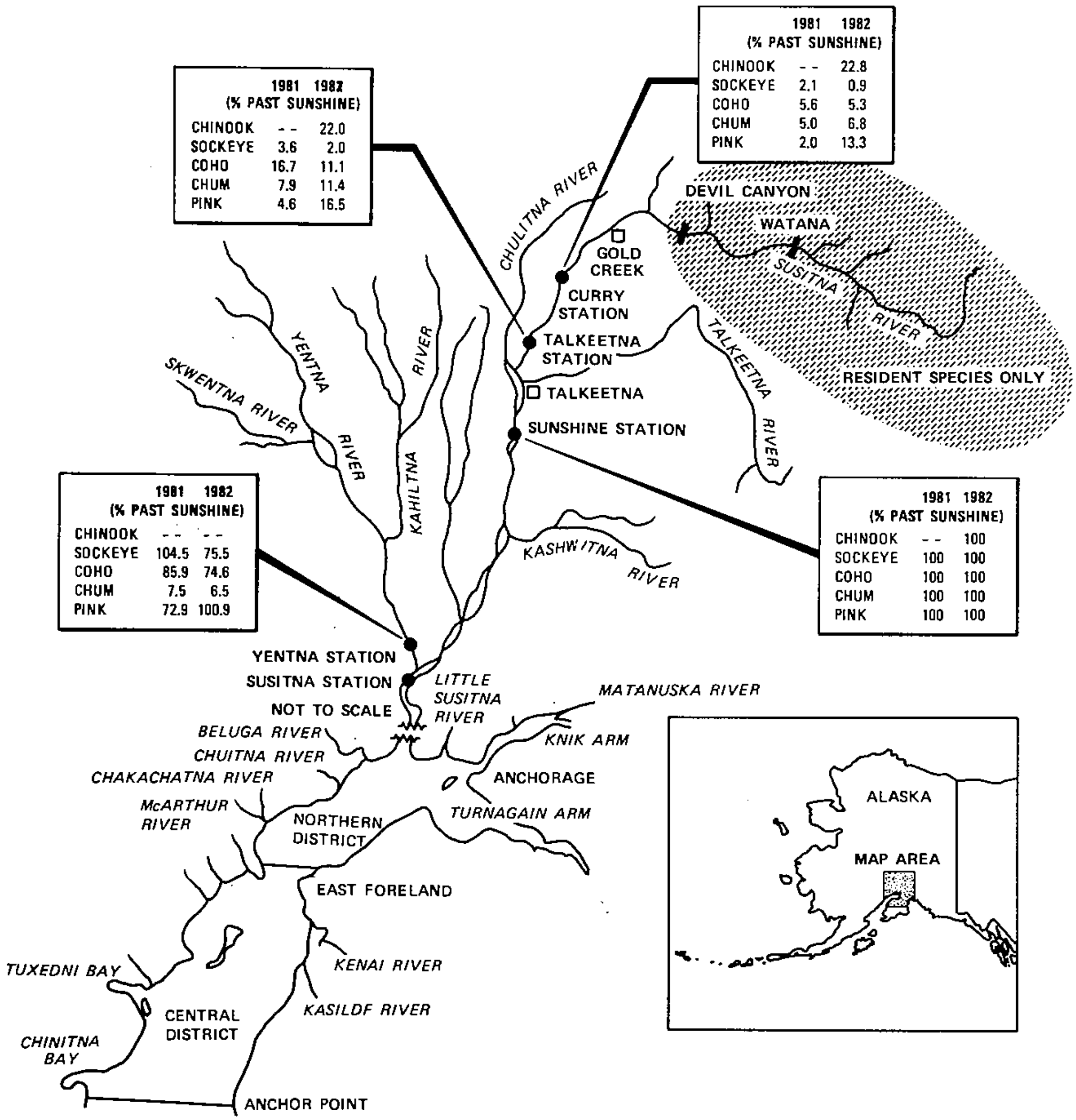
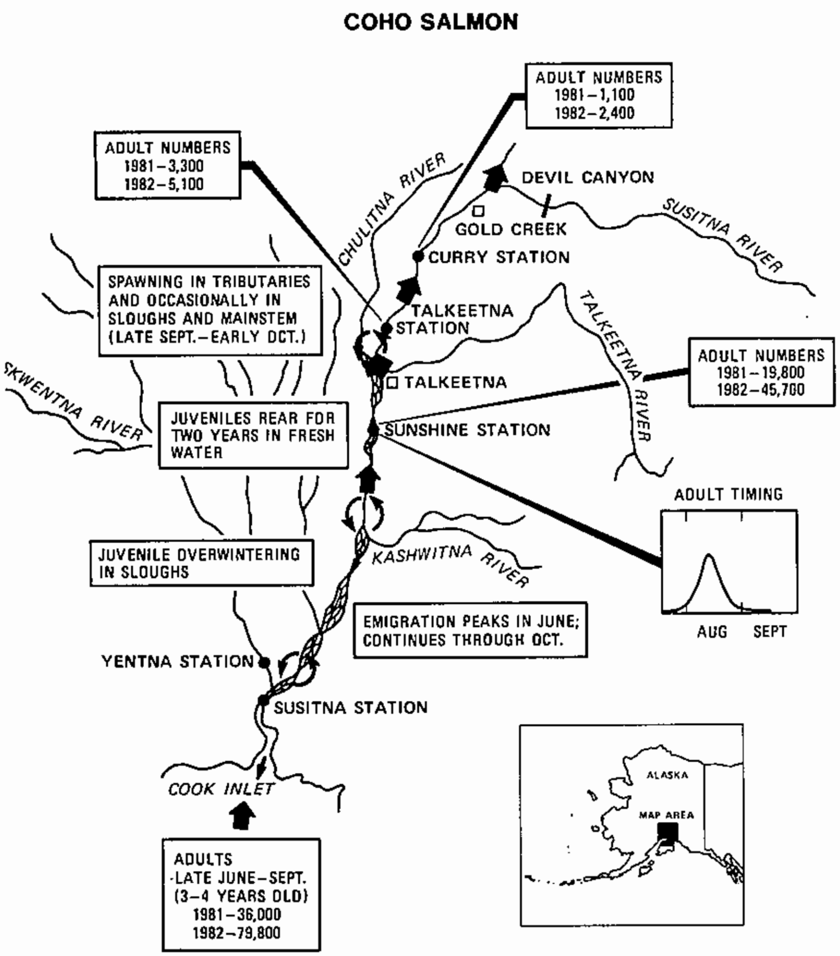
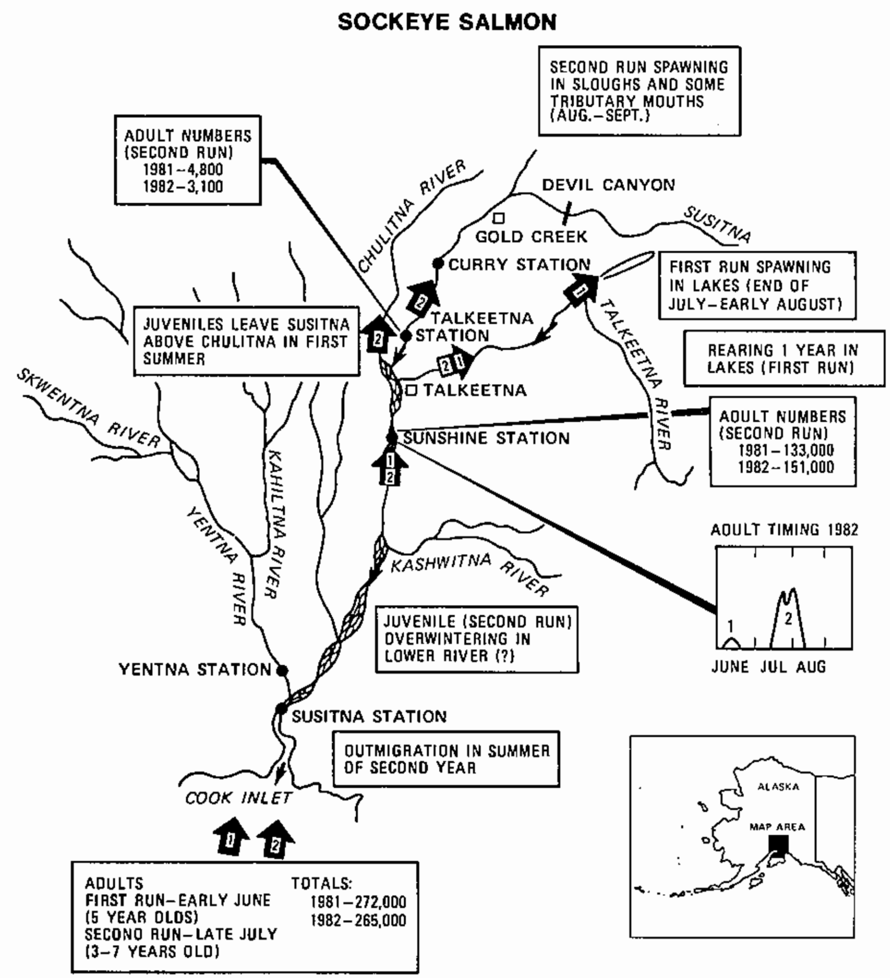


Figure 3-11. Upper Cook Inlet and the Susitna Drainage (not to scale), Showing Percent of Salmon Migrating Past Sunshine Station That Pass Talkeetna and Curry Stations, and the Relative Sizes of Runs Past the Yentna and Sunshine Stations. [Source: Adapted by FERC Staff from Application]



(A)



(B)

Figure 3-12 (A-B). Generalized Life Cycles of Pacific Salmon in the Susitna River Drainage: Coho and Sockeye.

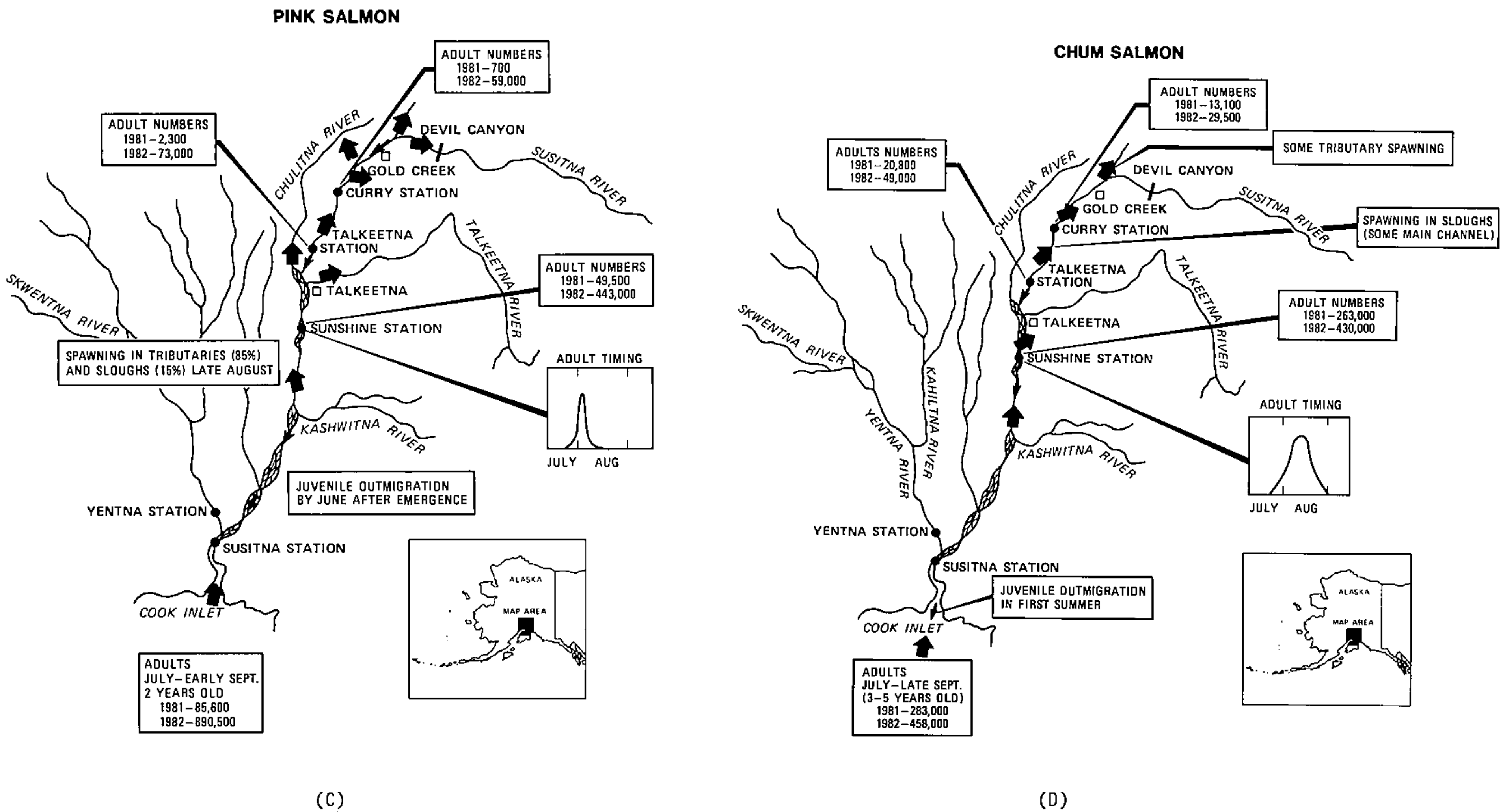
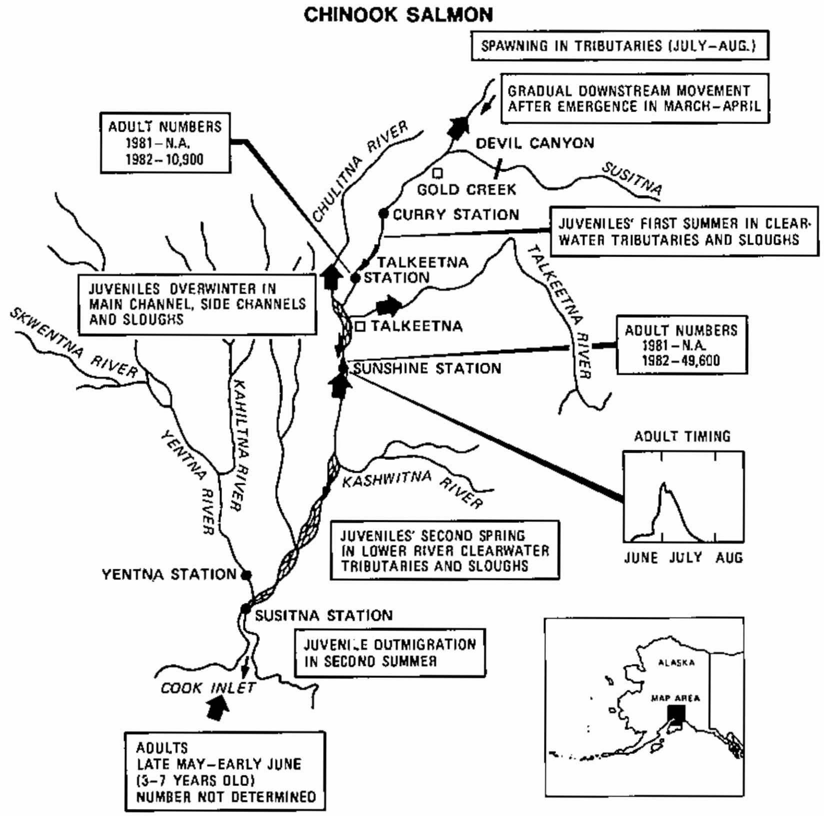
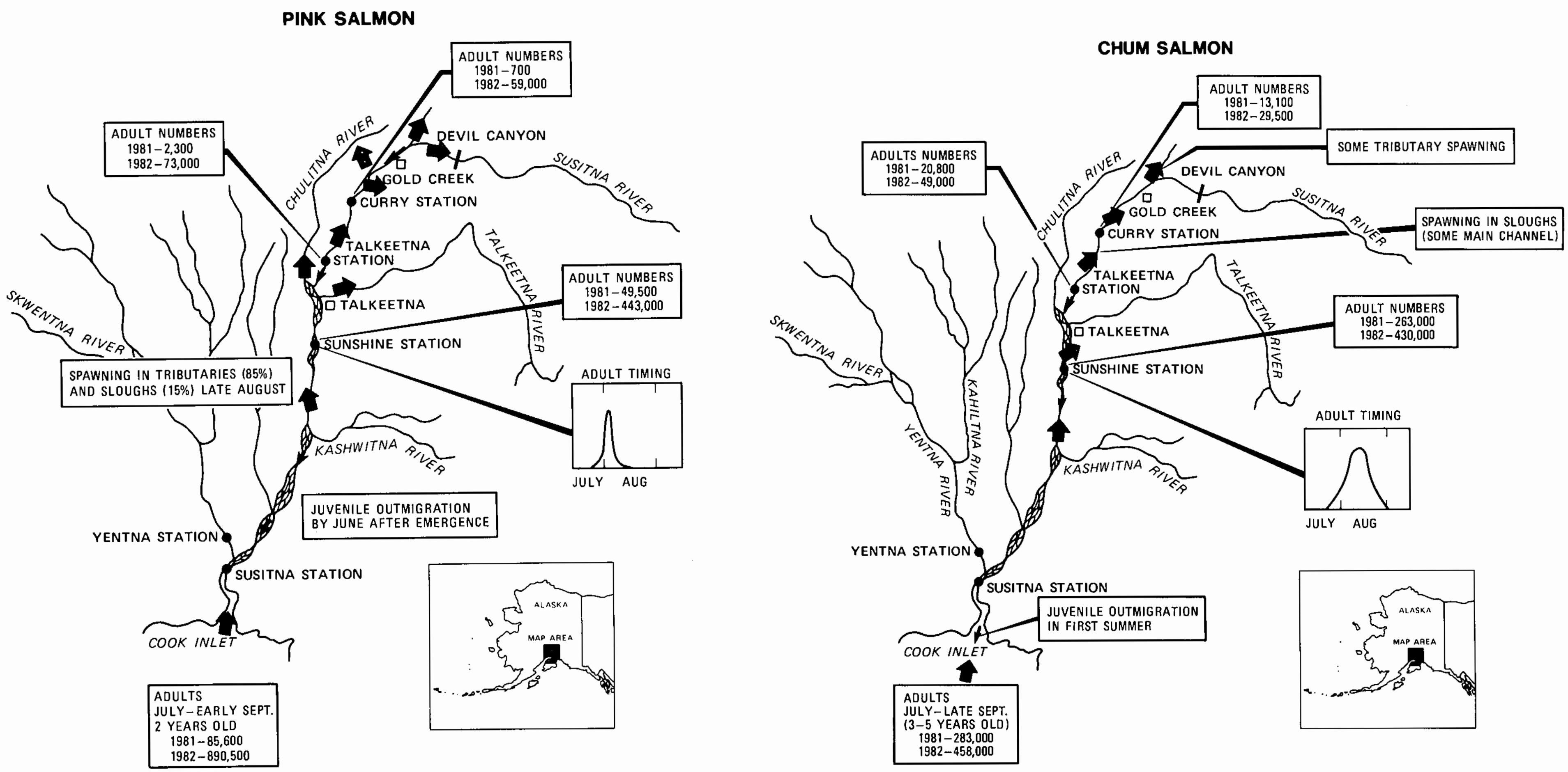


Figure 3-12 (C-D). Generalized Life Cycles of Pacific Salmon in the Susitna River Drainage: Pink and Chum.



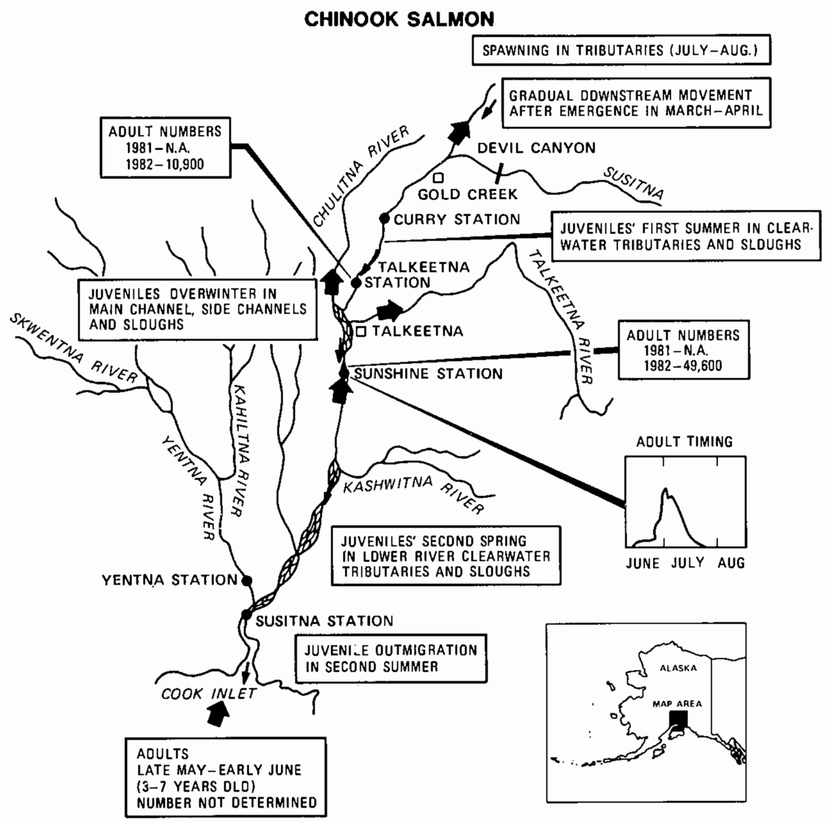
(E)

Figure 3-12 (E). Generalized Life Cycles of Pacific Salmon in the Susitna River Drainage: Chinook.



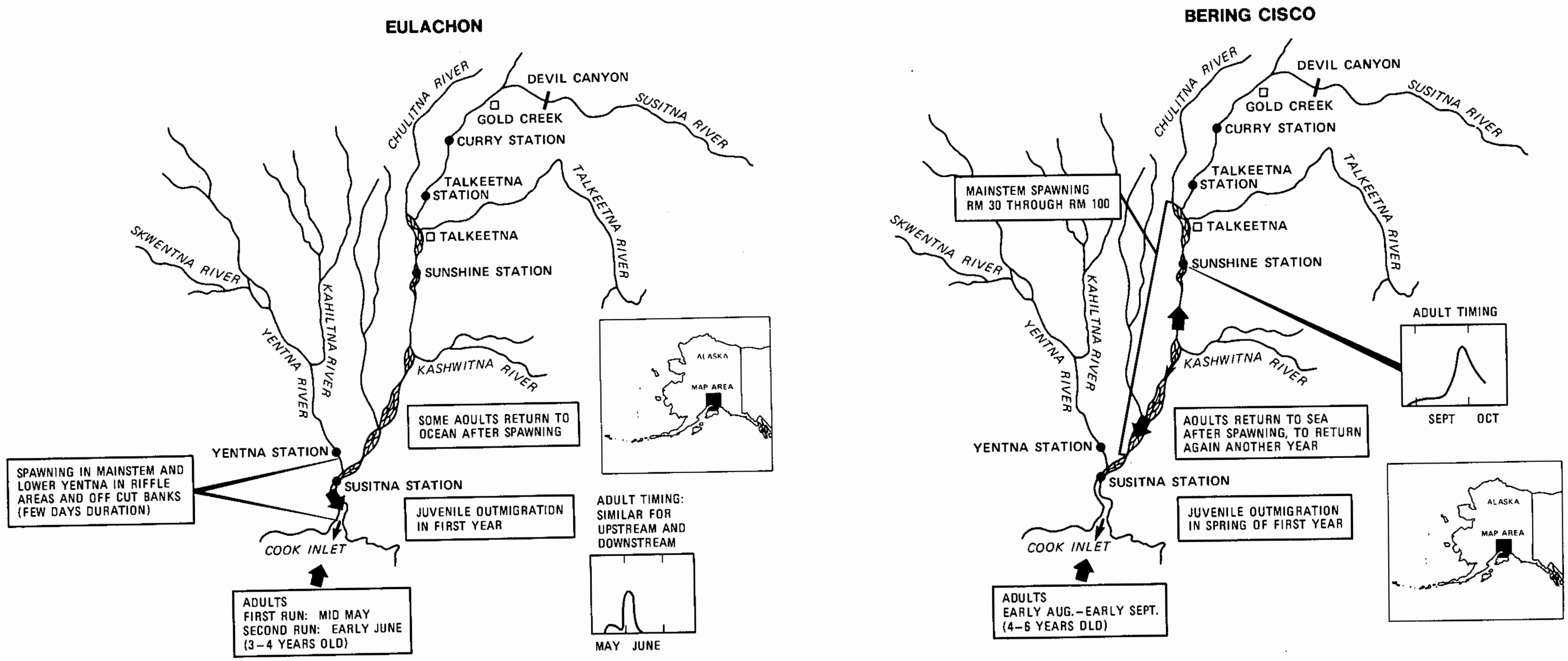
(C) (D)

Figure 3-12 (C-D). Generalized Life Cycles of Pacific Salmon in the Susitna River Drainage: Pink and Chum.



(E)

Figure 3-12 (E). Generalized Life Cycles of Pacific Salmon in the Susitna River Drainage: Chinook.



(A) (B)

Figure 3-13 (A-B). Generalized Life Cycles of Anadromous Eulachon and Bering Cisco in the Susitna River Drainage.

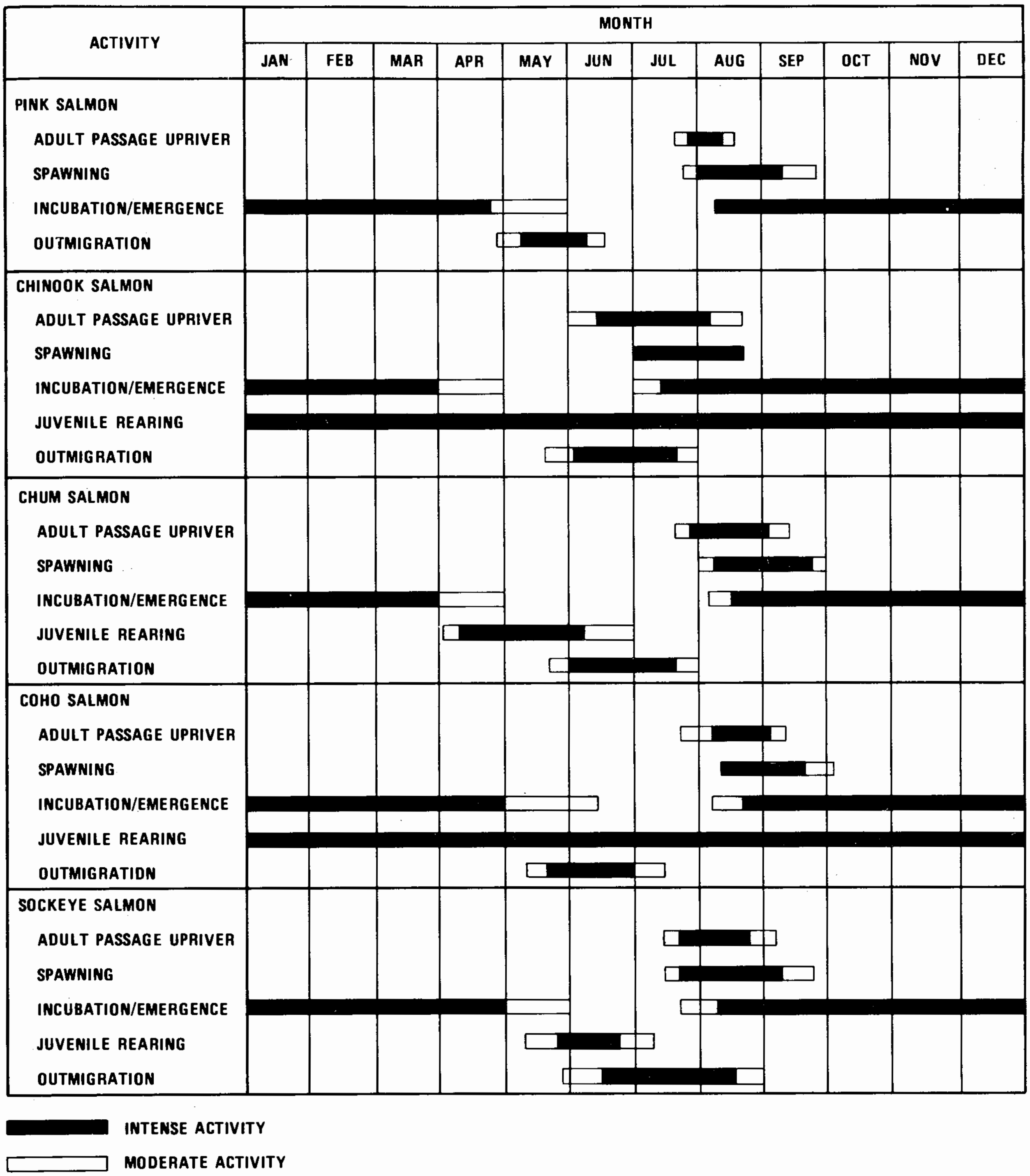


Figure 3-14. Timing of Stages of Salmon in the Susitna River from Talkeetna to Devil Canyon. [Source: Adapted by FERC Staff from Application]

sockeye and chum migrate from late July through mid-September; and coho extend migration from late July through September. Although there is considerable wandering and delay in "staging areas", adult salmon return to natal stream reaches to spawn. Chinook are primarily tributary spawners; the other species (of which chum is most abundant) occupy mostly side channels, sloughs, or tributary mouths which are strongly influenced by river stage. Eggs incubate in gravels from spawning in late summer or early fall through emergence of fry in March or April, with timing of emergence depending heavily upon incubation temperature. High river stages in winter caused by ice jamming create flows into side channels and sloughs which prevent dewatering and freezing of some spawning sites during low-flow periods, but which also cool groundwater seepage areas (normally warmer than the river channel) used for incubation. There is a complex interdependence of spawning and incubation with intergravel water flows and temperatures for which the relationships with river conditions are not clearly resolved.

Juvenile salmon also occur seasonally in this reach of the Susitna River and its tributaries. The period of seaward migration begins with ice breakup but primarily occurs in late spring and early summer at a time of rising river flows (Fig. 3-14). Although pink, sockeye, and chum in the Susitna generally pass downstream in the spring and summer of emergence, chinook and coho remain for one to two years, feeding and growing in fresh water. Clearwater sloughs and mouths of clearwater tributaries are especially important habitats for juvenile salmon, which depend on sight for locating food. Temperatures in tributaries and sloughs are closer to published optimum growth temperatures [near 60°F (15°C)] for young salmon than are temperatures in the main channels.

Resident species in this reach of the Susitna are similar to those in the reach above Devil Canyon. Benthic invertebrates and aquatic plants are important components of the river ecosystem for rearing of juvenile salmon and maintenance of resident species, and their abundance is probably limited by scouring and light attenuation due to waterborne silt. Fishing pressure is light, restricted primarily by limited suitable access.

3.1.4.3 Below Talkeetna

The Susitna River below the Talkeetna River is a major corridor for upstream and downstream migrating salmon of all five species. It also provides spawning habitat in its extensively subdivided and meandering channel that receives extensive contributions of loose glacial gravels from the Chulitna River. Numerous tributaries and sloughs are used by salmon in a manner similar to the use of tributaries and sloughs in the Talkeetna to Devil Canyon reach. Adult migration occurs from late May into September. Since the majority of Upper Cook Inlet salmon except sockeye are believed to originate in the Susitna system, this reach below the confluence of the Chulitna, Talkeetna, and upper Susitna rivers is highly important. Although all juvenile salmon must pass through this river reach during outmigration, juvenile chinook, coho, and probably sockeye depend on this reach for rearing in summer. The area is especially important as overwintering habitat for juvenile chinook; juvenile coho generally overwinter in tributary mouths.

The lower section of this river reach is inhabited by other anadromous species as well: the Bering cisco, eulachon, and lamprey. Bering cisco are abundant in the mainstem from August to October. Eulachon spawn in about the lower 50 mi (80 km). All resident species in the Susitna drainage except for lake trout are found in this reach. Improved access to this reach, which is in the Anchorage-to-Fairbanks Railbelt, allows substantial recreational fishing.

3.1.4.4 Access Roads and Transmission Line Corridors

The six major new corridors that would be required for access roads, transmission lines, and railroad spurs are as follows (Fig. 2-11): (1) upgrade of Oenali Highway from Cantwell to Watana Access Road; (2) Watana Access Road from Denali Highway to Watana Dam; (3) Devil Canyon Access Road and transmission line between Watana Dam and Devil Canyon Dam; (4) railroad spur from Gold Creek to Devil Canyon; (5) Susitna transmission line from Anchorage to Willow; and (6) Susitna transmission line from Healy to Fairbanks. The Applicant has identified more than 100 streams that would be crossed by these corridors (Exhibit E, Vol. 6a, Chap. 3, Tables E.3.19 through E.3.23). For most of these streams, it is possible only to infer what species are present. In the case of corridors (1), (2), (3), and (6), the most common species present is likely grayling, although cottids (sculpin) are probably numerous. Other species likely to be present in at least some of these streams are blackfish, burbot, Dolly Varden, inconnu (sheefish), longnose sucker, northern pike, and whitefish. Streams in corridor (4) (railroad spur) and corridor (5) (Willow-to-Anchorage transmission line) commonly have present one or more of the five Pacific salmon species and rainbow trout. In addition, the Willow-to-Anchorage transmission line segment would include an underwater crossing of Knik Arm. Knik Arm serves as a migration corridor to the Matanuska and Knik rivers and tributaries for the five species of Pacific salmon, as well as other anadromous species such as Dolly Varden, Bering cisco, eulachon, and lamprey.

3.1.4.5 Fishery Resources

Fishery resources in the Susitna River drainage constitute a major portion of the Cook Inlet commercial salmon harvest and provide sport and subsistence fishing for area residents and tourists. The commercial fishery in Upper Cook Inlet harvests all five species of Pacific salmon. In decreasing order of importance in terms of numbers caught, these salmon species are sockeye, pink, chum, coho, and chinook (Fig. 3-15). With the exception of sockeye, the majority of salmon harvested in Upper Cook Inlet are produced in the Susitna drainage. The quantitative contribution of these Susitna River salmon stocks to the commercial fishery in Upper Cook Inlet has not been established.

The sport and subsistence fisheries operate primarily in the Susitna River and its tributaries rather than Upper Cook Inlet. In decreasing order of number caught, the salmon species are pink, coho, chinook, chum, and sockeye. The chinook salmon (king salmon), however, is the largest and most highly prized. The pink salmon have a two-year life cycle that results in two genetically distinct stocks called "odd-year" or "even-year" on the basis of the year in which adults spawn. In the Susitna drainage the even-year runs of pink salmon are approximately ten times the size of the odd-year runs. Other species of importance to the sport fishery are (in decreasing order of number caught) rainbow trout, Arctic grayling, Dolly Varden, burbot, and lake trout.

The Applicant has estimated the percentage of salmon migrating past Sunshine Station (RM 80), which includes fish heading for the Chulitna, Talkeetna, and Upper Susitna rivers, that continue past Talkeetna Station (RM 103) and past Curry Station (RM 120) (Fig. 3-11). Less than 25% of the salmon that migrate past Sunshine Station go as far as Talkeetna Station, and generally less than 10% migrate past Curry Station. Data are not presently available to estimate the percentage of salmon migrating past Susitna Station (RM 26) that migrate as far upriver as Sunshine Station. However, with the exception of chum, the numbers of salmon migrating past Yentna Station are nearly equal to the numbers passing Sunshine Station (Fig. 3-11).

3.1.5 Terrestrial Communities

3.1.5.1 Plant Communities

The sites of the proposed Susitna project are located almost entirely within an ecoregion classified by Bailey (1978) as the Alaska Range Province of the Subarctic Division. Major vegetation types include conifer, deciduous, and mixed conifer-deciduous forests, as well as their various successional stages (see App. J, Sec. J.1.2) at lower elevations, and shrublands and tundra systems at higher elevations above the timber line [about 2,500 to 3,500 ft (760 to 1,100 m) MSL].

The occurrences of various forest and shrub types in the upper and middle Susitna Basin often can be related to such factors as elevation, slope, aspect, drainage, and fire history. In the taiga ecosystems (moist subarctic forests) of Interior Alaska, these factors apparently influence ecosystem structure and function through effects on air and soil temperatures, soil moisture, and the presence of permafrost (Van Cleve and Viereck, 1981; Van Cleve et al., 1983). In the upland areas of the taiga, fire is a major factor affecting the distribution of upland vegetation types. The fires are often patchy, resulting in a mixture of various-aged vegetation stands that are superimposed over variations in slope and aspect, thus creating a mosaic of vegetation types (Van Cleve et al., 1983). In contrast, vegetation types occurring on river floodplains are controlled primarily by river action, since these areas are relatively protected from fire except on the older terraces (Van Cleve and Viereck, 1981). maps in back

The general distribution of major vegetation classes within Southcentral Alaska in relation to the sites of the proposed dams is illustrated in Figure 3-16. Each of the vegetation classes delineated in the figure is described briefly in Table 3-1. The classification system presented in the table is useful for depicting the distribution of vegetation over relatively large areas. However, the following descriptions of vegetation types and their distribution in the regions around the proposed project features are based principally on plant ecology studies conducted for the Applicant by McKendrick et al. (1982) during the summers of 1980 and 1981. In these studies, McKendrick and coworkers identified vegetation types according to the hierarchical classification system proposed by Viereck and Dyrness (1980), which does not correspond directly to the classification system used in Figure 3-16. To provide some basis for comparison between the two systems, the Viereck and Dyrness (1980) vegetation types (App. J, Table J-3 and Sec. J.1.2.1) that are most likely to occur within the vegetation classes shown in Figure 3-16 are identified in Table 3-2.

The proposed dams, impoundments, and related project facilities would be located mostly in forested areas. In the vicinity of the proposed Watana dam site and impoundment (Figs. 3-16 and Fig. J-2 of App. J), more than 75% of the vegetated area is forested, and most of the remaining area is shrubland. The predominant forest types are black spruce and mixed conifer-deciduous forest with black and white spruce, paper birch, trembling aspen, and balsam poplar. The area around the proposed construction camp, village, and airstrip sites (Fig. 2-3 and Fig. J-2 of App. J) is covered by low shrub types characterized by birch and willow. The borrow sites (Figs. 2-2 and 2-6) would be located in areas covered predominately by various forest types and low shrubland. Borrow sites A,E,H, and I are mostly forested; whereas sites D and F are mostly low shrubland.

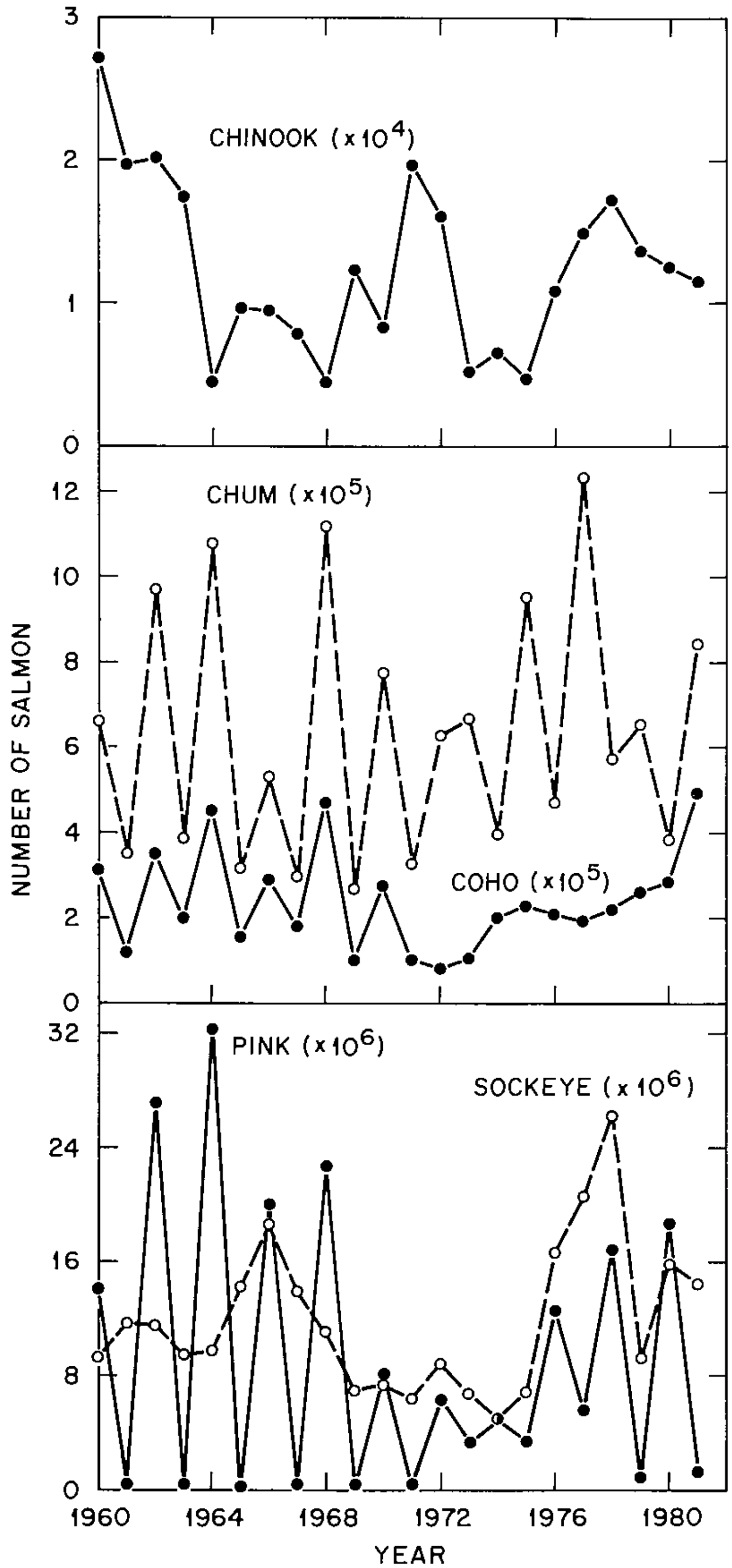


Figure 3-15. Commercial Catch of Salmon in the Upper Cook Inlet, by Species, 1954-1982. [Source: Application Exhibit E, Vol. 6A, Chap. 3, Table E.3.3]

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Figure 3-16. General Vegetation Distribution in Southcentral Alaska and Locations of Proposed Dam Sites, Non-Susitna Alternative Hydropower Sites, and Alternative Thermal Unit Sites. [Source: Adapted from Selkregg, 1974, 1977]

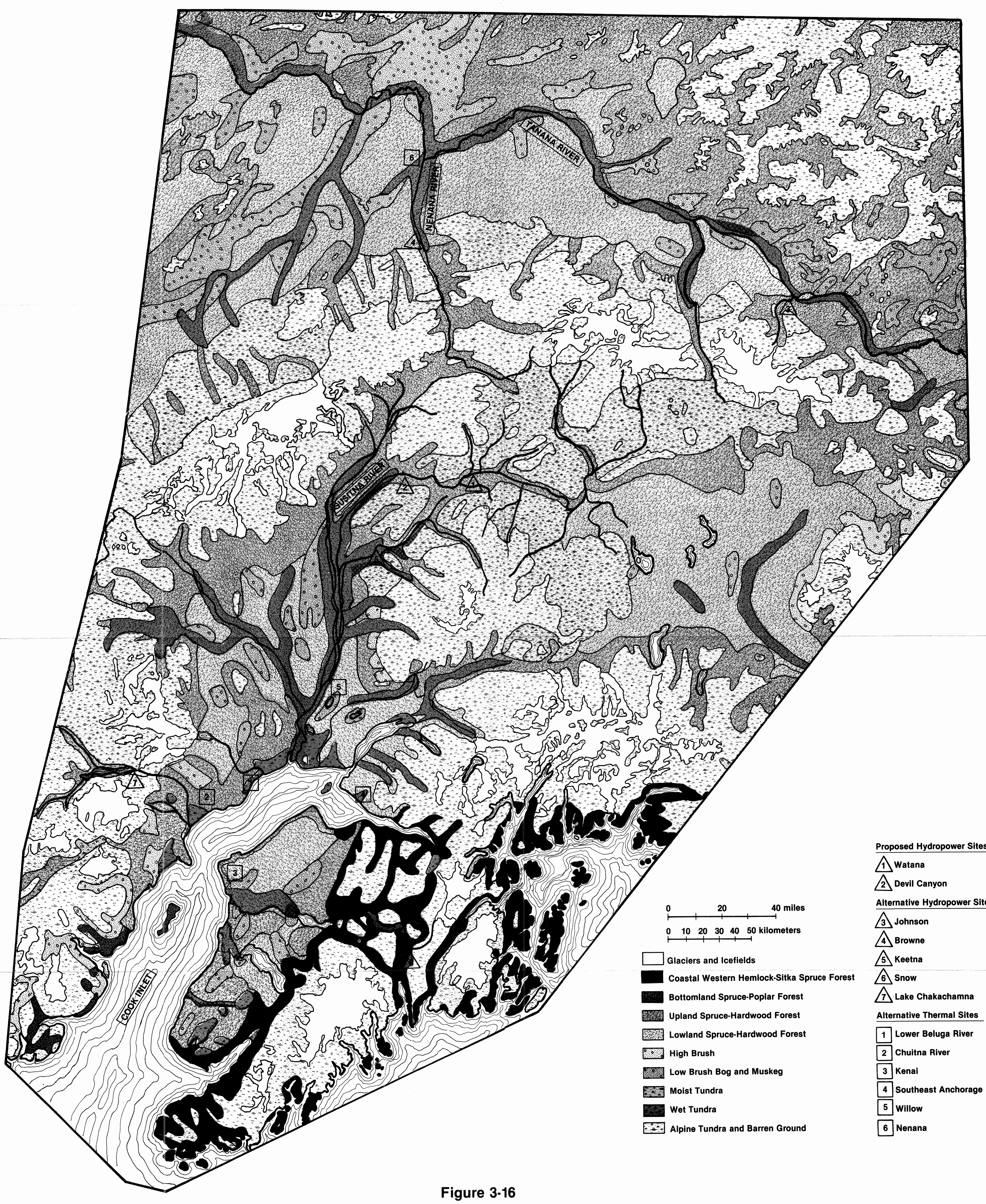


Figure 3-16

General Vegetation Distribution in Southcentral Alaska and Locations of Proposed Dam Sites, Non-Susitna Alternative Hydropower Sites, and Alternative Thermal Unit Sites. [Source: Adapted from Selkregg, 1974; 1977]

Table 3-1. Descriptions of Generalized Vegetation Classes Used for Mapping in Figure 3-16

Vegetation Class	Important Species	Description
Coastal Western Hemlock-Sitka Spruce Forest	Sitka spruce (Picea sitchensis) Western hemlock (Tsuga heterophylla) Mountain hemlock (Tsuga mertensiana) Balsam poplar (Populus balsamifera) Black cottonwood (Populus trichocarpa)	Extension of Pacific rainbelt forests; mountain hemlock replaces western hemlock in Cook Inlet area; west of Cook Inlet Sitka spruce dominates; deciduous hardwoods occur primarily on stream floodplains.
Bottomland Spruce-Poplar Forest	White spruce (Picea glauca) Balsam poplar Black cottonwood Paper birch (Betula papyrifera) Quaking aspen (Populus tremuloides)	Tall, relatively dense forests (and the successional stages leading to them) found on level to nearly level floodplains, low river terraces, and deeply thawed south-facing slopes; balsam poplar and cottonwood quickly invade floodplains following pioneer and alder-shrub stages; white spruce replaces hardwoods in later seral stages.
Upland Spruce-Hardwood Forest	White spruce Black spruce (Picea mariana) Paper birch Quaking aspen Balsam poplar	Varied forest types depending on conditions; successional stages often present due to fire; mixed white spruce-deciduous stands occur on south-facing slopes and well-drained soils; black spruce often replaces white spruce on north-facing slopes and on other cold or poorly drained soils; pure stands of white spruce or mixed white spruce-balsam poplar often occur along streams; pure stands of paper birch or aspen occur as successional stages following fire on warmer well-drained soils.
Lowland Spruce-Hardwood Forest	Black spruce White spruce Paper birch Quaking aspen Balsam poplar	Forests usually dominated by black spruce, sometimes in extensive pure stands; successional stages often present due to fire; occurs on areas of shallow peat, glacial deposits, outwash plains, intermontane basins, lowlands, and north-facing slopes; stands often underlain by permafrost; organic layer often well-developed.
High Brush	Sitka alder (Alnus sinuata) American green alder (Alnus crispa) Thinleaf alder (Alnus tenuifolia) Willows (Salix spp.) Resin birch (Betula glandulosa)	Occurs as three subtypes; coastal alder thickets are found between beach and forest along the southern coast of the Alaska Peninsula and eastern Cook Inlet; floodplain thickets dominated by willow and alder occur on alluvial deposits in rivers and along meandering streams; birch-alder-willow thickets occur between treeline and tundra, in avalanche paths, and old forest burn areas in interior Alaska.

Table 3-1. (Continued)

Vegetation Class	Important Species	Description
Low Brush, Muskeg-Bog	Black spruce Sedges (Carex spp.) Mosses (Sphagnum and others) Cottongrasses (Eriophorum spp.) Bog rosemary (Andromeda polifolia) Resin birch Dwarf Arctic birch (Betula nana) Labrador tea (Ledum groenlandicum) Willows Bog cranberry (Oxycoccus microcarpus) Blueberries (Vaccinium spp.) Crowberry (Empetrum nigrum)	Muskeg-bogs usually consist of a thick mat of mosses, sedges, lichens, and dwarf shrubs; shrubs dominate exposed and drier sites, and mosses and herbaceous species dominate waterlogged areas; coastal muskegs found in wet, flat basins on the Kenai Peninsula and bordering upper Cook Inlet often have conifers (western hemlock and Alaska cedar) scattered over drier areas; interior bogs often occur where conditions are too wet for trees, although scattered black spruce do occur on drier areas; string bogs have unevenly spaced string-like ridges that are often too wet for shrubs.
Moist Tundra	Cottongrass Polar grass (Arctagrostis latifolia) Bluejoint (Calamagrostis canadensis) Sedges Dwarf Arctic birch Resin birch Willows Labrador tea Blueberries Bearberry (Arctostaphylos spp.) Crowberry Bog cranberry	Community composition varies from almost continuous cotton-grass tussocks with sparse growth of sedges and dwarf shrubs to stands in which dwarf shrubs are dominant and tussocks are scarce or absent.
Wet Tundra	Cottongrass Sedges Rushes (Juncus spp.) Willows Dwarf Arctic birch Labrador tea Mountain cranberry (Vaccinium vitis-idaea)	Dominant species are sedges and cottongrass, which usually occur in a mat rather than in tussocks; woody and herbaceous species are infrequent and occur above the water table; found in low, flat areas where soils are wet and shallow lakes are common.
Alpine Tundra	Mountain avens (Dryas spp.) Moss campion (Silene acaulis) Cassiopes (Cassiope spp.) Dwarf arctic birch Crowberry Labrador tea Alpine bearberry (Arctostaphylos alpina) Bog blueberry (Vaccinium uliginosum) Mountain heather (Phyllodoce spp.) Willows Alpine azalea (Loiseleuria procumbens)	Most common on ridges, rubble slopes, and other shallow, dry and porous soils in mountains at elevations between 2,000 and 4,000 ft (600 to 1,200 m); vegetation is sparse and only a few inches high; plant associations vary, but mountain avens and lichens usually dominate; associated herbs, grasses, and sedges occur as low mats.

Source: Based on Selkregg (1974, 1977) and Neiland and Viereck (1977).

Table 3-2. Viereck and Dyrness (1980) Vegetation Types Most Likely to Occur within the Vegetation Classes Delineated in Figure 3-16

Vegetation Class†[1]	Vegetation Types†[2]
Coastal western hemlock-Sitka spruce forest	N.A.†[3]
Bottomland spruce-poplar forest	Balsam poplar forest, white spruce forest, mixed forest, tall shrubland, herbaceous
Upland spruce-hardwood forest	White spruce forest, black spruce forest, birch forest, aspen forest, mixed forest, low shrubland, tall shrubland
Lowland spruce-hardwood forest	Black spruce forest, low shrubland
High brush	Tall shrubland, low shrubland
Low brush, muskeg bog	Low shrubland, black spruce forest, wet sedge-grass tundra
Moist tundra	Mat and cushion tundra, mesic sedge-grass tundra, low shrubland
Wet tundra	Wet sedge-grass tundra
Alpine tundra	Alpine herbaceous tundra, mat and cushion tundra, mesic sedge-grass tundra

†[1] Classification system used in Figure 3-16 and described in Table 3-1. Based on Selkregg (1974, 1977) and Neiland and Viereck (1977).

†[2] Viereck and Dyrness (1980) vegetation types and subtypes identified in Table J-3 and described in Section J.1.2.1 of Appendix J.

†[3] N.A. = Not applicable. Coastal forests did not occur within Susitna Basin or transmission corridor study area.

Source: Based on Selkregg (1974, 1977); Neiland and Viereck (1977); and Viereck and Dyrness (1980).

Almost all of the area occupied by the proposed Devil Canyon dam site and impoundment (Fig. 3-16 and Fig. J-2 of App. J) is forested, and almost 50% of the forests are mixed conifer-deciduous types. Other significant forest types found in the area include paper birch, black spruce, and white spruce forests. The sites of the proposed construction camp and village (App. J, Fig. J-2) and over 75% of proposed borrow site K (Fig. 2-6) would be located in mixed conifer-deciduous forest. Proposed borrow site G (Fig. 2-6) is relatively small and has stands of black spruce, mixed conifer-deciduous forest, and tall shrubland characterized by alder.

The proposed access routes (Fig. 2-11), because of their lengths and varied elevations, would cross a variety of vegetation types. The proposed Denali Highway-to-Watana access route would cross mostly low shrubland, as well as smaller areas of mat and cushion tundra and both mesic and wet sedge-grass tundra types. The tundra types generally occur at the higher elevations. The proposed Watana-to-Devil Canyon access route would traverse mostly shrublands (both low and tall types) and various tundra types, but it also would cross forested areas (mostly mixed conifer-deciduous and white spruce types) near Tsusena Creek and the Susitna River. From Devil Canyon to Gold Creek, mixed conifer-deciduous forest is the predominant vegetation type that would be crossed by the proposed rail access. The proposed Dams-to-Gold Creek power transmission corridor (Fig. 2-7) would follow a route similar to that of the proposed Watana/Devil Canyon/Gold Creek access routes and, thus would cross similar vegetation types.

Below the proposed Devil Canyon dam site, plant communities occurring in the Susitna River floodplain constitute the vegetation most likely to be affected by the proposed project. These communities appear to be part of the floodplain successional sequence described by Van Cleve and Viereck (1981) (see App. J, Sec. J.1.2.2). Briefly, pioneer communities consisting of herbaceous and shrub species are replaced by communities dominated first by alder and then by balsam poplar. Finally, the oldest, most stable areas are covered by mixed conifer-deciduous (white spruce-paper birch) forest. Through physical disturbance--such as ice processes (especially during freezeup and breakup), flooding events, and bank erosion and sediment deposition during the open water period--later seral stages may be replaced by earlier seral stages. Thus, vegetation development in a given area may not proceed directly through the entire successional sequence.

The proposed power transmission route from Fairbanks to Anchorage (Fig. 2-7) crosses a wide variety of vegetation types. Forests (predominately spruce types) cover over 75% of the proposed Healy-to-Fairbanks segment. Most of the rest of this segment is covered by low shrubland and wet sedge-grass types. The southern two-thirds of the proposed Healy-to-Willow segment is primarily forested with white spruce-paper birch forests on the drier sites and white spruce-balsam poplar types in forested floodplain areas. Black spruce forests are found in poorly drained areas. The northern one-third of this segment would cross mostly shrubland, sparsely wooded areas, and tundra types. The proposed Willow-to-Anchorage segment is about two-thirds forested, with mixed conifer-deciduous and spruce forests being the predominant types. Wet sedge-grass tundra (marsh) is the other major vegetation type, covering about one-fourth of the segment.

Within the upper and middle Susitna Basin, wetlands include riparian zones, ponds, and lakes on upland plateaus, and areas with wet or poorly drained soils supporting communities such as wet sedge-grass tundra, low shrubland, or black spruce forest. Wetland areas that have been identified within the upper and middle Susitna Basin near the proposed project features include upper Brushkana and Tsusena creeks, the area between lower Deadman and Tsusena creeks, the Fog Lakes area, and the areas around Stephan Lake and Prairie Creek, Swimming Bear Lake, and Jack Long Creek (Fig. 3-17). There are also large numbers of lakes in the extensive flat areas of the upper and middle Susitna Basin, such as those in the vicinity of Lake Louise (Exhibit E, Vol. 6A, Chap. 3, p. E-3-223). Along the lower Susitna River floodplain, herbaceous pioneer communities as well as most of the areas in the immediate floodplain that are dominated by alder and willow can probably be classified as wetlands. However, communities dominated by white spruce-paper birch are not likely to be wetlands. Within the proposed Fairbanks-to-Anchorage power transmission corridor, wetlands supporting wet sedge-grass, spruce forest, and low shrub communities are known to occur (App. J, Secs. J.1.2.1.5, J.1.2.2.4, and J.1.2.3.4).

3.1.5.2 Animal Communities

The project area supports a diversity of wildlife species typical of Southcentral Alaskan ecosystems (Alaska Dept. of Fish and Game, 1973, 1978; Selkregg, 1974, 1977). These species include big game, furbearers, raptors, waterbirds, and a variety of small game and non-game birds and mammals. Because of the diversity and abundance of wildlife associated with the project, the following discussion cannot cover each wildlife species in depth. Therefore, emphasis has been given to: (1) species that would receive the greatest impact, (2) life history characteristics that would likely be affected, and (3) taxa considered important because of their value as game or furbearers, recreational interest, or high public interest.

Moose: Moose (*Alces alces*) are the most important big game species throughout the project area. In the upper and middle Susitna Basin, moose densities range from about 2 to 4/mi^2 (0.8 to 1.5/km^2) from Devil Creek to Deadman Creek and from Butte Creek to the upper reaches of the Oshetna River (App. K, Fig. K-2). Along the lower Susitna River, peak densities ranged from 3.5 to 10/mi^2 (1.5 to 4/km^2). Although moose range through all habitat types of the project area, riparian or lowland forest habitat near the river is preferred during the important overwintering and calving stages. Particularly important overwintering habitat likely occurs in the projected impoundment zones (App. K, Fig. K-5).

Downstream from Devil Canyon, riverine islands afford habitat for calving and rearing that is relatively isolated from predators and high in browse availability.

The seasonal changes in browse availability necessitate movement by large numbers of moose. The major moose migratory paths are east of Deadman Creek (App. K, Fig. K-1). Local movements of moose frequently entail crossing the Susitna River in the vicinity of the proposed impoundments. These movements have tended to be concentrated along the river from Fog Creek to opposite Stephan Lake, Deadman Creek to 5 mi (8 km) upstream, Watana to Jay Creeks, and from Goose Creek to Clearwater Creek. Along the lower Susitna River, movement to and from the river necessitates crossing the proposed transmission line route. Dispersal of moose from the mainstem of the Susitna River may be an important source of recruitment into more peripheral populations.

Barren-Ground Caribou: Caribou (*Rangifer tarandus*) are most characteristic of open tundra and shrubland habitats. Thus, in the project area, caribou are most abundant in the upland areas of the upper and middle basin and from Cantwell to Nenana along the proposed transmission line route. The Nelchina herd in the upper and middle basin comprises about 20,000 individuals ranging over about 20,000 mi^2 (50,000 km^2). During most of the year, caribou concentrations are removed from the principal project area (App. K, Figs. K-6 to K-8). However, during the summer, a few bull caribou may use habitat in the proposed project area. The major paths of caribou movement are southeast of the major project features, although some caribou may travel along the river during movement from wintering to calving range. Bull caribou dispersing to summer range north of the Susitna River may also cross the river in the projected area of impoundment. Movement from calving/summer range in the Chulitna Mountains to wintering range near Monahan Flat requires crossing the proposed access route to the Watana sites (App. K, Fig. K-7). These areas are used by a small (ca. 2,000 individuals) subherd of the Nelchina herd.

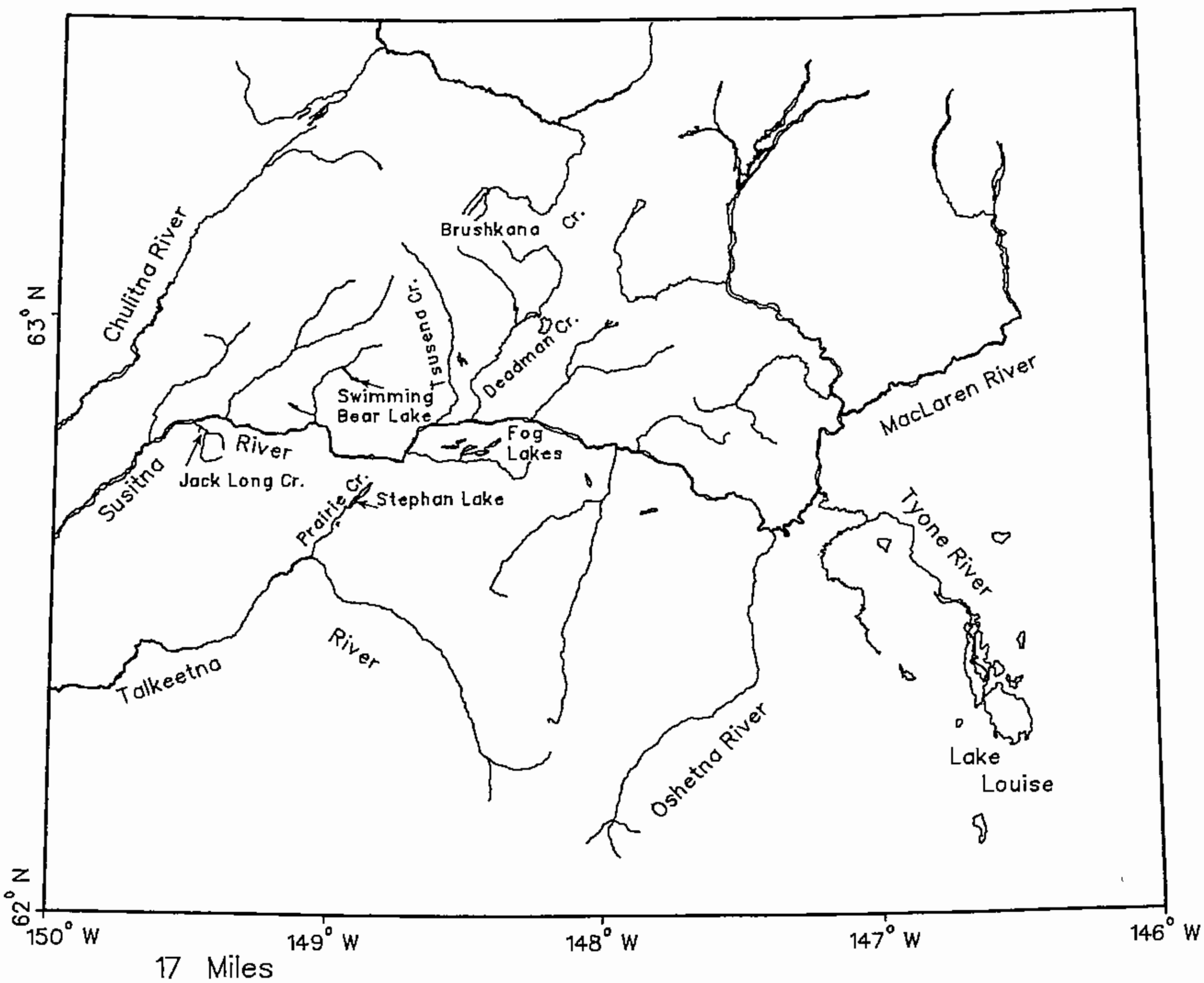


Figure 3-17. Locations of Creeks and Water Bodies in the Upper and Middle Susitna Basin Around Which Wetlands Have Been Identified.

Dall's Sheep: Dall's sheep (Ovis dalli) are typically found in rugged, upland areas and have a restricted range in the project area (App. K, Fig. K-9). Only the range of the Watana Hills population extends into areas of proposed project features. A mineral lick that receives extensive use from April to June is located along Jay Creek. A portion of this lick is located within the projected boundaries of the Watana impoundment. Mineral licks are of great importance as supplemental sources of mineral nutrients, especially sodium. Although other licks occur in the range of the Watana Hills population, the Jay Creek lick appears to be very important because it is heavily used even though it is below the extent of optimal sheep habitat and located away from other areas of high concentrations of sheep.

Brown Bear: Although brown bear (Ursus arctos) use all the habitat types found in the project area, they are most typical of open upland habitat such as found on the benches above the upper and middle Susitna River. Overwintering dens are frequently established in loose soils on slopes in upland habitat, through which the proposed access road to Watana would pass. After emergence from the den, bear move to the lowland forest along the river to take advantage of early spring plant growth and moose concentrations (App. K, Table K-3). Moose and caribou are the main prey of this highly carnivorous bear. In early to late summer, some bear move into the upland shrub and tundra areas to feed on the summer berry crop. During July and August, many bear move to salmon spawning areas, apparently in order to fish. Concentrations of 30 to 40 bear may be found along Prairie Creek during salmon spawning. Bear also move into the area of spawning sloughs downstream of Devil Canyon and along Portage Creek. Directional movements to areas of food concentration may be in excess of 30 mi (50 km), and may involve crossing the mainstem of the Susitna River.

Black Bear: Black bear (Ursus americanus) range throughout the project area; however, in the upper and middle Susitna Basin, suitable lowland forest habitat is restricted in extent to the Susitna River and principal tributaries (App. K, Fig. K-10). Farther downstream, black bear habitat is more extensive. In the area of the proposed impoundments, black bear overwintered in dens in the forests along the river at elevations averaging 2,000 ft (600 m) mean sea level (MSL). About 55% of the known dens are within the projected boundaries of the proposed impoundment. Because about 50% of the dens were reused, it appears likely that denning habitat is limited in the upper and middle Susitna Basin. After emergence from dens, black bear feed on the new spring plant growth and also use moose carrion or prey to a lesser extent. In early summer, black bear tend to move to shrublands adjacent to the lowland forests to feed upon the ripening berry crop (App. K, Table K-4). As with brown bear, some black bear move to salmon spawning areas in order to exploit the fisheries resource. As brown bear become less common downstream, black bear more commonly frequent the spawning areas. Movements in response to food availability frequently necessitated crossing the Susitna River in the projected impoundment zones.

Gray Wolf: Gray wolf (Canis lupus) range throughout much of the project area, being most abundant in areas away from human development. The principal habitat features determining wolf presence are prey distribution and abundance. Moose, caribou, and a variety of small birds and mammals are the chief components of wolf diets in the region. There are about 13 known or suspected groups or packs of 2 to 15 individual wolf each in the upper and middle Susitna Basin. From 1980 to 1982, from 20 to 50 individual wolf ranged through the basin, although only two or three packs ranged over the project area itself. Wolf play a minor role in limiting numbers of moose in the basin, but are probably a principal factor, along with hunting, in limiting caribou numbers.

Furbearers: Habitat for aquatic furbearers is limited in the projected impoundment zones because of the fast and fluctuating flows along the Susitna River and the lower reaches of its tributaries. In the middle reaches of Deadman Creek, one active beaver lodge per stream mile (0.5/km) was observed in 1982; higher densities were found in the upper, more marshy reaches. Muskrat sign was found along some of the lakes above the river. Pine marten were the most abundant terrestrial furbearers, averaging about 2/mi^2 (5/km^2) along the river from Deadman to Watana creeks. Most marten sign was in spruce forest below 3,300 ft (1,000 m) MSL. Other furbearers found in the proposed project area include wolverine, red fox, river otter, mink, lynx, and weasel.

Raptors and Ravens: Many raptors or birds-of-prey range through the project area, including golden eagle, bald eagle, gyrfalcon, goshawk, and raven, a functional raptor. Cliffs along the Susitna River offer some of the major cliff-nesting habitat of high quality in Southcentral Alaska. In the upper and middle Susitna Basin, 21 raven, 16 golden eagle, 3 gyrfalcon, and 1 bald eagle cliff-nesting locations are known to exist. Known tree-nesting locations in the basin are less common and include 7 bald eagle and 3 goshawk locations. A number of these nesting locations are situated in areas that might be affected by project features.

Waterbirds: Waterbirds do not make extensive use of the aquatic habitats available in the upper and middle Susitna Basin. However, along the lower Susitna Basin, habitat for an abundance of waterbirds exists. High densities of waterbirds exist in the Susitna Flats Game Refuge, through which the proposed transmission line route would pass. These coastal wetlands support on the order of 200-600 ducks/mi^2 (80-230/km^2), 20-100 geese/mi^2 (10-40/km^2), and 60-300 shorebirds/mi^2 (20-100/km^2). The area is used extensively for waterfowl hunting. Trumpeter swan nesting and summering areas occur along the proposed transmission line route from Cook Inlet to Nenana. Breeding habitat for trumpeter swans in Alaska generally consists of water bodies with stable water levels and dense stands of emergent vegetation. In the upper and middle basin, most suitable trumpeter swan habitat is located to the south and east of the proposed project features.

Other Birds and Mammals: A large variety of small birds and mammals range through the habitats of Southcentral Alaska. Many of these form the prey base for the smaller predators, such as pine marten, red fox, and several of the raptors. Although some species can be found in a variety of habitats, others are more restricted in their use of habitat. For example, ptarmigans, Baird's sandpiper, Lapland longspur, Arctic ground squirrel, and hoary marmot are characteristic inhabitants of open tundra or shrubland habitat; woodpeckers, black-capped chickadee, brown creeper, red squirrel, and porcupine are more restricted to forest habitat. Forest and woodland habitats support the most diverse and abundant faunas, whereas alpine tundra supports the least diverse and abundant faunas.

3.1.6 Threatened and Endangered Species

At present no plant species known to occur in Alaska have been officially listed as threatened or endangered by Federal or state authorities. There are, however, 30 plant taxa under review for possible protection under the Endangered Species Act of 1973, as amended. To date, none of the candidate taxa under review has been found in any of the areas that would be affected by the proposed Susitna project.

The U.S. Fish and Wildlife Service and Alaska Department of Fish and Game list only four taxa of wildlife as threatened or endangered in Alaska. Of these, only the American peregrine falcon (*Falco peregrinus anatum*) ranges over the area of the proposed project and transmission facilities. Both Federal and state wildlife authorities list the American peregrine falcon as endangered. Peregrine nest in cliff ledges associated with waterbird habitat. Their principal foods are waterbirds and other birds. No peregrine falcon has been observed during recent surveys in the vicinity of the proposed dams, reservoirs, and access routes, although peregrine occasionally have been observed in the area in the past. In general, this area is not considered to be of high quality as peregrine breeding habitat. However, prime peregrine habitat is located along the Tanana River upstream from the town of Nenana. Six known historical nesting locations are situated within 1 to 5 mi (2 to 8 km) of the proposed transmission line in this area.

3.1.7 Recreation Resources

The proposed Watana and Devil Canyon dam sites and project access routes are located in a remote area of limited accessibility, and no public agencies currently provide sites or facilities that contribute to an organized outdoor recreation program. Local recreation activities consist primarily of hunting and fishing, and, to a lesser extent, trail-related recreation.

Developed recreation sites in the project area are privately owned lodges and isolated cabins. The largest of the three lodge complexes in the area is the Stephan Lake Lodge (17 structures), which is located 14 mi (23 km) southwest of the proposed Watana dam site (Terrestrial Environmental Specialists, 1982a). High Lake Lodge (11 structures) is located 6 mi (10 km) northeast of the proposed Devil Canyon dam site. The Tsusena Lake Lodge (3 structures) is 8 mi (13 km) north of the Watana dam site. The principal mode of access to the lodges is via float plane. These lodges are primarily base facilities for hunting and fishing. Opportunities for sport fishing are abundant in the area. Both sport and trophy hunting occur; favored species are Dall's sheep, moose, caribou, and black and brown bears. The lodges also accommodate river travelers and overland trail users.

Individually owned cabins are located in clusters around lakes, as well as in relatively remote areas. These structures are used for a variety of activities, but about 50 units have been identified as providing shelter specifically for supporting hunting and fishing activities (Exhibit E, Vol. 8, Chap. 9, Table E.9.5).

The existing network of overland travel corridors in the immediate project area was built primarily for access by miners, trappers, hunters, and fishermen. Summary information relative to the various trails is presented in Table 3-3, and general locations are shown in Figures 3-18 and 3-19. The various roads and trails provide opportunities for such activities as hiking, snowmobiling, and off-road-vehicle pleasure driving. Local waterways also constitute important recreation travel corridors. The Stephan Lake-Prairie Creek-Talkeetna River corridor is a commonly used river-running route, and the Susitna River-Denali Highway junction is a popular access point for river recreation. From this launch point, river travelers follow the Susitna River downstream to upper Vee Canyon and portage to Clarence Lake, or divert from the Susitna and power upstream on the Tyone River to Lake Louise. Natural features of the Susitna River that also contribute to river recreation include the Vee Canyon and Devil Canyon rapids, which are significant white-water resources. The latter is generally considered to be Class VI waters,

Table 3-3. Existing Trails in the Susitna Project Recreation Study Area†[1]

Trail type	Beginning	Middle	End	Years Used	Use
1. Cat, ORV	Gold Creek		Devil Canyon	1950s - present	
2. Cat, ORV	Gold Creek	Ridge top west of VABM Clear	Confluence of John & Chunilna Creeks	1961 - present	
3. Cat	Alaska Railroad mile 232		Chunilna Creek	1957 - present	
4. Packhorse, Old Sled Road	Chunilna	Portage Creek	Mermaid Lake	1920s - present	
5. ATV	Denali Highway	Butte Lake	Tsusena Lake	1950s - present	
6. Snodgrass Lake Trail	Denali Highway		Snodgrass Lake		Foot, snowmobile, skis
7. Portage Creek Trail	Chunilna		Portage Creek		Sled road foot use
8. Susitna River Trail	Near Cantwell		To Maclaren River		Dry, snowmobiles and foot
9. Talkeetna Trails	Random throughout the southern area of the study area				Unknown
10. Stephan Lake Trail	Susitna River		Stephan Lake		Best portaging
11. Big Lake Trail	Denali Highway Near Butte Lake		Big Deadman Lakes		Biking & off-road vehicles
12. Butte Creek Trail	Denali Highway near the Susitna Bridge		Butte Creek drainage		Off-road vehicles & hiking
13. Byers Lake Trail	Byers Lake		same (loop)		Hiking
14. Little Coal Creek	Parks Highway		Curry Ridge		Hiking
15. Curry Ridge Trail	Park Highway at Little Coal Creek		Parks Highway at Troublesome Creek Crossing		Hiking; to be built in 1983

†[1] Existing trails are shown in Figure 3-18.

Source: Modified from Exhibit E, Vol. 8, Chap. 7, Table E.7.6.

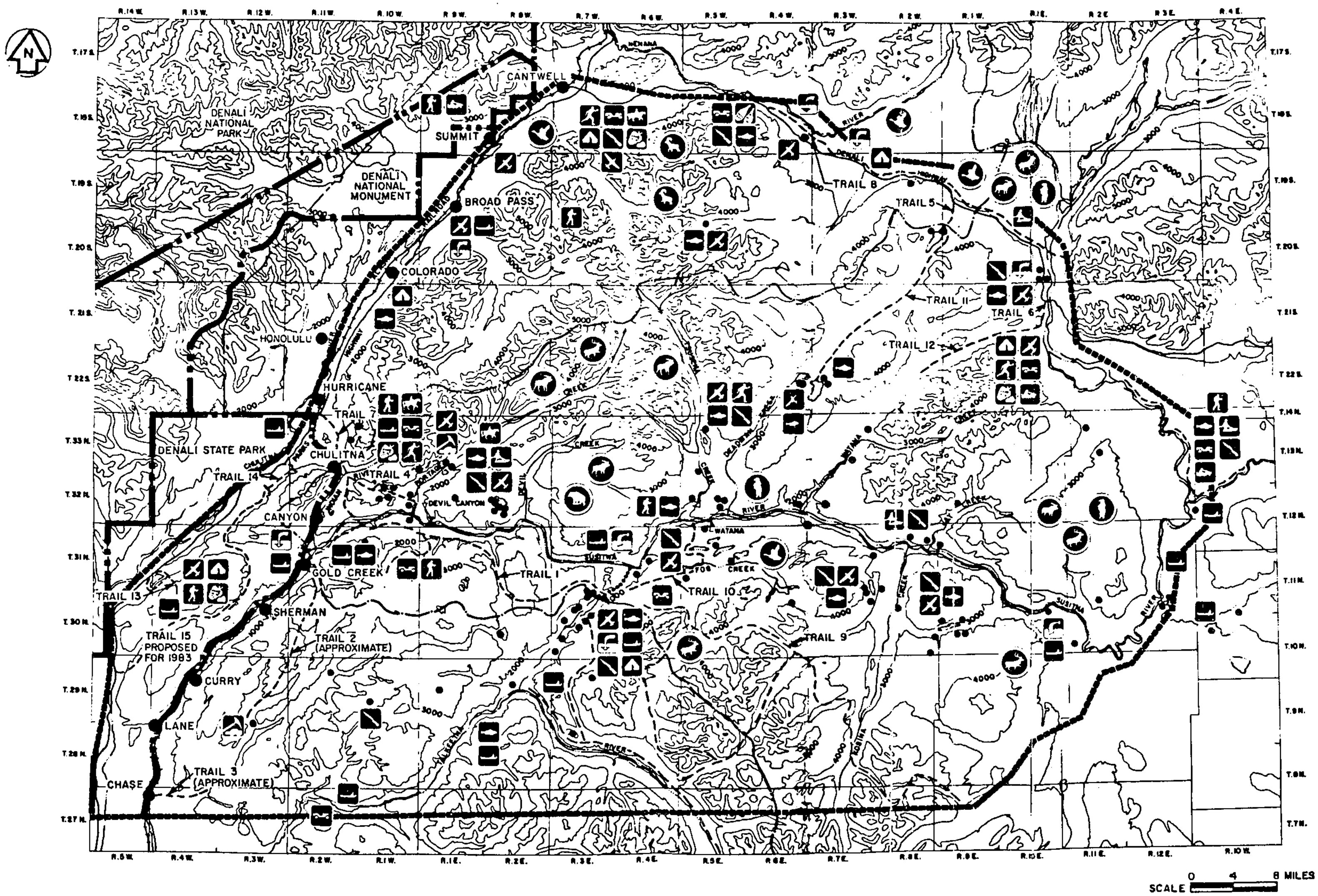


Figure 3-18. Schematic Representation of Recreation Features in the Susitna Project Area. (See next page for legend.) [Source: Application Exhibit E, Vol. 8, Chap. 7, Fig. E.7.4 (Revised June 1983)]

RECREATION ACTIVITIES:

HIKING
CROSS COUNTRY SKIING
DOG SLEDDING
BOATING
ROCK HUNTING
BERRY PICKING
CAMPING
SNOW MACHINING
TAKE-OUT POINT
HUNTING
SNOWSHOEING
PUT-IN POINT
FISHING
MOUNTAINEERING
PHOTOGRAPHY
FLYING
OFF-ROAD DRIVING
SHELTER
BIRD WATCHING
HORSEBACK RIDING

WILDLIFE CONCENTRATIONS:

MOOSE
SHEEP
BROWN BEAR
CARIBOU
WATER FOWL
BLACK BEAR

LANDSCAPE FEATURES:

WATERWAYS
RAILROADS
EXISTING ROADS
PROPOSED ROADS
TRAILS
SUSITNA WATERSHED BOUNDARY
PROPOSED TRANSMISSION LINES
LIMITS OF RECREATION STUDY
PARK BOUNDARIES

PORTAGE TRAIL
TOWNS
STRUCTURES
BUILDING CLUSTERS
HIGH POINTS
MINOR VIEWS
MAJOR VIEWS
SIGNIFICANT LANDSCAPE SETTINGS

NOTE: SEE TABLE E.78 FOR SPECIFIC TRAIL DATA.

RECREATION LEGEND

Figure 3-19. Legend for Figure 3-18. (See Table 3-3 for specific trail data.)

based on the international scale of white-water classifications (Exhibit E, Vol. 8, Chap. 7, Sec. 3.1.2).

The major recreation resource areas adjacent to proposed project boundaries are the Denali National Park and Preserve and Denali State Park. At nearest distance, the state park is within 10 mi (16 km) of the Devil Canyon project boundary. Encompassing 324,000 acres [131,000 hectares (ha)], Denali State Park abuts the Denali National Park and Preserve at both the western and northern boundaries. The vast Denali National Park and Preserve comprises 6.03 million acres (2.44 million ha), about 31% of which is designated wilderness area (National Park Service, 1982). Denali National Park is the most popular recreation resource area in the region, with over 250,000 visitations reported in 1981. Other public recreation areas adjacent to the project area include several sites along the Denali Highway. The principal site adjacent to the project area is the Brushkana Campground, comprised of 31 campsites. The campground is administered by the U.S. Bureau of Land Management.

Various private establishments located along the Parks Highway and Alaska Railroad also contribute to available recreation opportunities. Some examples include lodges, campgrounds, recreation outfitters, and tour guide services. Several private recreation-related developments also occur along the Denali Highway.

Recreation use in the area that would be traversed by the proposed Dams-to-Gold Creek transmission line (Fig. 2-7) is typified by low-density dispersed recreation activities; primarily hunting and fishing. The 37-mi (60-km) Watana-to-Gold Creek transmission line right-of-way would pass within 2 mi (3.2 km) of the High Lake Lodge complex, the only developed facilities in proximity to the proposed lines. The proposed corridor would intersect Tsusena Creek and the Susitna River, which are used for sport fishing and other water-based recreation activities. Several recreation trails also would be intersected and/or paralleled, primarily in the Gold Creek area.

The proposed Gold Creek-to-Fairbanks transmission line would bypass a few isolated residential/ recreation cabins, but no major private or dedicated recreation resource areas or facilities occur along the corridor. A few recreation trails, unimproved roads, and secondary highways, as well as major tourist routes, would variously parallel and/or intersect the right-of-way. The Parks Highway would be intersected at three locations, the Alaska Railroad at two locations, and the Denali Highway near Cantwell (Exhibit G, Vol. 4, Plates G30-G52). Intersected river corridors would include the Nenana (three locations), Susitna, and Tanana, which are particularly important sources of recreation opportunities. Four other rivers also would be crossed.

The Gold Creek-to-Anchorage segment of the proposed transmission system would extend through the Susitna Flats State Game Refuge for about 5 mi (8 km), and traverse a proposed expansion of the Willow Creek State Recreation Area (Park Planning Section, 1983). Compared to the isolated developments along most of the corridor, residential/recreational cabins and recreation trails are of relatively common occurrence in the area to the southwest of Willow and in the vicinity and south of the Nancy Lakes area. Major tourist routes that would intersect the transmission line include the Alaska Railroad and the Glenn and Davis Highways. Intersected major river recreation corridors would include the Little Susitna, Kashwitna, and Talkeetna rivers.

3.1.8 Socioeconomic Factors

With the exception of a portion of the transmission line route, the proposed Susitna project would be located entirely in the Matanuska-Susitna (Mat-Su) Borough of Alaska (Fig. 3-20). Only a few isolated residences exist within or near the proposed project boundaries, but many communities in the Mat-Su Borough and elsewhere outside project boundaries might be affected as project workers and their families are likely to maintain residences in these larger, more established communities. The socioeconomic environment is the same for the proposed dams, onsite structures, access routes, and transmission line routes.

3.1.8.1 Population

Development of numerous large-scale projects in Alaska led to a 32% increase in the population of the state between 1970 and 1980 (from 302,361 to 400,481) (Table 3-4). Over this same period population of the Mat-Su Borough grew at even a greater rate--173% (from 6,509 to 17,816 people). This growth was primarily in unincorporated areas, chiefly in the southern part of the borough. Estimates of 1980 population by borough administrators are even higher, about 22,000. Cantwell, Healy, Nenana, and Paxson currently have small populations. The population of Cantwell rose by about 44% between 1970 and 1980. Healy, Nenana, Anchorage, and Fairbanks also grew considerably in the 1970s. Anchorage and Fairbanks populations are expected to increase by about 65% and 50%, respectively, by 2010. No projections have been made for nearby Yukon-Koyukuk Borough communities or Paxson.

About 95% of the Mat-Su Borough population is white and another 2% is American Indian (Natives). In Cantwell, the percentage of Natives is probably about half, but exact figures are not available.

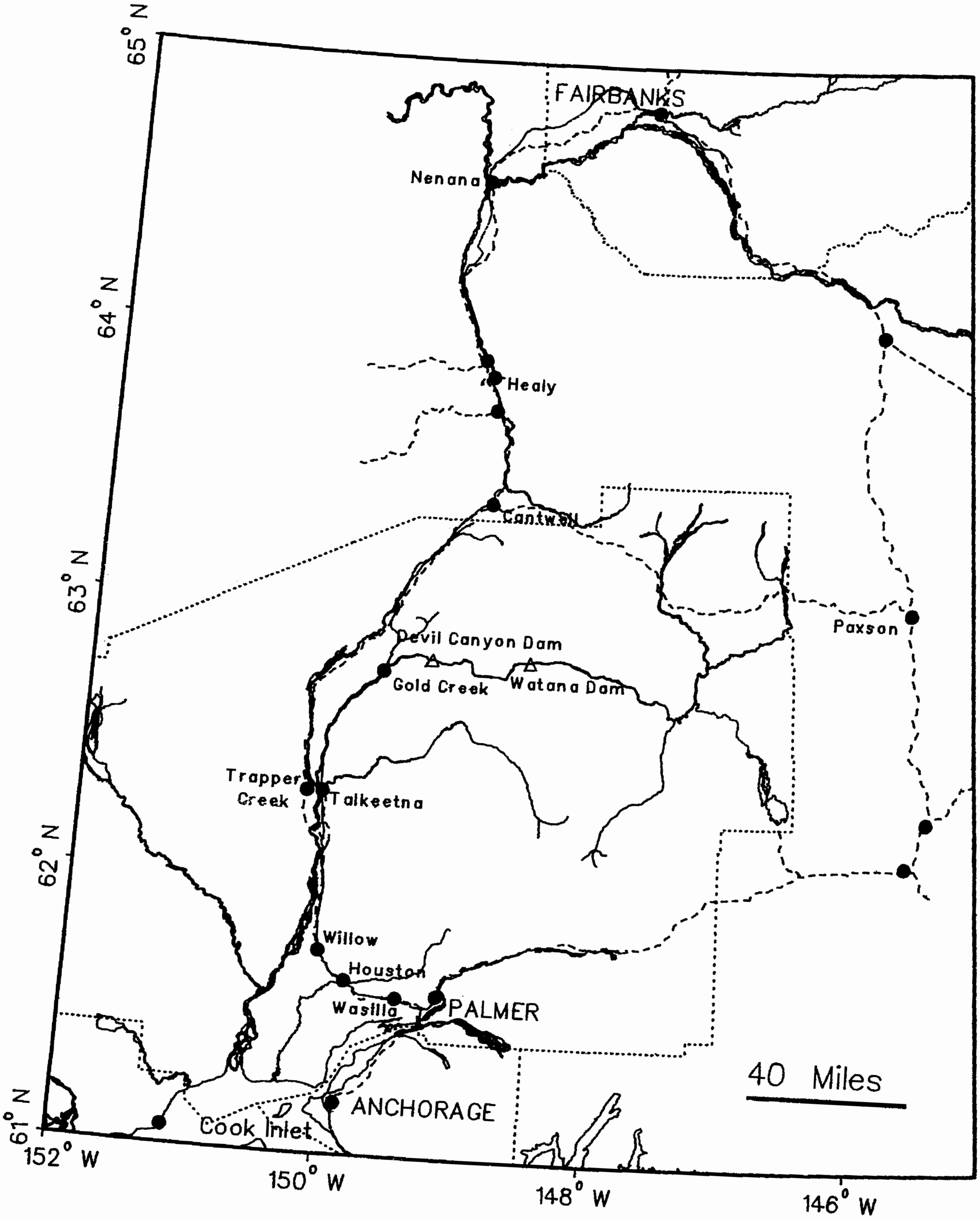


Figure 3-20. Map of the Location of Susitna Hydropower Project Structures and Features of the Socioeconomic Environment.

Table 3-4. Baseline Population Projections, 1970-2010

Political Subdivision	1970†[1]	1981	1985 ISER†[2]	1985 Appli-cant†[3]	1990 ISER†[2]	1990 Appli-cant†[3]	1995 ISER†[2]	1995 Appli-cant†[3]	2000 ISER†[2]	2000 Appli-cant†[3]	2005 ISER†[2]	2005 Appli-cant†[3]	2010 ISER†[2]	2010 Appli-cant†[3]
Matanuska-Susitna Borough														
Talkeetna	182	640†[3]	623	780	700	1,000	726	1,281	741	1,642	779	2,106	834	NA
Trapper Creek	NA	225†[3]	215	263	241	320	250	390	255	474	269	577	288	NA
Willow	38	139†[4]	129	NA	145	NA	150	NA	153	NA	161	NA	173	NA
Houston	69	600†[3]	580	878	652	1,415	676	2,278	690	3,669	726	5,909	777	NA
Wasilla	300	2,168†[3]	2,082	2,895	2,342	4,157	2,428	5,967	2,479	8,474	2,607	12,053	2,791	NA
Palmer	1,140	2,567†[3]	2,469	3,302	2,776	4,525	2,878	5,374	2,938	6,383	3,091	7,581	3,309	NA
Big Lake	36	410†[4]	386	NA	434	NA	451	NA	460	NA	484	NA	518	NA
Other	4,818	16,085†[3]	15,498	23,084	17,430	31,547	18,072	39,317	18,449	48,692	19,405	59,843	20,777	NA
Total Borough	6,509	22,285†[4]	21,466	31,202	24,142	42,964	25,030	54,607	25,553	69,334	26,877	88,069	28,777	NA
Paxson	Unknown, very small		Projections not made											
Yukon-Koyukuk Borough														
Cantwell†[5]	62	89†[4] (1980)	97		107		117		128		143		158	
Healy†[5]	79	334†[4] (1980)	425		470		519		573		632		698	
Nenana†[6]	362	470†[4] (1980)	529		613		710		823		929		1,077	
Total Borough	4,752	7,691†[4] (1980)	NA		NA		NA		NA		NA		NA	
Municipality of Anchorage†[7]	126,385	187,761	200,918		NA		NA		NA		NA		NA	
Anchorage Census Division (includes Greater Anchorage Area Borough)	124,542	173,017†[2]	197,829	NA	218,123	NA	234,393	NA	246,390	NA	264,329	NA	287,865	NA
Fairbanks Census Division	45,864	57,366†[2]	63,561	NA	70,060	NA	74,043	NA	76,743	NA	81,536	NA	87,959	NA

NA: Not Available or not made because supporting information not available.

†[1] U.S. Bureau of the Census (1973), pp. 3-15, 3-16.

†[2] Projections of Institute of Social and Economic Research (ISER), University of Alaska, as in Reeder et al. (1983) for Mat-Su Borough, Anchorage, and Fairbanks only. Projections made only at borough or census division level. Baseline population projections for the communities in the Mat-Su and Yukon-Koyukuk boroughs were made in the following way: Because of the lack of data, a general assumption was made that the distribution of borough population to the communities in 1981 would hold through 2005. This assumption is weak in that many factors affect where immigrants settle, e.g., distance from project locations, commercial development, availability of housing and community services. Lacking this information, the assumption of constant distribution pattern was used. These distribution percentages were then applied to the ISER borough total projections for each year to generate projections by community. Totals are less than sum of allocation (by 0.024%) to communities because of rounding errors in calculating percentages.

†[3] Frank Orth & Associates (1982) p. 4-7. Projections made for Mat-Su Borough only.

†[4] U.S. Bureau of the Census (1980).

†[5] Projections are made by Staff and assume 2% growth rate, the same rate assumed for Cantwell by Frank Orth & Associates (1983), p. 33.

†[6] Projections are made by Staff and assume 3% growth rate, slightly higher than the Cantwell rate because of Nenana's greater percentage growth between 1970 and 1980 (6%) and its proximity to Fairbanks.

†[7] Yarzebinski (1983), pp. 25, 27. Projections made only through 1988. Includes more census divisions than do ISER projections below.

†[8] U.S. Bureau of Land Management (1982).

Because uncertainty exists about the speed at which growth may occur in the Mat-Su Borough, three sets of baseline projections of population growth are used in this document, one set much lower than the others (Table 3-4). The Applicant's projections show a nearly 300% increase in total Mat-Su Borough population by the year 2005, the anticipated end of project construction. Projections made more recently by the Institute of Social and Economic Research (ISER) at the University of Alaska show an increase of only about 20% by 2005. Projections made by the Mat-Su Borough Planning Oepartment show an increase of about 200% in baseline growth by 2001 (Table 3-5). These projections are also made by Planning Districts, which include the identified community plus dispersed population on land around the community. Thus, the allocations are similar to, but not entirely comparable with, the other two projections. The ISER baseline projections and Mat-Su Borough baseline projections have been used in this document for calculating capacities of services.

3.1.8.2 Institutional Issues and Quality of Life

The cities of Anchorage, Fairbanks, Palmer, Wasilla, Houston, and Nenana, and the Mat-Su Borough are the only incorporated government entities in the study area. Incorporated political units in general have powers to levy taxes and provide and maintain many community services. No formal regional or local forms of government exist in the Yukon-Koyukuk Borough. Native organizations have jurisdiction over much of the land in the area. The Ahtna Corporation, a Native Alaskan organization, administers Native financial concerns in Cantwell, and other Native corporations have jurisdiction over Paxson, Nenana, and other land in the region of the proposed project.

In general, non-Native residents value the isolated, rural settings and the scenic wilderness. Because employment opportunities are limited and tourism is not well-developed, residents are often willing to accept a self-sufficient existence or live on low incomes in order to remain in the setting. Native corporations have a generally positive attitude toward further development.

Legal and cultural conflicts exist in the Susitna Basin area among those who claim subsistence uses (hunting and fishing for rural custom and traditional uses) of the lands, others competing for the same harvests, and government agencies that must interpret and enforce Alaska's subsistence laws (Associated Press, 1983; U.S. Bureau of Land Management, 1982). Subsistence activities are protected by law for a particular population of Alaskans, and such activities remain an important aspect of the economy and culture of rural Native communities and of individuals who reside in remote areas. Subsistence users may rely on subsistence activities for a majority of their sustenance needs or may use them to supplement their food and material supplies and cash income.

3.1.8.3 Economy and Employment

Economic activity of Mat-Su Borough is centered primarily in the southern part of the borough, in and around the communities of Palmer, Wasilla, Houston, Big Lake, and Willow. In general, the economy of the Railbelt (which encompasses the communities along the Alaska Railroad and Parks Highway between Anchorage and Fairbanks) is undeveloped, with the exception of some tourist-related commerce along the Parks Highway. Construction and retail sales have the largest receipts in Mat-Su Borough. Government is the major employer in Mat-Su and Yukon-Koyukuk boroughs (App. N, Table N-4). Additionally, many employed residents of both boroughs (from 36% to 50% in Mat-Su) work outside the boroughs in Anchorage, Fairbanks, or elsewhere (Ender, 1980; Commonwealth Associates, 1982). Employment in both Fairbanks and Anchorage has been primarily in government: 25.1% and 35.8%, respectively, in 1982. Both cities have about 20% of their employment in each of services and trade and 10% in construction. Commercial and sport fishing and hunting are important industries in the Susitna Basin and in the Cook Inlet region. A 1980 study found that "commercial fishermen received over $7 million from Susitna Basin fish" (Grogan, 1983:p. 4).

Employment and income in many regions of Alaska are highly dependent on state sources. On an institutional level, the state provides funds to finance energy development and community infrastructure to support population increases related to that development (Alaska Dept. of Commerce and Economic Development, 1983:p. III-12). It provides funding to aid boroughs in need of services that cannot be provided with local tax income. Currently, the state provides about 85% of the total Mat-Su Borough budget, when both shared revenue and grants are included (Campbell, 1983). Through the Alaska Housing Finance Corporation and the Division of Housing Assistance, the state also buys mortgages made by private lending institutions. It has been estimated that state spending has accounted for 84% of employment growth since 1978 and an average of about 31% of wage and salary income. In rural areas where subsistence activities may be the primary source of livelihood, residents rely on public funds for about 45% to 50% of personal wage-and-salary income (Hoffman, 1983; Irvin, 1983; Oarbyshire & Associates, 1980; Myers, undated).

Volatile unemployment rates, ranging from 7% to 19% in the project area between 1976 and 1981, reflect the dependence of much of the Alaskan work force on temporary and seasonal large-scale projects for employment (Table 3-6). Average per-capita personal income in Alaska in 1980 was $12,759, which was 134% of the national average. Mat-Su Borough per-capita personal income was

Table 3-5. Mat-Su Borough Planning Department Baseline Population Projections

Political Subdivision	1983	1985	1987	1989	1990	1991	1993	1995	1997	1999	2001
Matanuska-Susitna Borough											
Talkeetna	1,027	1,209	1,463	1,723	1,861	2,010	2,280	2,538	2,746	2,970	3,213
Trapper Creek	146	172	208	245	265	286	324	360	389	421	456
Willow	911	1,073	1,298	1,528	1,650	1,782	2,021	2,249	2,433	2,631	2,845
Houston-Big Lake	3,291	3,874	4,687	5,518	5,959	6,436	7,300	8,125	8,788	9,506	10,281
Wasilla	11,397	13,709	16,942	20,363	22,217	24,237	28,041	31,824	35,085	38,667	42,600
Palmer	5,959	6,722	7,779	8,742	9,216	9,710	10,461	11,029	11,265	11,467	11,626
Other	2,168	2,580	3,190	3,846	4,178	4,487	5,047	5,582	6,011	6,476	6,981
Total Borough†[1]	24,899	29,339	35,567	41,965	45,346	48,948	55,474	61,707	66,717	72,138	78,002
	(27,589)	(32,534)	(39,807)	(47,075)	(50,771)	(54,722)	(61,513)	(68,368)	(73,935)	(79,525)	(86,032)

†[1] Total Borough figures in parentheses are updated Borough Planning Department projections (no date). Updated projections are not available for each planning district.

Source: Calculated from DOWL Engineers (1983), pp. IV-18 - IV-19, IV-21 - IV-24. Figures were calculated by subtracting the Planning Department's projections of "Susitna Hydro Impact Population Projections" (pp. IV-21 - IV-22) from total population projections.

Table 3-6. Total Labor Force and Unemployment Rates for Proposed Project Area and Transmission Line Route, 1976 through 1981

	Political Subdivision				
	Matanuska-Susitna Borough	Yukon-Koyukuk Borough	Anchorage	Fairbanks	State of Alaska
1976					
Total Labor Force	5,495	2,689	68,053	24,789	164,000
Employment	4,683	2,390	63,184	22,917	150,000
Unemployment Rate (%)	14.8	11.1	7.2	7.6	8.5
1977					
Total Labor Force	6,345	2,283	77,648	21,924	172,000
Employment	5,341	1,986	72,065	19,046	156,000
Unemployment Rate (%)	15.8	13.0	7.2	13.1	9.3
1978					
Total Labor Force	6,891	2,243	82,184	21,817	181,000
Employment	5,591	1,874	75,435	17,967	161,000
Unemployment Rate (%)	18.9	16.5	8.2	17.6	11.0
1979					
Total Labor Force	9,194	2,070	80,063	20,916	183,000
Employment	7,869	1,788	74,106	18,221	166,000
Unemployment Rate (%)	14.4	13.6	7.4	12.9	9.3
1980					
Total Labor Force	9,125	2,079	81,647	20,488	187,000
Employment	7,723	1,738	75,616	17,982	169,000
Unemployment Rate (%)	15.4	16.4	7.4	12.2	9.6
1981					
Total Labor Force	9,362	2,063	86,064	20,813	192,000
Employment	8,167	1,768	79,956	18,288	174,000
Unemployment Rate (%)	12.8	14.3	7.1	12.1	9.4

Source: Alaska Department of Labor (1983), pp. 23-24.

$10,846; Yukon-Koyukuk Borough, $12,429; Anchorage, $14,266; and Fairbanks, $13,308 (Alaska Dept. of Labor, 1983). However, when the high cost of living in Alaska is accounted for, the average per-capita income is lower than the U.S. average per-capita income (0.86 of the U.S. average in 1979) (Edgar et al., 1982:p. 46).

Native households are generally among the poorest in the state. In Anchorage in 1979, one-sixth of a total of 12,000 families made less than $5,000; 73% of Native families were below the median income for Anchorage families, and 21% were below the poverty level, as compared with about 7% for Anchorage overall (Yarzebinski, 1983:pp. 44-45, 49).

3.1.8.4 Housing

Housing in Mat-Su Borough is a mixture of permanent year-round residences and recreational or part-year residences. Cantwell, Healy, Nenana, Anchorage, and Fairbanks have fewer recreational units than Mat-Su Borough communities. All the communities in the region have volatile housing markets that follow the boom-and-bust cycles of the economy.

Over 80% of residential housing stock in the area in 1979 was in single-family dwelling units, about 10% was in mobile homes, and the remainder was in multi-family units. Few of these are rental units (App. N, Table N-6). Vacancy rates range from 5% to 20%, depending on whether the data include recreational, seasonally used units. Housing is being built rapidly in southern Mat-Su Borough, Anchorage, and Fairbanks to meet the demand from the growing and mobile population.

A total of 35 temporary living unit facilities, mostly lodges and cabins between Wasilla and Healy, were counted in a survey by the Applicant (App. N, Table N-6). Three of these are identified as being in the project vicinity; others are available along major highways in the project area. Capacity of these facilities is not known. Many of these temporary lodging facilities are open only in the summer months. Most are in great demand by tourists, hunters, and fishermen, are reserved in advance, and are filled, particularly on summer weekends.

Baseline projections of the number of households that would be needed in the study area through 2010 according to the lowest (ISER) and highest (Applicant) population projections are shown in Table 3-7. There would be a 300% increase in Mat-Su Borough housing needs under the Applicant's projections, but only a 20% increase in needs under 1983 ISER projections. Anchorage would need about 65% more housing units, and Fairbanks about 50% more.

3.1.8.5 Community Services and Fiscal Status

Most community services in Mat-Su Borough near proposed sites of project facilities are provided and administered by the borough. The Yukon-Koyukuk Borough does not have these powers, so Cantwell, Healy, and Nenana must provide their own services and facilities. Many of the services in both boroughs are supported by state funds, as well as local community taxes. Anchorage and Fairbanks provide all community services through municipal systems. Available data on the capacities of present and planned community services in the project area are shown in Table 3-8. Years when capacities will be reached under all three baseline population projections are shown in Tables 3-9 and 3-10. Based on the community service standards used to evaluate existing capacities and using ISER and the Applicant's projections (Table 3-9), most services in communities in the project area should suffice to meet baseline needs through 2000. Exceptions are fire and police services in the southern part of Mat-Su Borough and schools in Anchorage. However, it cannot be estimated using projections by ISER and the Applicant if residents outside community boundaries (the "Other" category in all tables) would be adequately served, as they cannot be appropriately allocated on a community-by-community basis. Because Mat-Su Borough Planning Department population projections are made by Planning Districts that include residents outside community boundaries, Table 3-10 provides a more pessimistic picture and might be considered a high-impact projection.

Major sources of revenue for the Mat-Su Borough and its communities are residential property taxes, municipal assistance funds, and state and Federally shared funds. Total assessed value of all land, businesses, and homes rose 19.2% between 1982 and 1983 assessments (Campbell, 1983). Most communities rely on borough and state funding. Cantwell and Healy both rely primarily on state grants and on annual state-shared revenues. Some additional funding for community services in Cantwell comes from per-capita grants via the Native village council. When shortfalls have occurred in borough budgets in the past, the state has contributed to the budget to prevent deficits. As is the case in most rural areas, education is the largest expenditure in borough budgets, followed by road maintenance.

3.1.8.6 Transportation

Besides having their own networks of streets, Fairbanks and Anchorage are junctions of major road, air, and rail transportation routes for the region. Anchorage also has a ship port. Most communities in the project area have airstrips for small aircraft. Major north-south roadways traversing the region are the Parks Highway, which is the primary route between Anchorage and Fairbanks, and the Richardson Highway, which lies east of the project site and connects Valdez and Fairbanks. Both highways have excess capacity. The Denali Highway connects Cantwell on the Parks Highway with Paxson on the Richardson Highway. The Alaska Railroad connects Anchorage and Fairbanks. It serves some communities and residences without road access, carrying freight (at an estimated 20% of capacity) and passengers (daily in the summer, twice per week in the winter).

3.1.8.7 Human Use and Management of Wildlife Resources

A principal human use of the upper and middle Susitna Basin is the harvesting of big game and furbearers. Wildlife harvesting is carried out for recreational, subsistence, and commercial purposes. A secondary human use is nonconsumptive viewing of wildlife, chiefly big game and birds. Nonconsumptive use is generally restricted to the periphery of the affected project area due to limited access. Access to the proposed project area is currently limited by the number and quality of ground transportation routes. The principal modes of transport are air; off-road, all-terrain vehicles; and a combination of highway and foot access. In addition, boat access is available from Talkeetna to Devil Canyon and from Oenali Highway to Vee Canyon.

Table 3-7. Baseline Projections of Number of Households, 1970-2010

Political Subdivision	1970†[1]	1980†[2]	1985 ISER†[2]	1985 Appli-cant†[3]	1990 ISER†[2]	1990 Appli-cant†[3]	1995 ISER†[2]	1995 Appli-cant†[3]	2000 ISER†[2]	2000 Appli-cant†[3]	2005 ISER†[2]	2005 Appli-cant†[3]	2010 ISER†[2]	2010 Appli-cant†[3]
Matanuska-Susitna Borough														
Talkeetna	54	209	201	246	226	334	235	453	240	618	252	792	270	NA
Trapper Creek	NA	74	71	83	80	107	83	138	84	178	89	217	95	NA
Willow	11	45	42	NA	47	NA	49	NA	50	NA	53	NA	57	NA
Houston	20	197	189	308	212	508	220	837	225	1,381	236	2,224	253	NA
Wasilla	88	708	683	930	768	1,404	796	2,124	812	3,189	855	4,536	915	NA
Palmer	335	839	808	1,083	909	1,551	942	1,928	962	2,402	1,012	2,853	1,083	NA
Big Lake	11	134	140	NA	158	NA	164	NA	167	NA	176	NA	188	NA
Other	1,417	5,257	5,063	7,277	5,695	10,514	5,904	13,891	6,027	18,326	6,340	22,523	6,788	NA
Total Borough	1,841	7,283	7,015	9,927	7,890	14,417	8,180	19,371	8,351	26,095	8,783	33,146	9,404	NA
Paxson	Unknown, very small number. Projections not made.													
Yukon-Koyukuk Borough														
Cantwell	16	20	31		34		37		40		45		50	
Healy	20	105	134		148		163		180		199		219	
Nenana	91	148	166		193		223		259		292		339	
Total Borough	1,015	2,280	NA		NA		NA		NA		NA		NA	
Anchorage Census Division (includes Greater Anchorage Area Borough)	34,988	60,470 (70,104)†[4]	70,653		77,901		86,922		87,996		94,403		102,809	NA
Fairbanks Census Division	11,590	18,224	21,918		26,946		28,478		29,517		31,360		33,830	NA

NA: Not Available

†[1] 1970 household data for the boroughs & census divisions are taken from the U.S. Bureau of the Census (1973), pp. 3-31, 3-52. Household data for communities are estimated by dividing the population estimates from Table 3-4 by the estimated average household size for the borough in which the community is located (U.S. Bureau of the Census, 1973: p. 3-31).

†[2] Anchorage and Fairbanks data are from Bureau of the Census (1980). Assumes Mat-Su Borough household size of 3.06; Yukon-Koyukuk Borough household size of 3.18; Anchorage household size of 2.8; and Fairbanks household size of 2.6 (U.S. Bureau of the Census, 1980). Calculated from ISER model population projections (Reeder et al., 1983) shown on Table 3-4. (See footnote 2 on that table for explanation of distribution to communities.) Mat-Su Borough estimates for 1981 are higher, giving a total of 7,701 housing units in the borough (DOWL Engineers, 1983).

†[3] Household projections by Frank Orth & Associates (1982), Table 4.1-6, p. 4-14. Assumes household size of 3.07 for 1982, decreasing to Census Bureau's national average of 2.657 in year 2000.

†[4] 1982 figure from Yarzebinski (1983) for municipality of Anchorage, which includes more census divisions than do ISER's Anchorage projections.

Table 3-8. Existing or Planned Capacity (persons served) of Community Services of Project-Area Communities†[1]

Community	Water†[1]	Sewers†[1]	Solid Waste†[1] Disposal	Schools†[4] Elementary (students)	Schools†[4] Secondary (Jr/Sr) (students)	Fire†[2]	Police†[1]	Hospital Facilities
Talkeetna	Individual sources	Individual septic tanks	Rely on borough landfills	120(65)	180(122)	4500	Covered by borough	None exist
Trapper Creek	Individual sources	Individual septic tanks	Rely on borough landfills	150†[3]	Attend in other communities	No facilities	Covered by borough	None exist
Houston	Individual sources	Individual septic tanks	Rely on borough landfills	350(177)	300†[3]	1800-1920	Covered by borough	None exist
Wasilla	4,400	Individual septic tanks	Rely on borough landfills	1,170(959)	600/1,200 (353/715)	1800-1920	Covered by borough	None exist
Palmer	13,200	5,000	Rely on borough landfills	950(754)	500/900 (332/619)	1800-1920	5,400	30,000
Matanuska-Susitna Borough	NA	NA	28,352 by 2009†[5]	3500	3700	NA	20,000	Provided in Palmer
Anchorage†[6]	227,000	340,000	NA	29,700 (21,090)	12,090 (15,854)	140,000	168,000	NA (4 hospitals, 709 beds; 5 long-term care facilities, 266 beds; 1 psychiatric hospital, 175 beds)
Fairbanks†[6]	53,000	80,000	NA	8,850 (6,667)	6,750 (4,341)	28,000	30,000	NA (2 hospitals, 227 beds; 2 long-term care facilities, 155 beds)
Cantwell	Individual sources	Individual septic tanks	Rely on private landfill	60		3000	Covered by state	None exist

NA = Not applicable or not available.

†[1] Sources: DOWL Engineers (1983); Exhibit E, Vol. 7, Chap. 5, p. E58-7; all numbers are calculated using standards from Stenehjem and Metzger (1980).

†[2] Source: Frank Orth & Associates (1982); Exhibit E.

†[3] Planned or planned plus actual.

†[4] Existing enrollment, when available, is inside parentheses. Sources: DOWL Engineers (1983), p. III-48, and Exhibit E, Vol. 7, Chap. 5, p. E58-7.

†[5] Accumulated over time to total this population in year 2009, when landfill will reach capacity.

†[6] Division of Budget and Management 1982 school capacities calculated assuming 25 students per classroom.

Table 3-9. Years When Community Service Needs Will Equal Existing or Planned Capacity in Project-Area Communities Using ISER Population Projections†[1]

				Schools				
Community	Water	Sewers	Solid Waste Disposal	Elementary	Secondary (Jr/Sr)	Fire	Police	Hospital Facilities
Talkeetna	Individual sources	Individual septic tanks	Rely on borough landfills	2010+	2010+	2010+	Covered by borough	None exist
Trapper Creek	Individual sources	Individual septic tanks	Rely on borough landfills	2010+	Attend in other communities	No facilities	Covered by borough	None exist
Houston	Individual sources	Individual septic tanks	Rely on borough landfills	2010+	2010+	2010+	Covered by borough	None exist
Wasilla	2010+	Individual septic tanks	Rely on borough landfills	2010+	2010+/2010+	1983	Covered by borough	None exist
Palmer	2010+	2010+	Rely on borough landfills	2010+	2010+/2010+	1983	2010+	2010+†[3]
Matanuska-Susitna Borough	NA	NA	2009+†[2]	2010+	2010+	NA	1982	Provided in Palmer
Anchorage	1992	2010+	NA	2010+	1983	1983	1983	NA
Fairbanks	1983	2004	NA	2010+	2001	1983	1983	NA
Cantwell	Individual sources	Individual septic tanks	Rely on private landfills	Unknown	Unknown	2010+	Covered by state	None exist

NA = Not applicable

†[1] Calculated from Table 3-4, ISER projections, and Table 3-8.

†[2] See comparable entry in Table 3-4.

†[3] The Mat-Su Borough Planning Department estimated capacity would be reached in 1995 (DOWL Engineers, 1983).

Table 3-10. Years When Community Service Needs Will Equal Existing or Planned Capacity Using Mat-Su Borough Population Projections†[1]

Community	Water	Sewers	Solid Waste Disposal	Schools		Fire	Police	Hospital Facilities
				Elementary	Secondary (Jr/Sr)			
Talkeetna	Individual sources	Individual septic tanks	Rely on borough landfills	1985	1989	2001+	Covered by borough	None exist
Trapper Creek	Individual sources	Individual septic tanks	Rely on borough landfills	2001+	Attend in other communities	No facilities	Covered by borough	None exist
Houston	Individual sources	Individual septic tanks	Rely on borough landfills	1983	1983	1983	Covered by borough	None exist
Wasilla	Serves community only	Individual septic tanks	Rely on borough landfills	1983	1983/1990	1983	Covered by borough	None exist
Palmer	2001+	1983	Rely on borough landfills	1989	1990/2001+	1983	1983	1985+†[3]
Matanuska-Susitna Borough	NA	NA	1985†[2]	1987	1987	NA	1983	Provided in Palmer

NA = Not applicable

†[1] Calculated from Tables 3-5 and 3-8.

†[2] See comparable entry in Table 3-4.

†[3] The Mat-Su Borough Planning Department estimated capacity would be reached in 1995 (DOWL Engineers, 1983).

Limited access to the areas serves, in part, as a constraining factor on the human uses of the basin's wildlife resources.

The responsibility for regulating human uses of wildlife and managing wildlife resources of Alaska rests in the Alaska Department of Fish and Game, which implements the management policies of the Alaska Board of Game. Hunting and trapping intensity is controlled by Alaska Department of Fish and Game regulations through three basic methods: (1) limiting the hunting season, (2) establishing harvest quotas, and (3) imposing direct limitations on effort, e.g., issuing a limited number of permits. These methods are used to varying degrees in controlling harvest of moose, other game, and furbearers in the affected game management units.

Subsistence uses of wildlife resources have a recognized priority under both Federal and state laws, provided that such uses do not interfere with wildlife conservation goals. Subsistence users harvest game and furbearers as a source of food, clothing, or for other utilitarian purposes. Subsistence user statistics are not distinguishable in harvest statistics for game species, with the exception of caribou. Therefore, specific subsistence user patterns for the area are not currently known.

Indirect commercial benefits accrue from recreational and subsistence hunting of game species. Big game hunting by non-residents of Alaska requires by law the employment of licensed guides who provide guiding services and may offer transportation, lodging, food, or camping services. There are a number of lodges in the general region that serve consumptive and nonconsumptive users of game resources in the impact area. In addition, financial gain can accrue to interests outside the project region through supplying game hunters with transportation, food, equipment, taxidermy services, and meat and hide preparation.

The principal game species in the affected area are moose, caribou, Dall's sheep, black and brown bear, and wolf (Sec. 3.1.5.2). The status of these populations has been discussed individually above. The economic importance of each species is difficult to ascertain. There is no information on the business volume associated with each species. Moreover, hunts are often conducted as combined hunts and costs are not apportioned to each species. In lieu of such data, relative importance may be expressed on the basis of take in the basin during 1978-1979 as a proportion of statewide harvest: moose - 14.5%; wolf - 9.0%; black bear - 5.0%; caribou - 9.0%, brown bear - 8.0%.

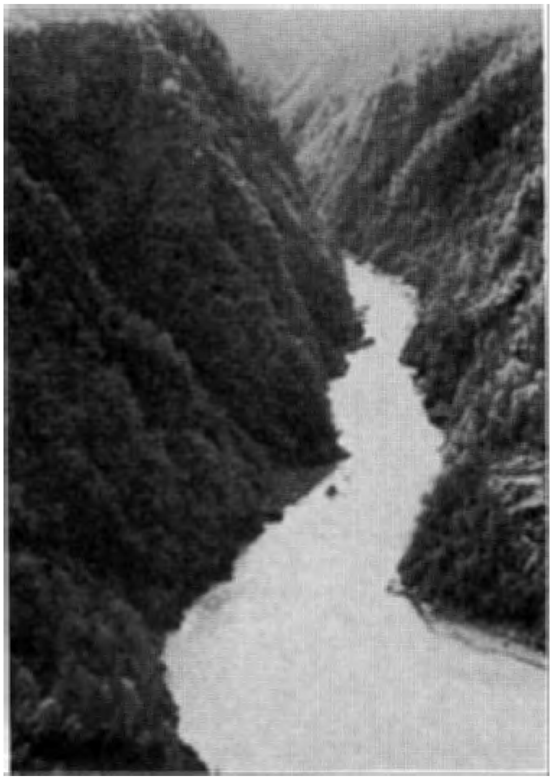
3.1.9 Visual Resources

3.1.9.1 Landscape Character Types

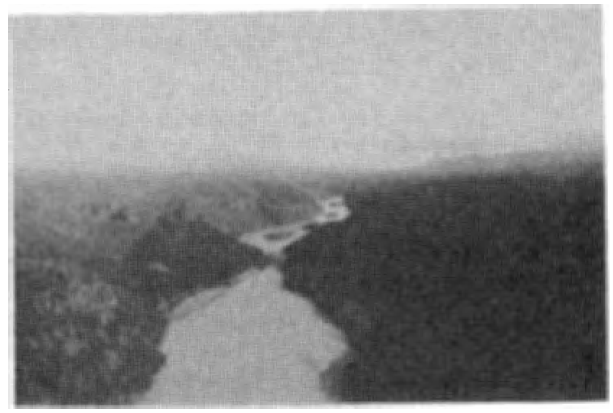
The upper and middle Susitna River Basin and the area along the proposed power transmission line corridor contain 24 aesthetically distinct landscape character types, consisting of a mixture of various topographic (mountains, broad valleys), vegetation (woodlands, tundra, barren land), and water resource (rivers, waterfalls, rapids, lakes, and streams) features (App. M, Sec. M.2.1, Tables M-2 and M-3). These physical features are enhanced by other visual and aesthetic elements, such as atmospheric conditions, presence of wildlife, and natural scents and sounds.

Landforms within the upper and middle Susitna Basin are defined by three major elements: (1) the deeply incised Susitna River Valley and its tributaries, (2) the northern Talkeetna and Chulitna mountains, and (3) the northern Talkeetna plateau (Terrestrial Environmental Specialists, 1982b). Selected photos of these landforms are shown in Figure 3-21 (also see App. M, Sec. M.2.1.1, Table M-2 and Figs. M-1 to M-3). The vegetation is diverse and varies with elevation. Dense spruce-hardwood forests cover the lower drainage areas and slopes, while large areas of tundra vegetation cover the higher elevations. A variety of shrub-type vegetation occurs between the forest and tundra areas. Color variation also enhances the aesthetic quality of the area. This is particularly true in fall when the leaves of the deciduous trees turn color (yellow, orange, and red) and are contrasted against the dominant dark-green spruce. The tundra also undergoes brief color change in the autumn, and there can be considerable contrast against mountain backdrops and areas of open, blue sky. During the winter, partial and complete snow cover dominates the landscape.

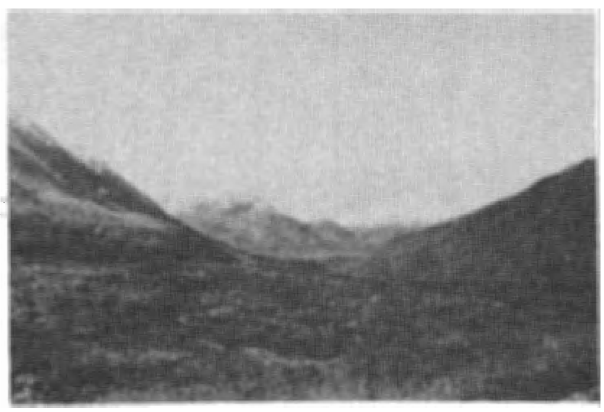
The route of the proposed power transmission corridor generally follows portions of the George Parks Highway (Route 3), the Alaska Railroad, and the Anchorage-Fairbanks Transmission Line Intertie route. The landforms along the transmission line corridor are mainly defined by the Tanana, Nenana, Chulitna, and Susitna river valleys and their tributaries; the Alaska Mountain Range (including Mt. McKinley); the Talkeetna Mountains; and the Cook Inlet off the Gulf of Alaska. The area also contains a number of human developments (e.g., cities, towns, small settlements, highways, and railroad). As previously discussed, the vegetation in the area is diverse and varies with elevation, slope, drainage, and season. Selected views of the landscape types along the proposed transmission corridor are shown in Figure 3-22 (also see App. M, Sec. M.2.1.2, Table M-3 and Figs. M-4 to M-9).



(A) Devil Canyon

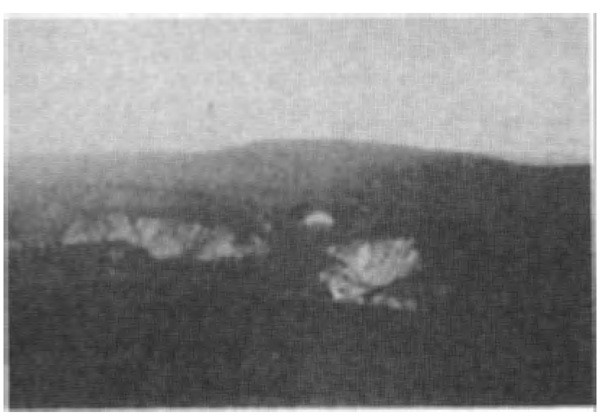


(B) Susitna River Valley

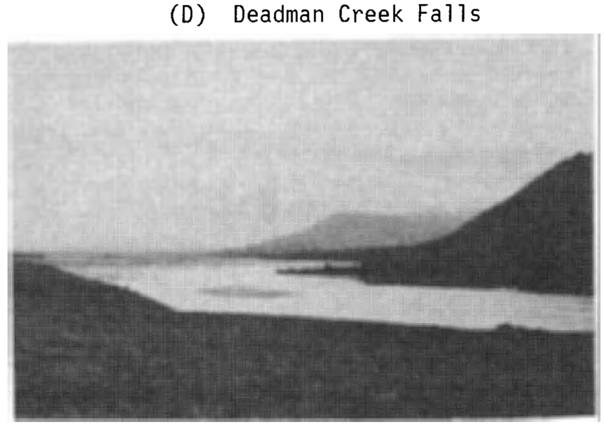


(C) Chulitna Mountains

(D) Deadman Creek Falls



(E) Vee Canyon

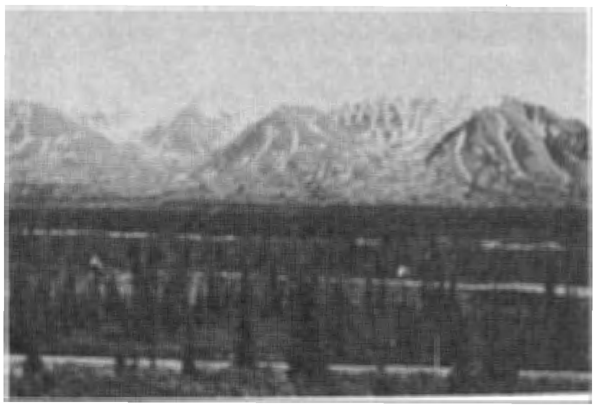


(F) Susitna River Uplands
and Wet Tundra Basin

Figure 3-21. Views of Selected Landscape Character Types and Prominent Natural Features of the Upper and Middle Susitna Basin. [Source: Application Exhibit E, Vol. 8, Chap. 8]

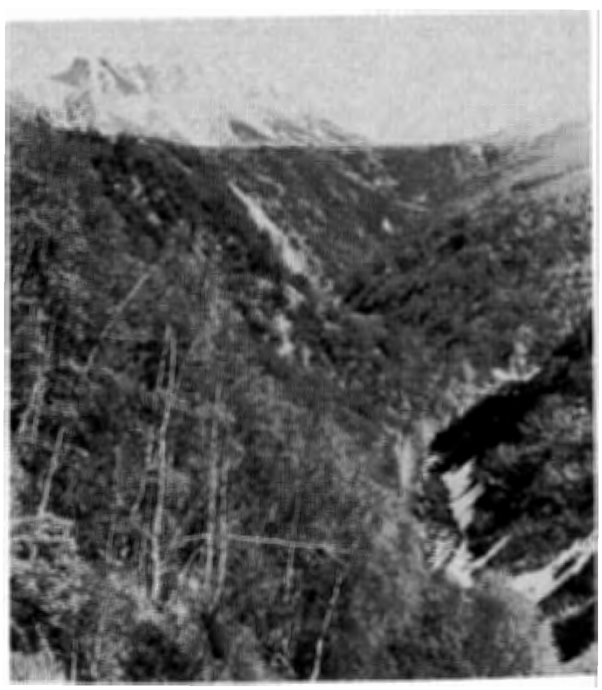
(A) Tanana Ridge

(B) Alaska Range (Windy Pass Area)



(C) Broad Pass

(D) Curry Ridge



(E) Hurricane Gulch

(F) Susitna River Lowlands

Figure 3-22. Selected Landscape Character Types and Prominent Natural Features Along the Proposed Transmission Line Corridor. [Source: Application Exhibit E, Vol. 8, Chap. 8]

3.1.9.2 Prominent Natural Features

A number of prominent natural features occur within the upper and middle basin. The V-shaped valleys of the Susitna River and its tributaries are visually prominent, and forested areas associated with the valleys form distinct paths of green through a predominantly tundra-type landscape. The Susitna River valley is particularly prominent at and near Devil and Vee canyons (see Fig. 3-21), where turbulent rapids, rock outcroppings, shear cliffs, and enclosed canyon walls predominate (see App. M, Sec. M.2.1.1.2). Devil Canyon is a steep-sided, nearly enclosed gorge. The unusual geology, hydrology, and aesthetic characteristics of the canyon make it a notable natural feature within the proposed Devil Canyon dam site and impoundment area, as well as the entire state. Vee Canyon includes a double hairpin bend, has a deeply cut channel, and has a stretch of white-water. The canyon is unusually colorful because it is often interlaid with marble and green schist. Vee Canyon, with its more open walls, is more visible than Devil Canyon, and is a significant visual resource located within the proposed Watana dam reservoir area.

There are numerous clear, fast-flowing mountain creeks within the upper and middle Susitna Basin. Some of these creeks flow over steep and rocky embankments, forming waterfalls and flumes. Deadman Creek Falls is one of the largest and most scenic waterfalls in the project area. It surges over loose rock in an incised channel and plummets vertically over rocky slopes and outcroppings into a clear, boulder-strewn pool (see Fig. 3-21). These falls are located within the proposed Watana impoundment area. There are also numerous lakes in a variety of shapes and settings--from small, irregular-shaped lakes in woodland settings to larger glacial lakes and a complex set of fine, finger-shaped lakes set in a black spruce and shrub wetland area. Views surrounding the basin are often of higher mountain peaks and distant mountain ranges.

A number of prominent natural features occur either within or adjacent to the proposed transmission line corridor (see App. M, Sec. M.2.1.2.2). Many of the mountainous natural features occur within the Alaska Range. The most significant natural feature within the region is Mt. McKinley, which dominates the landscape from various locations along the corridor. A colorful "badlands" type area (soft rock strata rapidly eroding) occurs in the Nenana Uplands. The narrow, steep-walled Nenana Gorge is located to the west of the corridor. Natural features surrounding the scenic Broad Pass area include Mt. McKinley, Mt. Deborah, Mt. Pendleton, Panorama Mountain, and the Reindeer Hills. Notable natural features located within the Chulitna River Valley landscape area include Hurricane Gulch, which has a steeply incised valley that provides for a spectacular view from the Alaska Railroad bridge and George Parks Highway bridge (see Fig. 3-22). The prominent Curry Ridge extends through the Denali State Park, and the Talkeetna Mountains are located to the east. The Susitna River lowlands landscape area includes the scenic Nancy Lake State Recreation Area.

3.1.9.3 Significant Viewsheds, Vista Points, and Travel Routes

The higher mountain peaks, including Deadman, Devil, and Watana mountains, provide vista points that overlook the proposed dam sites and adjacent areas. Views can also be obtained from the more accessible overlooks of Tsusena and Chulitna buttes and along the ridges above Vee Canyon and at Big Lake and Swimming Bear Lake. Many of these sites allow extensive views of the central Talkeetna Mountains and the Alaska Range (see App. M, Sec. M.2.1.1.3, Table M-2).

Views extending within the proposed transmission line corridor area would occur at various points along the George Parks Highway, Alaska Railroad, and from towns and settlements located adjacent to the highway and railroad between Anchorage and Fairbanks (see App. M, Sec. M.2.1.2.3, Table M-3). Significant viewsheds and vista points would occur in numerous locations along the Tanana, Nenana, Chulitna, and Susitna river valley and ridge areas. Views extending into the transmission line corridor would be possible by recreationists along ridge lines and also would occur from various locations within the Denali National Park and Preserve and Denali State Park. Travelers on the George Parks Highway outside of Fairbanks view an existing transmission line at various points between Fairbanks and the line's terminus at Healy. Visible transmission lines and other types of human development are also clearly visible in the Anchorge area.

3.1.10 Cultural Resources

An understanding of the geological context of the cultural resources (i.e., geoarcheology) of the proposed project area is essential to an appreciation of their significance. A large portion of the middle and upper Susitna River Basin contains a sequence of at least three and possibly four distinguishable layers of volcanic tephra (Dixon et al., 1982, 1983). This sequence provides a datable stratigraphic context for numerous archeological sites in the region.

The project study area has been inhabited for at least 12,000 years and contains remains of four prehistoric archeological traditions (identified by diagnostic artifact types): American

Paleoarctic (12,000-6,500 years Before Present, or B.P.), Northern Archaic (6,500-4,000 years B.P.), Arctic Small Tool (4,000-1,500 years B.P.), and Athapaskan (after 1,500 A.D.). Remains from the historic period, following European discovery in the mid-18th Century A.D. and eventual purchase of Alaska by the United States, include non-Native trade goods and sites occupied by miners, hunters, and trappers.

The cultural resources study area for the proposed project contains a total of 423 identified archeological and historic sites. Ongoing survey seems likely to yield additional sites. Most of the sites are concentrated in the middle and upper Susitna Basin, and many of these are likely to be significant (i.e., eligible for inclusion in the National Register of Historic Places) due to their potential contributions to knowledge of Alaskan prehistory and history. Many contain artifacts in stratigraphic (volcanic tephra) context, while some contain multiple components, features, and faunal remains. The following cultural resources occur in areas that would be affected by the proposed project (Dixon et al., 1982, 1983, 1984):

1. Watana dam, impoundment, and associated facilities: 122 archeological and 4 historic sites, 22 of which have been assessed for significance (Fig. 3-23, site groups 1 and 2).

2. Devil Canyon dam, impoundment, and associated facilities: 8 archeological and 3 historic sites, 3 of which have been assessed for significance.

3. Access routes: 30 archeological and 2 historic sites, 1 of which has been assessed for significance (Fig. 3-23, site groups 3 and 5).

4. Transmission lines: 42 cultural resource sites, at least 6 of which are historic and 1 of which has been assessed for significance.

The major remaining task in the evaluation of the existing environment is the assessment of significance for most of the sites in the affected areas. Only one of the sites assessed to date has been termed insignificant. It is apparent that a large proportion of the sites in the proposed Watana and Devil Canyon impoundment areas (but not other project areas) will be judged as significant.

In terms of paleontological resources, plant macro-fossils of Tertiary age have been recovered from a series of localities along Watana Creek (within the Watana impoundment area) (Dixon et al., 1982), and large Pleistocene mammal remains have been found near the Susitna-Tyone confluence and at archeological site TLM 196 on Goose Creek (within the Watana impoundment area) (Dixon et al., 1982, 1984). None of these has been assessed as significant to date.

3.2 SUSITNA DEVELOPMENT ALTERNATIVES

The Susitna development alternatives are described in Section 2.2 (see Figs. 2-13 to 2-17).

3.2.1 Land Resources

The geology and soils for the Watana I-Devil Canyon alternative, the Watana I-Modified High Devil Canyon alternative, and the Watana I-Reregulating dam alternative are similar in nature to those described in Section 3.1.1.1.

Similarly, the land use and ownership for the areas of alternative dam locations and designs, access routes, power transmission routes and borrow areas within the upper and middle Susitna River Basin is as described in Section 3.1.1.2.

3.2.2 Climate, Air Quality, Noise

Because of the short distances between the sites of the proposed Susitna project features and those of the Susitna development alternatives, the information provided in Section 3.1.2 applies. The sites of these alternatives should also have Continental Zone climate, excellent ambient air quality, and very low ambient noise levels.

3.2.3 Water Quantity and Quality

The existing water quantity and quality associated with the sites of the Susitna development alternatives are identical to that of the proposed project sites, as discussed in Section 3.1.3.

3.2.4 Aquatic Communities

The existing aquatic communities in the areas of the in-basin alternatives are identical to those in the area of the proposed project sites, as discussed in Section 3.1.4.

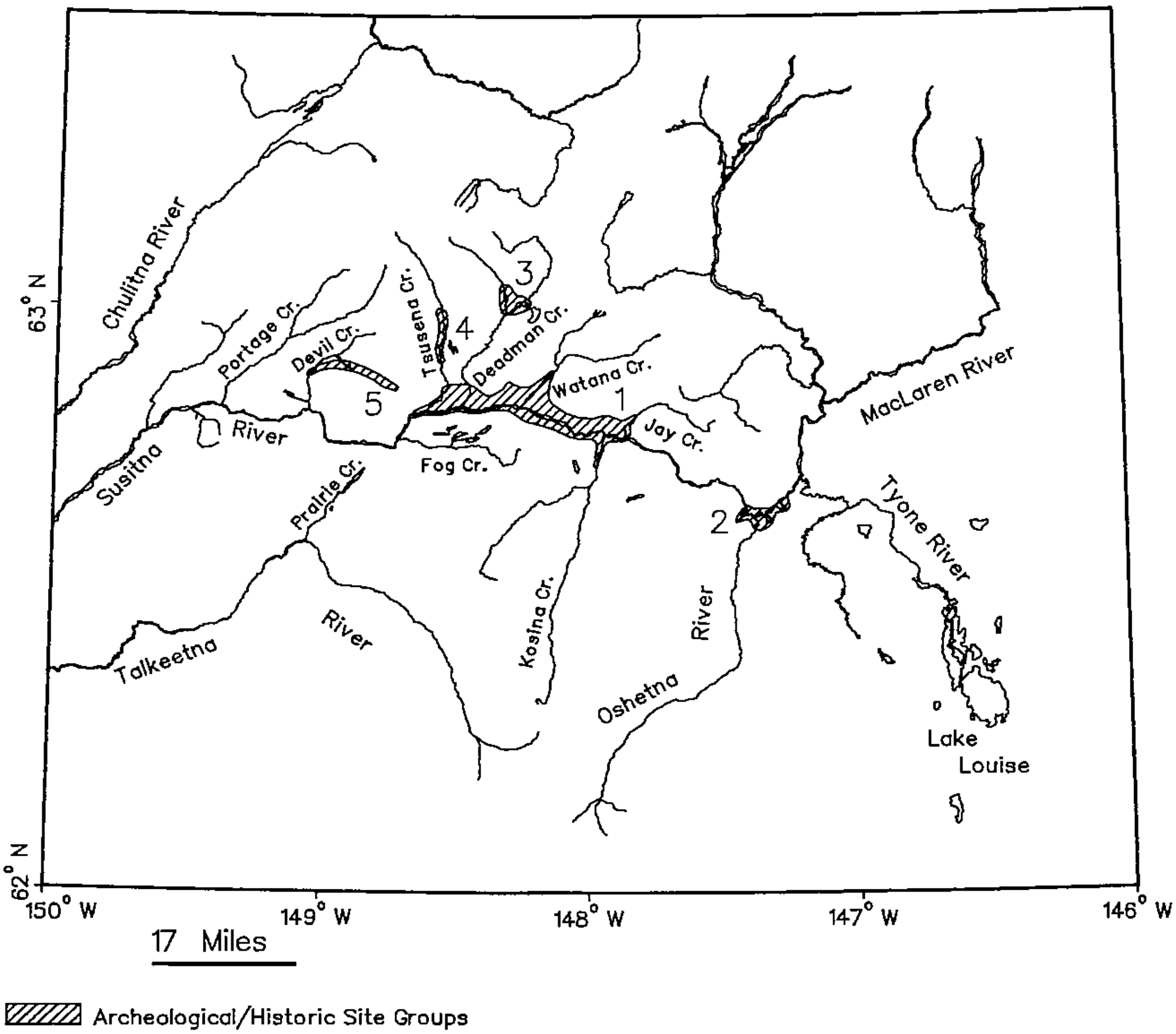


Figure 3-23. Major Cultural Resource Site Groups in the Middle and Upper Susitna Basin. [Source: Based on data from Dixon et al., 1982, 1983, 1984]

3.2.5 Terrestrial Communities

3.2.5.1 Plant Communities ✓

Vegetation types found in the vicinity of the Watana I alternative are essentially the same as those described for the proposed Watana dam and impoundment (Sec. 3.1.5.1). For the Reregulating dam alternative (Fig. 2-17), the dam, impoundment, and powerhouse would be located in spruce and mixed conifer-deciduous forest types. The Modified High Devil Canyon alternative (Fig. 2-17) would be located in essentially the same environment as the proposed Devil Canyon dam and impoundment (Sec. 3.1.5.1), except that mixed conifer-deciduous forest located between the two dam sites would not be affected.

The northern access alternative (Sec. 2.2.2.4 and Fig. 2-13) between Hurricane and Devil Canyon and then over to Devil Creek would traverse mostly white spruce and mixed conifer-deciduous forests, as well as some tall shrub communities (e.g., along Portage Creek) and some riparian and wetland areas. At the higher elevations between Devil Creek and Watana, the route would cross mostly shrublands and various tundra types. The southern access alternative (Sec. 2.2.2.4 and Fig. 2-13) would cross predominately mixed conifer-deciduous forest between Gold Creek and Devil Canyon, and white spruce, mixed forest, and tall shrub types between Hurricane and Devil Canyon. From Devil Canyon to Watana, the route would cross a complex mosaic of vegetation types, including mixed forest, tall shrub, low shrub, tundra, and spruce forest, as well as numerous wetland areas in the eastern portion near Prairie Creek, Stephan Lake, and Tsusena and Deadman creeks.

The alternative power transmission corridors (Figs. 2-14 through 2-16) would cross similar vegetation types as those crossed by the proposed corridors (Sec. 3.1.5.1); however, the proportions of specific vegetation types within the various alternative corridors are not always similar to those of the proposed corridors.

The locations of alternative borrow sites B, C, J, and L are illustrated in Figs. 2-2 and 2-6. Borrow site B is covered mostly by mixed conifer-deciduous forest. Most of borrow site C is covered by a mixture of spruce forest and low shrubland, but tundra types are found at higher elevations. Borrow site J is contained within the Susitna River. Borrow site L is covered by deciduous forest and a marshy area of tall shrub.

3.2.5.2 Animal Communities

In general, alternative Susitna developments would occur within the wildlife ranges described previously for the proposed project. Variations of the Watana dam height would affect the same general wildlife populations described previously, as would alterations in the design of the proposed Watana development features. The High Devil Canyon alternative would be located in an area of lower quality moose habitat than the Watana site and would affect the same populations affected by the upper portions of the proposed Devil Canyon reservoir. The Reregulating dam below Watana would be located in the uppermost 10 mi (16 km) of the proposed Devil Canyon impoundment.

All alternative access routes, power transmission line routes, and borrow sites are within the wildlife ranges previously described. Alternative access to the Parks Highway would cross wetlands between the highway and Gold Creek that are productive aquatic furbearer habitat. The southern alternative access and power transmission line routes between Devil Canyon and Watana would pass near Stephan Lake and Prairie Creek. The latter area has large concentrations of brown bear during salmon spawning in July and August. That area also supports moderate to high densities of moose.

3.2.6 Threatened and Endangered Species

Several of the alternative transmission line corridors from Healy to Fairbanks would pass near the peregrine falcon habitat north of Nenana. Although this area is not currently used by peregrine, several historical nesting locations are situated in the hills overlooking the Tanana River. No other threatened or endangered species of plants or wildlife would be associated with Susitna development alternatives (see Sec. 3.1.6).

3.2.7 Recreation Resources

The pattern of recreation uses throughout the area encompassing the proposed and alternative dam locations is characterized by low-intensity, dispersed recreation activities and trail-related modes of recreation. Thus, the discussion presented in Section 3.1.7 is applicable to alternative dam sites and designs.

No meaningful differences are distinguishable between recreation resource areas and activities associated with the proposed and alternative access routes. The Applicant indicates that considerations of recreation resources were essentially eliminated as criteria for the designation and evaluation of alternative access routes (Exhibit E, Vol. 9, Chap. 10, p. E-10-49).

Following successive screenings, the Applicant identified four alternative corridors for routing the Dam-to-Gold Creek transmission lines. Recreation use patterns of the four alternative corridors are essentially similar; i.e., low-density dispersed recreation activities (see App. L, Sec. L.1.3.3.1). The alternative corridors for the Willow-to-Anchorage transmission lines (Fig. 2-16) encroach on, or are in proximity to, state recreation areas, privately owned recreation sites, and otherwise sensitive areas in several locations, particularly in the Nancy Lakes and Wasilla-Palmer areas. The corridors also variously parallel and/or intersect major tourist routes and recreation trails (see App. L, Sec. L.1.3.3.2). All three of the alternate corridors for the Healy-to-Fairbanks section of the transmission line traverse remote terrain (Fig. 2-15). Recreation use patterns are characterized by low-density, dispersed activities and trail-related modes of recreation (see App. L, Sec. L.1.3.3.3).

Discussion of recreation resource areas and activities presented in Section 3.1.7 relative to dam sites and access routes is also applicable to the alternate borrow sites (see App. L, Sec. L.1.3.4).

3.2.8 Socioeconomic Factors

All the alternative dam locations and designs in the Susitna Basin, and alternative access routes, power transmission routes, and borrow sites would be located in the same socioeconomic setting as the proposed Susitna development as described in Section 3.1.8. Native concerns are particularly important in regard to the access routes, as Native groups control or will eventually acquire control of much of the land in the Susitna Basin area. Project access roads would provide access to this land to develop recreational and business pursuits. However, Native organizations are divided in their preferences for access routes. Each organization prefers the route that would provide greatest access to its land. The Ahtna Corporation supports the proposed Denali-North route; other organizations prefer the southern access route (Federal Energy Regulatory Commission, 1983; Exhibit E, Vol. 9, Chap. 10, p. E-10-48).

3.2.9 Visual Resources

In general, the landscape character types, prominent natural features, and viewing areas for the alternative Susitna dam sites and designs and alternative access routes, borrow areas, and power transmission routes are those described in Section 3.1.9. However, the alternative transmission route segments also extend through four landscape character types not previously identified. These landscapes include (1) Fairbanks landscape character type, characterized by an urban town landscape situated within nearly level floodplains and lowlands with alluvial fans, (2) Little Susitna River landscape character type, bordered by high mountains on three sides and extending into the broad, open Susitna River lowlands to the west, (3) Knik-Matanuska Delta landscape area, which includes the Knik Arm of Cook Inlet and surrounding tideflats (mudflats), tidal marshlands, and some rolling morainal terrain and (4) the narrow, glaciated Chugach Foothills lowland landscape area located between Anchorage and the Knik River delta, bordered by the steep Chugach Mountains to the east and the Knik Arm to the west.

3.2.10 Cultural Resources

Existing cultural resources for the Watana I-Modified High Devil Canyon alternatives would be the same as those described for the proposed Watana and Devil Canyon developments, respectively (see Sec. 3.1.10). The Reregulating dam alternative would affect an area smaller than that impacted by the proposed Devil Canyon dam, excluding one historic and one archeological site.

The following cultural resources occur in the alternative access corridors:

1. Corridor 1 (North): 12 archeological sites, 2 historic sites (Fig. 3-23, site group 5).

2. Corridor 2 (South): no sites reported to date.

3. Corridor 3 (Denali-North): 18 archeological sites (Fig. 3-23, site group 3).

Only one of these has been evaluated for significance (with positive results); it appears likely that the majority of these sites, which lack a stratigraphic context, will not be termed significant. Additional survey would be necessary in order to fully assess existing cultural resources.

The affected environment would be essentially the same for the various alternative transmission line routes with respect to cultural resources. In the Healy area, alternative route Nos. 3 and 4 would affect eight archeological sites, while No. 10 would affect only one. In the Anchorage area, alternative route Nos. 4, 7, and 16 would each affect one site, while Nos. 15 and 17 would affect two and three sites, respectively (Dixon et al., 1984). An on-ground survey would be necessary in order to fully assess existing cultural resources.

Only three borrow sites contain cultural resources:

1. Borrow site C: 20 archeological sites, 1 of which has been assessed as significant (Fig. 3-23, site group 4).
2. Borrow site E: 2 archeological and 1 historic site, 1 of which has been termed significant.
3. Borrow site F: 10 archeological and 1 historic site (Fig. 3-23, site group 4).

A high proportion of these sites are likely to be judged significant, since a majority possess volcanic tephra stratigraphy.

3.3 NATURAL-GAS-FIRED GENERATION SCENARIO

Features of the natural-gas-fired generation scenario are outlined in Section 2.3 (see Fig. 2-18).

3.3.1 Land Resources

3.3.1.1 Geology and Soils

Anchorage-Kenai Peninsula. Thick unconsolidated glacial outwash deposits of the Cook Inlet lowlands cover the eastern shore of the Kenai Peninsula from the Knik River to Katchemak Bay along the edge of the rugged Kenai and Chugach mountain ranges that form the backbone of the peninsula. The agricultural suitability of the Spodsolic soils that cover these lowlands of the Cook Inlet region ranges from good to unsuitable, depending primarily on local drainage. Permafrost deposits are absent in this area. The Kenai Peninsula and Anchorage areas of the Cook Inlet Lowland are located within an area identified as having a high potential for gas and oil development and having known lignite to subbituminous coal deposits.

Chuitna and Lower Beluga Rivers. The Beluga and Chuitna areas are located on the thick fluvial, glacial and glaciofluvial deposits of the western Cook Inlet Lowlands. The Beluga area is situated in the poorly drained floodplains of the braided river channel of the lower Beluga River and the Cook Inlet tidal plains. Soils in the Beluga area are primarily Histosols in the marshy tidal flats and Spodols near the Beluga River and are generally unsuitable for agricultural use. The Chuitna area is located on a broad, rounded moraine southwest of the Chuitna River. Soils at the Chuitna area are Inceptisols and are generally unsuitable for agricultural use because of steep slopes and soil wetness. No mineral resources are known to occur at either the Beluga or Chuitna areas, and permafrost is absent in these areas.

3.3.1.2 Land Use and Ownership

Current land use in the Beluga and Chuitna rivers area is diverse and of low intensity. Dispersed recreation activities occur within the region. Natural resources being developed in the area include oil, gas, coal, and timber. No major ground transportation routes occur in the region. Land ownership in the Beluga area is varied and includes the State of Alaska; Cook Inlet Region, Inc.; Tyonek Native Corp.; and the Kenai Peninsula Borough. Within the northwestern Kenai area land use is mixed and includes developed areas, as well as lands of low-intensity use. Much of the Kenai region is used for recreation purposes. More than half of the Kenai Peninsula is encompassed by the major federal holdings of the Kenai Fjords National Park, Kenai National Wildlife Refuge, and the Chugach National Forest. The major ground transportation corridor in the northwestern Kenai area is the Sterling Highway. Anchorage land use is mixed and ownership diverse. Land use in and surrounding the Anchorage metropolitan area includes residential, commercial, industrial, and recreation. The area is served by the George Parks Highway, Glenn Highway, the Alaska National Railroad, the Anchorage International Airport, and an ocean port.

3.3.2 Climate, Air Quality, Noise

3.3.2.1 Climate

All of the plants that would be developed as part of the natural-gas alternative would be located in the Transition Zone between the inland Continental climates and the Maritime climates bordering the ocean. The plants near Anchorage, the Chuitna River, the Beluga River, and near Kenai would fall in this Transition Zone. At these locations there is a less extreme climate than that of the Interior, with temperatures being moderated somewhat by the nearby seas.

The Cook Inlet area, in general, is in a transitional climate zone between the Continental climate of the Interior and the Maritime climate more common to the coastal areas farther south.

3.3.2.2 Air Quality and Noise

The Cook Inlet Air Quality Control Region is designated a Class II attainment area for all criteria pollutants. The Tuxedni National Wildlife Refuge, about 100 mi (160 km) southwest of the Tyonek area, is the closest Class I area. Anchorage is one of two areas of Alaska (along with Fairbanks) that is nonattainment in terms of the ambient air quality standards for carbon monoxide.

The actual air quality on the western shore of Cook Inlet near Tyonek is not known. Several sources of emissions of particulate matter, sulfur oxides, carbon monoxide, nitrogen oxides, and hydrocarbons are scattered throughout the onshore area, with a number of offshore oil and gas platforms concentrated in the Nikishka/Kenai area. Nitrogen dioxide emissions are greatest, with products of combustion representing the majority from both offshore and onshore pollutant emission sources. The impact of these existing sources on ambient air quality tends to be very localized, with the highest regional pollutant concentrations occurring where source congestion is greatest. The most congested areas include Trading Bay and Salamatof, and even in these areas separation between individual sources is good. For these reasons, air quality within the area is expected to be well within the National and Alaska Ambient Air Quality Standards.

Visibility is occasionally a problem throughout the inlet area. At Anchorage, the visibility is 0.5 mi (0.8 km) or less for 5% of the time during December and January, primarily due to fog.

Air quality data do exist for the Kenai Peninsula area. A monitoring station was set up to provide ambient data for a potential expansion of the Tesoro refinery. Monitoring was conducted from June 1, 1981, to May 31, 1982, at the site. The monitoring site was located about 9 mi (14 km) north-northwest of Kenai and 0.9 mi (1.4 km) south of the refinery. Comparison of the monitoring data with the National Ambient Air Quality Standard reveals that the ambient pollutant levels in the Kenai area are well within the standards.

Recent data on total suspended particulates (TSP) in the northern Kenai Peninsula have shown some excursions beyond the 24-hour average standard, but these are thought to be due to natural dust rather than plant emissions. The occurrences were recorded simultaneously on dry, windy days at both the sampling site in the City of Kenai and the industrial site 10 mi (16 km) north of town. Of particular significance is the 20 to 40 $\mu g/m^3$ increase in TSP concentrations in the industrialized area since land was cleared for construction of a new LNG facility and a major construction project commenced at the ammonia-urea plant.

As mentioned above, Anchorage is designated nonattainment with respect to carbon monoxide due to automobile emissions. It is strictly nonattainment due to TSP but is designated attainment since the TSP violation is due largely to natural sources of particulates. There exists no large stationary source of TSP in Anchorage. Anchorage has air quality monitors inside the city limits and one in an outside rural area that measures sulfur oxides, nitrogen oxides, ozone, carbon monoxide, and TSP.

As described in Section 3.1.2, ambient noise levels are expected to be very low in rural areas such as those identified for the gas-fired plants.

3.3.3 Water Quantity and Quality

Two of the four sites for alternative gas-fired generating facilities are located on river systems--the Beluga and Chuitna rivers, which drain into the western side of Cook Inlet. The other two gas-fired plants would be sited on or very close to Cook Inlet at Kenai and in the Anchorage vicinity. Both the Beluga and the Chuitna sites are in the Beluga flats, a marshy lowland area. The rivers in the Beluga region originate in the Alaska Range and have glacial flow regimes similar to those described for the Susitna Basin.

Although specific water sources for all sites of the combined-cycle, gas-fired unit alternative have not been specified, data for two sites (Beluga River and Chuitna River) do not indicate any water quality characteristics that would preclude construction and operation of gas-fired, combined-cycle power plants at these sites (Exhibit E, Vol. 9, Chap. 10, Table E.10.35). Water quality of these sites is comparable to that of most other large rivers in Southcentral Alaska in terms of the concentration of major ions, dissolved solids and gases, nutrients, and suspended solids. Since water use is zero for the gas-fired combustion turbines, water quality is not an issue for this alternative.

3.3.4 Aquatic Communities

Although specific sites for the units that would be developed under this alternative have not been designated, the list of fish species in potentially affected streams and lakes in the vicinity of the lower Beluga River, the Chuitna River, Cook Inlet near Kenai, Turnagain Arm southeast of Anchorage, and in the immediate vicinity of Anchorage are likely to include some or all of the following: the five Pacific salmon, burbot, cottids, Dolly Varden, grayling, northern pike, rainbow trout, sculpin, suckers, whitefish, and a variety of marine fish and invertebrate species that depend greatly on the exact locations selected. Because of the larger size of the facilities and the greater requirements for water, the combined-cycle units (as compared to the smaller combustion turbines) are likely to be associated with larger streams and lakes having more of these species. The combined-cycle units are also more likely to be located in relatively remote areas.

3.3.5 Terrestrial Communities

3.3.5.1 Plant Communities

Based on Figure 3-16, vegetation in the lower Beluga River area is mostly upland spruce-hardwood forest except near the coast, where wet sedge-grass predominates. The Chuitna River originates in an area of high brush and then extends through upland spruce-hardwood forest on its way to Cook Inlet. North of Kenai the vegetation is primarily lowland spruce-hardwood forest, although a relatively narrow strip of upland spruce-hardwood forest occurs along the coast. Southeast of Anchorage the natural vegetation has probably been altered somewhat by development activities. Undisturbed or relatively undisturbed areas are likely to be bottomland spruce-popular forest, upland spruce-hardwood forest, or lowland spruce-hardwood forest.

3.3.5.2 Animal Communities

Principal big game in the Chuitna-Beluga area are brown and black bear and moose. Summer concentrations of moose occur on the lower Chuitna River and upper Chuit Creek and to the east along the Beluga River. A winter concentration area of moose occurs westward along Nikolai Creek and eastward from the mouth of the Beluga River. Black bear denning habitat occurs along the middle Chuitna and upper Nikolai Creek. Brown bear denning occurs in the uplands; however, summer feeding concentrations occur in several areas in the lower drainage of the Chuitna River. Bald eagles are common raptors throughout the area, whereas cliff-nesting raptors are uncommon. A number of waterbirds, including trumpeter swan and sandhill crane, occur in the coastal wetlands. A variety of ducks, geese, and loons are common in the area.

The Kenai Peninsula supports a wide array of wildlife populations. Concentrations of moose, caribou, and waterfowl occur in all the areas with available natural gas. An area of intensive use by black bear occurs northwest of Kenai and Soldotna. Other species occurring in the Kenai area include brown bear, Dall's sheep, mountain goat, and wolf.

Anchorage is basically urbanized and provides limited wildlife habitat. However, moose and other wildlife do use the area on occasion. South of Anchorage along the Seward Highway, Potter Marsh supports a large number of waterbirds.

3.3.6 Threatened and Endangered Species

No threatened or endangered species of plants or wildlife would be associated with any features of the natural-gas-fired generation scenario (see Sec. 3.1.6).

3.3.7 Recreation Resources

No substantial developed recreation sites occur in the relatively remote Beluga and Chuitna river areas, although recreation use is substantial (Bechtel, 1983). Hunting and fishing are the principal dispersed recreation activities, which also include hiking, camping, and skiing, and other water-based recreation activities.

Readily accessible by land or water, much of the northwestern Kenai Peninsula is within the Kenai National Wildlife Refuge, which affords opportunities for wilderness recreation experiences, as well as use of developed facilities (Simmerman, 1983). State recreation areas afford additional opportunities for public use of developed facilities.

In the Anchorage-Turnagain Arm area, recreation resources of municipal parks, Chugach State Park, and Chugach National Forest afford numerous opportunities for public use of developed recreation sites, as well as a wide range of dispersed recreation activities (Simmerman, 1983). The Alyeska Resort and other private developments further contribute to locally abundant recreation opportunities (Alaska Northwest Publishing, 1983).

3.3.8 Socioeconomic Factors

The socioeconomic environments of the potential sites of the eight 200-MW combined-cycle units are Kenai, Soldotna, the northern Kenai Peninsula, the Tyonek area southwest of Anchorage, and the Anchorage metropolitan area (Fig. 3-24). The potential sites of the two 70-MW combustion turbines using gas would be near Anchorage. The socieconomic environment of the Anchorage area is discussed in Section 3.1.8; socioeconomic factors of the northern Kenai Peninsula and of the Tyonek area are summarized here.

Kenai, Soldotna, and some small settlements north of Kenai (e.g., Salamatof and Nikishka) are in what is called the Central Peninsula area of the Kenai Peninsula Borough. The economy and life of the area are based on fishing and timber industries, oil and gas development, tourism, and

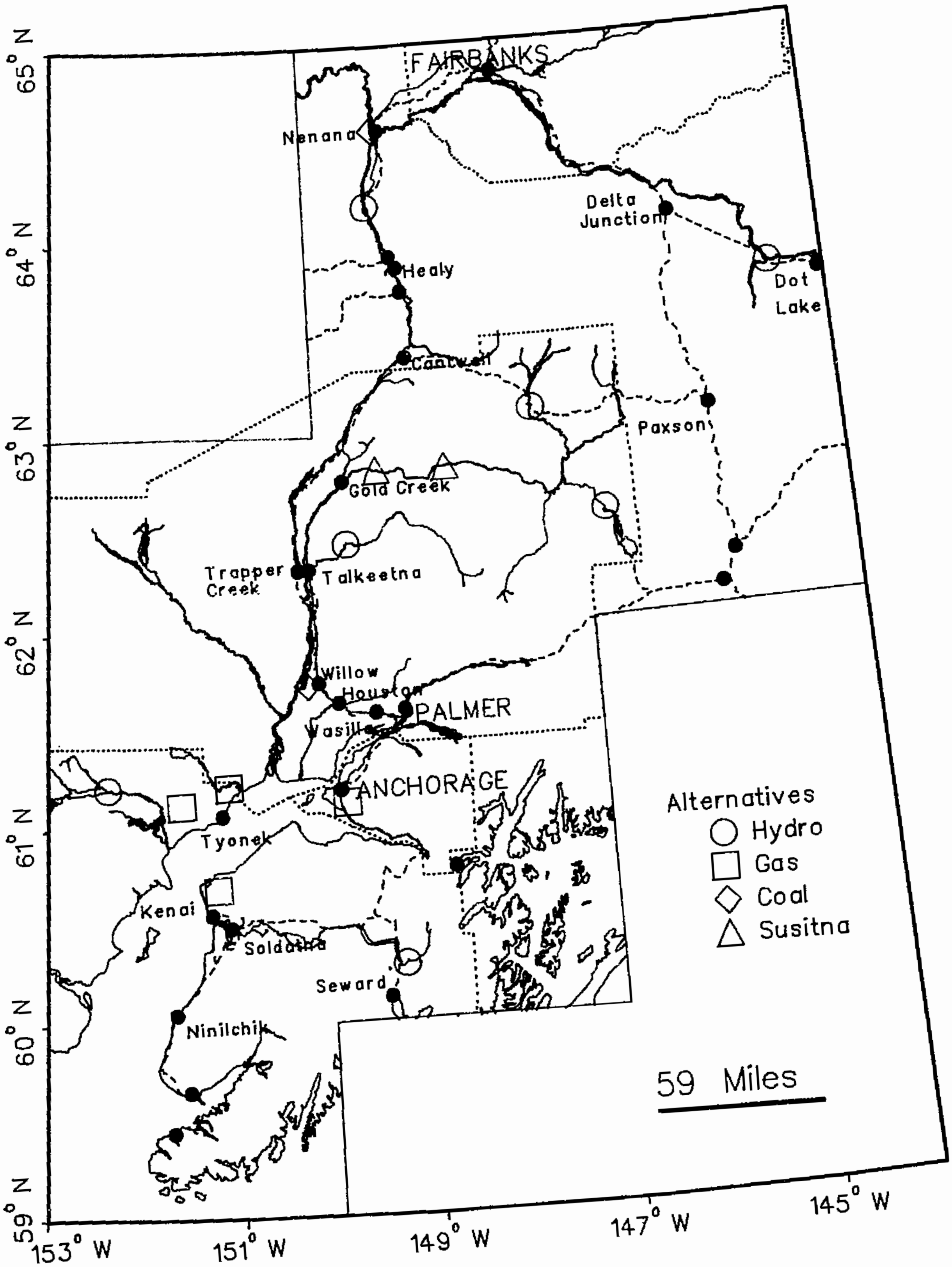


Figure 3-24. Locations of Susitna Hydropower Alternatives and Features of the Socioeconomic Environment.

subsistence activities. Almost 90% of the population of Kenai Peninsula Borough reside in the Central Peninsula in the communities of Kenai, Soldotna, Homer, and Seldovia (Fig. 3-24). The 1982 populations of Kenai and Soldotna were 5,231 and 3,008 persons, respectively. North and northeast of the Kenai-Soldotna area, the 1982 population totaled 4,120--2,014 in Nikishka, 1,143 in Salamatof, and the remainder scattered outside of communities. Population increased by 20% or more in this region between 1978 and 1982, and growth is expected to continue through 1992. Borough planners have three growth scenarios projecting growth rates of 3.3%, 48%, or 106% between 1978 and 1992. The actual growth rate between 1978 and 1982 was about halfway between the medium and high scenarios. The population in Kenai and Soldotna is over 90% white; the remainder is primarily Native Alaskan (Kenai Penin. Bor. Resour. Dev. Off., 1983).

Employment in the Central Peninsula is concentrated in government, followed by manufacturing, services, and wholesale and retail trades, in that order. As with other areas in Alaska, the unemployment rate is high, varies considerably seasonally, and has ranged widely over the past decade. Per-capita income for the borough was $10,158 in 1980, a value that ranked 18th among Alaska's 29 census divisions and is lower than the U.S. average (Alaska Office of Management and Budget, 1983; Kenai Penin. Bor. Resour. Dev. Off., 1983). Personal and property taxes make up only slightly more than a third (39%) of total borough revenues; intergovernmental sources (e.g., from the state) contribute 45% of total revenues. In contrast, the incorporated cities of Kenai and Soldotna rely on personal property taxes from their residents for over 50% of their revenues. Schools are the greatest expense (U.S. Bureau of Land Management, 1981; Kenai Penin. Bor. Resour. Dev. Off., 1983).

In 1977, Kenai and Soldotna had about 1,300 and 700 households, respectively. Single-family units are most common in all communities (App. N, Table N-11), and between 30% and 40% of residences units are rented. Vacancy rates for apartments vary seasonally.

Both Kenai and Soldotna have a full range of elementary and secondary schools. Most households in the two communities rely on city water and sewer systems. Fire service is provided by each city and by borough-administered service area departments. The latter are supported by property taxes in the service areas. The Central Peninsula General Hospital is in Soldotna. There are also three district mental health care centers, one of which is in Kenai (Kenai Penin. Bor. Resour. Dev. Off., 1983).

The Kenai Peninsula is accessible by highway from Anchorage via Sterling Highway (Highway 1). Smaller roads, most unpaved, extend north of Kenai to Salamatof and the area around Nikishka. Fishing boats, personal boats, commercial ships, and barges also serve the coastal areas of the peninsula. Rail service on the peninsula is available only between Anchorage and Seward, via Portage. Kenai and Homer both have airports, which are used below capacity. Other airstrips for small planes are scattered around the peninsula.

Tyonek is located between the Chuitna and Beluga rivers on the western shore of Cook Inlet (Fig. 3-24). Tyonek is a Federally chartered Native Alaskan village that had a population of 239 in 1980 - only seven persons more than in 1970. Except for Tyonek, the area is sparsely populated. The Tyonek Native Corporation represents the Natives in the village. The policy of the corporation in the past has been not to allow easements and rights-of-way across their land, thus limiting the development of natural resources in the Tyonek area (Bechtel, 1983).

Employment opportunities in the Tyonek area are limited to a few service jobs in the Village and to jobs in the development of natural resources, e.g., commercial fishing, timber harvesting and processing, and exploration for petroleum. Most of these opportunities are seasonal, and unemployment is high, particularly in winter. Personal income is low, and most households rely on Native/Public Health benefits or some other form of aid (e.g., food stamps, Social Security) to supplement their incomes. Because of strong ties to Native Alaskan culture, the lack of employment opportunities, and the low incomes, there is heavy reliance on subsistence activities. Like employment, subsistence activities are more productive and accessible during the summer (Bechtel, 1983). Residents of Tyonek Village pay property taxes to the Central Hospital Service Area, which supports the hospital (located in Soldotna on the Kenai Peninsula), borough services, and public recreation facilities.

Almost all of the approximately 90 homes in Tyonek are single-family residences owned by the Tyonek Village Council. There are only six trailers (two for temporary residences for school teachers) and no multifamily units. A permanent worker camp at the nearby lumber mill and nearby Shirleyville Lodge provide housing facilities for workers and visitors.

Village houses are connected to the village water system, which depends on a lake as it source, while public buildings and services and industry use well water. Large septic tanks, currently in poor condition, provide the village with wastewater disposal. Police service is provided by a resident constable who is employed by the Alaska State Troopers; fire protection is provided by the U.S. Bureau of Land Management. A medical center in Tyonek has emergency medical and dental care facilities, but no doctors or dentists are in permanent residence in the community. One school, with capacity for 240 students, serves about 90 elementary through high school students (Bechtel, 1983).

Tyonek and the Chuitna and Beluga river areas are accessible by unpaved roads. No road connecting the area to Anchorage is open year-round, except when the Susitna River freezes to provide a winter crossing. There is one primary airport in Tyonek, controlled by the Village, and several other privately owned, smaller, and less well-maintained strips. Tyonek and industrial operations along the coast also are served by barge.

3.3.9 Visual Resources

Visual characteristics of the Beluga/Chuitna rivers region include steep mountains, vegetated uplands, and coastal wetlands. The region is dominated by mountains, glaciers, lakes, and streams in the Alaska Range. Panoramic views of spectacular mountainous and glaciated terrain are common.

Within the Kenai Peninsula area, visual resources range from high mountains and glaciers to uplands, dense forests, lakes, rivers, and wetlands (Alaska Geographic Society, 1981). A number of small communities and homesteads are scattered along the Sterling Highway. Views of the Cook Inlet and lowlands, uplands, and mountainous regions are often highly scenic.

The Anchorage area consists of an urbanized town landscape situated within rolling and flat terraced lowlands. Rolling and moderately steep slopes occur in the Chugach Foothills. The area is dominated by the Knik and Turnagain arms of the Cook Inlet. Because of the flat to undulating terrain, views are generally open. The Alaska Range, nearby Mount Susitna, the Kenai Mountains, and the Cook Inlet, with its unusual mud flats, can be viewed within the Anchorage urban area.

3.3.10 Cultural Resources

Few cultural resources have been discovered in the areas that would be affected by the natural-gas generation scenario. Four archeological sites are known in the Kenai area, but here, as well as in the Beluga-Chuitna and Anchorage areas, site-specific surveys would be necessary to adequately assess cultural resources.

3.4 COAL-FIRED GENERATION SCENARIO

The coal-fired generation scenario is described in Section 2.4 (see Fig. 2-18).

3.4.1 Land Resources

3.4.1.1 Geology and Soils

The Willow area is located in the flat, poorly drained, alluvial plain of the lower Susitna River Basin. Well to poorly drained Entisol soils with severe use limitations are present adjacent to the Susitna River and on the river terraces east of the river in the Willow area. Spodsolic soils are present. These soils are suitable for cultivation and have few use limitations. Permafrost is absent in this area and, to date, with the exception of coal, no mineral resources have been identified.

The Nenana area is located on thick alluvial floodplain deposits south of the Tanana River. Poorly drained Inceptisol soils are present in low lying areas of the Tanana floodplains and have severe use limitations due to permafrost deposits and wetness. Away from the floodplains, the Inceptisols are well drained and are potentially suitable for cultivation. With the exception of coal, no mineral resources have been identified in the area to date.

3.4.1.2 Land Use and Ownership

General land use and ownership patterns in the Nenana/Healy area and Willow area are described in Section 3.1.1.2. Mining activities occur in the Nenana vicinity and extensively in the Healy area. Residential development and recreational use occurs within the Willow area. Agricultural sales have occurred along the George Parks Highway and 5 mi (8 km) southwest of Willow. Land use and ownership in the Cook Inlet area is diverse. Much of the region is relatively remote, and current land use is diverse and generally of low intensity. Dispersed recreation activities occur within the region. Natural resources being developed include oil, gas, coal, and timber. The City of Anchorage, the state's major metropolitan area, is also located within the Cook Inlet Region.

3.4.2 Climate, Air Quality, Noise

3.4.2.1 Climate

The coal-fired generation scenario would involve plants sited at Willow and Nenana. These locations are in the Continental Climatic Zone and should have similar climatic features as the proposed Susitna project area (Sec. 3.1.2). Data collected at Willow since 1963 reveal a record high temperature of 90°F (32°C) and record low temperature of -56°F (-49°C).

3.4.2.2 Air Quality and Noise

The nearest air quality monitoring stations to Willow are at Palmer and Eagle River. These data are for TSP alone and reveal frequent exceedences of the 24-hr TSP standard due to fugitive emissions. Recent data at Palmer reveal much lower TSP concentrations (below the standard) and this is probably due to a recent paving of a nearby road. Baseline data from the Healy Plant near Nenana revealed excellent air quality. The Healy measurement stations were at North Nenana and Garner. Measurements were available in the periods of January 1979 - August 1979 (SO_2 and meteorological data) and March 1978 - July 1979 (TSP). The SO_2 data revealed no exceedence of standards; the TSP data indicated increases from very low levels only when the wind was blowing from the river bank. At both sites, ambient levels of all pollutants are expected to be extremely low, except for TSP. Ambient noise levels are expected to be very low in the rural environment in which the coal-fired plants would be located.

3.4.3 Water Quantity and Quality

The river basins affected by coal-fired power plants would be the Lower Susitna River Basin below Willow (approximately RM 45), the Tanana River Basin below the confluence of the Nenana and Tanana rivers, and the basin within which coal mining would be located (probably the Nenana River Basin). Both generating facilities would be located on relatively large river systems with low gradients and highly braided channels. The Susitna River at the USGS gaging station at Sunshine (RM 84) has a upstream watershed area of 11,100 mi^2 (28,750 km^2) and an average annual flow of 23,611 ft^3/s (669 m^3/s). The Tanana River at Nenana has a upstream watershed area of 25,600 mi^2 (66,300 km^2) and an average annual flow of 23,490 ft^3/s (665 m^3/s). Low flows of record at the two sites are during the winter months: 5,400 ft^3/s (153 m^3/s) for the Susitna River at Sunshine and 4,000 ft^3/s (113 m^3/s) for the Tanana River at Nenana.

Water quality of the existing environments likely to be affected by the coal-fired power plant alternative (two units on the Susitna River near Willow and three units on the Nenana River near Nenana) can be classified as good and is similar to that for the Susitna River (see Sec. 3.1.3.2), and other large rivers in Southcentral Alaska. These rivers typically have low to moderate concentrations of dissolved solids and nutrient ions, high concentrations of dissolved oxygen, and seasonally varying concentrations of suspended solids, reaching a maximum in summer and a minimum during winter.

3.4.4 Aquatic Communities

The list of fish species in potentially affected streams and lakes at Willow, Nenana, and around Cook Inlet may include burbot, cottids, Dolly Varden, grayling, longnose sucker, northern pike, rainbow trout, sculpin, and whitefish. Due to the larger size of the facilities and the greater requirements for water, the coal units, as compared to the smaller combustion-turbine units, would be associated with larger streams and rivers, such as the Chuitna and Susitna, having more of these species.

3.4.5 Terrestrial Communities

3.4.5.1 Plant Communities

Based on Figure 3-16, vegetation in the Willow area is primarily lowland spruce-hardwood forest, although bottomland spruce-poplar forest is found along the Susitna River. Along the Tanana and Nenana rivers near Nenana, the vegetation is primarily bottomland spruce-poplar forest. Farther away from the rivers the predominant vegetation type is lowland spruce-hardwood forest. In the vicinity of Healy, where the coal would be mined (Fig. 1-14), vegetation along the Nenana River and its tributaries is upland spruce-hardwood forest. Away from the river, at higher elevations, the vegetation grades into moist tundra and alpine tundra. Vegetation occurring in likely locations for siting of gas combustion turbines for this scenario has been described in Section 3.3.5.1.

3.4.5.2 Animal Communities

The area around Willow supports wildlife populations typical of those found along the lower Susitna drainage. Moose concentrate along the river and near Nancy Lakes. Black bear make intensive use of areas southwest of Willow. Waterfowl occur in low to moderate densities in the vicinity of Willow. Bald eagle and trumpeter swan nest along drainages in the area.

The Nenana area is located in the northern third of the proposed transmission line route. In the vicinity of Nenana, winter concentrations of moose occur along the river. Low to high densities of waterfowl are found in the vicinity of Nenana. The Minto Flats area to the north supports a high density of waterfowl.

The Healy mining area is also situated along the northern portion of the proposed transmission line route. The area supports species characteristic of more open habitats, such as caribou and brown bear. Winter aggregations of caribou occur in the vicinity of the mine. Moose and black bear range through the area in fewer numbers. Habitat for Dall's sheep and cliff-nesting raptors is located in the highlands 10 mi (16 km) south of the mine area.

3.4.6 Threatened and Endangered Species

Development of coal-fired power generation facilities in Nenana would occur in the vicinity of peregrine falcon habitat situated north of the Tanana River. Although this area is not currently used by peregrine, several historical nesting locations are known to exist northeast of Nenana. No other threatened or endangered species of plants or wildlife would be associated with the coal-fired generation scenario (see Sec. 3.1.6).

3.4.7 Recreation Resources

Dedicated recreation areas near Willow include the Nancy Lake State Recreation Site and the Willow and Nancy Lake State Recreation Areas; other nearby dedicated areas include the Finger Lake, Rocky Lake, and two Big Lake State Recreation Sites (Park Planning Section, 1982). Several commercial developments and private recreation cabins further contribute to local recreation resources.

In the Nenana area, local accommodations serve travelers of the Parks Highway and Alaska Railroad, which are major tourist routes (Alaska Northwest Publishing, 1983). The Nenana and Tanana rivers are popular recreation corridors, and local dispersed recreation consists primarily of hunting and fishing activities.

Recreation resources in the Cook Inlet area are presented in Section 3.3.7.

3.4.8 Socioeconomic Factors

The socioeconomic environment for the coal-fired generation scenario would include the communities of Healy and Nenana (coal mine site) in the Yukon-Koyukuk Borough, Willow, the Tyonek area, metropolitan Anchorage, and the northern Kenai Peninsula. Socioeconomic aspects of these areas are described in Sections 3.1.8 and 3.3.8.

3.4.9 Visual Resources

The landscape character types and associated prominent natural features and views in the Nenana/Healy and the Willow areas are generally described in Section 3.1.9. Views can become monotonous within the braided river areas of the Nenana River lowlands and the Willow area because of the lack of topographical relief and lack of distinctive and varying foreground features. The Nenana upland views are oriented to the Alaska Range to the south and the high foothills to the east. Existing transmission lines are visible in the region. Visual characteristics of the Cook Inlet region are extremely varied and include steep mountains, vegetated uplands, and coastal wetlands, as generally described in Section 3.3.9. Views are often open and panoramic, with mountainous and glaciated terrain visible in the background. The Cook Inlet region also includes the Anchorage area, which is described in Section 3.3.9.

3.4.10 Cultural Resources

Only limited information on cultural resources is presently available for the areas that would be affected by the coal-fired scenario. One archeological and three historic sites are known in the Willow area, and seven cultural resource sites are currently recorded for the Nenana area. A number of archeological and historic sites are known around the shores of Cook Inlet (Dixon et al., 1984; Smith, personal communication*). Site-specific surveys, which seem likely to yield additional sites, would be necessary in order to fully assess existing cultural resources.

3.5 COMBINED HYDRO-THERMAL GENERATION SCENARIO

Features of the combined hydro-thermal generation scenario are described in Section 2.5 (see Figs. 2-18 to 2-22).

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*Smith, T.A. (Office of History and Archaeology, Alaska State Division of Parks). Oral communication to J.F. Hoffecker (Argonne National Laboratory), March 24, 1984.

3.5.1 Land Resources

3.5.1.1 Geology and Soils

The Johnson alternative would be on the Johnson River, which flows from its headwaters in the glaciers of the Alaska Range through the Alaska Range foothills northward through the broad, flat plains of the Tanana River valley in the Tanana-Kuskokwin Lowlands. Thick outwash deposits from the Alaska Range and alluvial materials cover the alternative site. Permafrost deposits are discontinuous, and Inceptisol soils potentially suitable for agriculture are present in the lowlands. No mineral resources are present in the site area.

The Keetna alternative would be located on the lower Talkeetna River at the edge of the steep Talkeetna Mountains in the Copper River Plateau. Glacial deposits cover the slopes of the Talkeetna River in the Keetna area. Spodsolic soils occur in this area, but are agriculturally unsuitable due to steep slopes. No mineral resources are present in the area.

Located in the extremely rugged Kenai Mountain Range of the Kenai Peninsula, the Snow site would occupy a deep bedrock gorge on the Snow River near the southern end of Kenai Lake. Graywackes and states are exposed throughout the area, and surficial deposits and soils are generally absent. Spodsolic soils occur only in the river valley. Numerous mineral resources are expected to exist in the area, although none has been identified in the proposed reservoir area.

The Browne alternative would be located in the modified moraine and glacial drift deposits of the Nenana River Valley just north of Healy at the northern edge of the unglaciated Northern foothills of the Alaska Range. Easily eroded, soft Tertiary sediments that include extensive coal deposits of the Nenana coal field are present north and east of Healy. Inceptisol soils capable of limited agricultural use and discontinuous permafrost are present.

The Chakachamna alternative would be located at Lake Chakachamna, which is in a deep glaciated valley in the southernmost region of the Alaska Range. The lake is surrounded by numerous glaciers, moraines, and high mountain peaks, one of which, Mt. Spurr, is an active volcano. Volcanic, glacial, and fluvial deposits and agriculturally unsuitable Inceptisol soils cover much of the area. Isolated masses of permafrost are present in this area. The area has geothermal energy potential and is located adjacent to the Beluga coal fields.

Descriptions of the geology and soils for the lower Beluga River, the Chuitna River, and the Anchorage environs are presented in Section 3.4.1.1. Descriptions for the Nenana area are presented in Section 3.3.1.1.

3.5.1.2 Land Use and Ownership

The Chakachamna Lake area is remote, and current land use is diverse and of low intensity. Recreation use within the area is limited but increasing (Bechtel, 1983). Future land use will probably revolve around resource extraction, processing, and transportation of oil, gas, coal, and timber. The Browne site is located within the Alaska Railbelt Region near the vicinity of the communities of Healy, Suntrana, and Ferry. Land use is diverse and of low intensity. Dispersed recreation use occurs throughout the area. Extensive coal deposits and mining occur in the area east of Healy. Major transportation routes in the area include the George Parks Highway and the Alaska National Railroad.

Land uses in the Keetna area are characterized by dispersed, low-intensity recreation and subsistence activities. The closest development consists of several homesteads at Parson Lake, about 13 mi (21 km) southwest of the site area. Access in the site area is limited. The nearest major transportation routes are the George Parks Highway and the Alaska National Railroad, located approximately 15 mi (24 km) west of the area. The Snow site alternative is located within the Chugach National Forest, which is managed for multiple use. Occasional and intermittent uses in the region include recreation, sport hunting and fishing, subsistence, seasonal residences, and resource exploration (Selkregg, 1974). Major transportation routes in the area include the Alaska Highway and the Alaska National Railroad.

Occasional and intermittent land use in the Johnson area includes recreation, sport hunting and fishing, subsistence, seasonal residences, and resource exploration. Some rural settlement and agricultural use occurs along the Tanana River east of the Johnson River confluence. The nearest community is Dot Lake, located about 15 mi (24 km) east of the Johnson site on the Alaska Highway. Land use and ownership patterns for the Nenana, Chuitna River, and Anchorage areas are described in Sections 3.3.1.2. and 3.4.1.2.

3.5.2 Climate, Air Quality, Noise

Under this alternative scenario, the coal-fired, combined-cycle, and gas turbine plants would be located primarily near Anchorage and Nenana. The existing environments in these areas have been described previously in Sections 3.1.2 through 3.4.2. The non-Susitna Basin hydropower units at

Johnson, Browne, Keetna, and Snow should have similar climate, air quality, and noise features as the Susitna project area. The Chakachamna site is close to Tyonek, which was discussed in Section 3.3.2.

3.5.3 Water Quantity and Quality

The five potential hydropower sites included in this alternative are located outside of the upper Susitna River Basin. Watershed area and summary flow statistics for these sites are given in Table 3-11. With the exception of the Johnson and Snow sites, annual hydrographs for these sites are dominated by glacial meltwaters similar to each other and to the Susitna River at the Devil Canyon/Watana dam sites. At the Johnson site, glacial influence is minimal and peaks in the annual hydrograph occur later in August and September due to summer rainfall. The Snow site is in a coastal drainage with high elevation and high annual precipitation [greater than 100 inches (250 centimeters) per year].

Table 3-11. Watershed and Stream Flow Characteristics of Alternative, Out-of-Basin Hydroelectric Projects

			Summer Peak Flows		
Site/River	Watershed Area (mi^2)	Mean Annual Flow (cfs)	90th Percentile	10th Percentile	Winter Low Flows (cfs)
BROWNE/ Nenana River	2,450	4,700	22,000	9,100	500-1,000
CHAKACHAMNA/ Chakachatna River	1,120	3,600	17,000	9,600	400-700
JOHNSON/ Tanana River	10,450	11,000	40,000	24,000	4,000-6,000
KEETNA/ Talkeetna River	2,006	2,400	14,000	5,000	400-1,000
SNOW/ Snow River	634	710	1,200	750	400-1,500

Conversions: To convert square miles (mi^2) to square kilometers (km^2), multiply by 2.59; to convert cubic feet per second (cfs) to cubic meters per second (m^3/s), multiply by 0.0283.

Source: Based on data from Chapman (1982).

Water quality of the existing environments likely to be affected by construction and operation of the proposed hydropower alternatives can be classified as good and is comparable to that for the Susitna River sites described in Section 3.1.3.2 (U.S. Geological Survey, 1979). The major difference among the four alternative hydropower sites for which data are available is in the magnitude of seasonal variations in suspended solids, with the maximal summer concentration being greater in rivers and lakes fed by glacial melt water (Nenana, Tanana, Chakachamna) than in the system fed by snowmelt alone (Talkeetna) (U.S. Geological Survey, 1979). There is an indication of depressions in dissolved oxygen in the Tanana River during winter, with the magnitude of the depression being greater downstream than upstream (Schallock and Lotspeich, 1974). Water quality data for the Snow River was not available.

3.5.4 Aquatic Communities

Out-of-basin hydroelectric alternatives are located in areas that represent a diversity of aquatic communities.

For the Johnson alternative, three species of salmon (chinook, coho, and chum) are harvested by sport fisherman in the Tanana River drainage (Alaska Dept. of Fish and Game, 1983). Most of the spawning occurs in the lower basin, but some may occur near the potential dam site. Rainbow trout, grayling, whitefish, burbot, and sheepfish are species resident in the region. A comparison of the sport fish harvest to that in other drainage basins is presented in Table 3-12.

Four species of anadromous salmon (chinook, coho, chum, and sockeye) are present in the reach of the Talkeetna River containing the potential dam site for the Keetna alternative. Chinook are

Table 3-12. Summary of Five-Year Average Sport Fish Harvests in River Basins That Include Alternative Hydropower Sites

Basin (alternative)	Number of Fish (thousands)									
	Chinook	Coho	Chum	Grayling	Sockeye	Pink†[1]	Rainbow	Burbot	D. Varden	Total
Kenai (Snow)	18	43	0.35	1.9	75	43/14	32	0	65	280
W. Susitna (Chakachamna)	4.6	9.4	1	6.9	1.7	5.4/3.8	12	0.33	3.7	45
E. Susitna (In-basin) (Keetna)	1.4	7.8	5.6	9.5	1.3	52/13	7.2	0.38	3.5	89
Tanana (Browne) (Johnson)	0.5	0.1	0.35	73	0	0	12	2.3	0.6	23

†[1] High/low runs.

Source: Mills (1979-1982).

known to spawn in tributaries near and upstream from the site. Data from Alaska Department of Fish and Game monitoring stations on the Susitna River at Sunshine (below the Talkeetna confluence) and Talkeetna (above it) show many fish not progressing up the Susitna River that may use the Talkeetna River (App. I, Fig. I-10). Resident species in the river, tributaries, and surrounding lakes are likely to include rainbow and lake trout, grayling, burbot, and whitefish.

No anadromous fish are known to occur in the Snow River. Sockeye and coho are present in the drainage system and in Kenai Lake. Resident species of interest in Kenai Lake include rainbow trout and whitefish.

No anadromous fish occur in the Nenana at the potential Browne alternative site. Resident species in the river, tributaries, and surrounding lakes are likely to include grayling, rainbow and lake trout, burbot, and whitefish.

In the area of the potential Chakachamna alternative site, all five species of Pacific salmon are found in the Chakachatna River and tributaries. Resident species in Lake Chakachamna include lake trout, Dolly Varden, grayling, whitefish, and sculpins. Spawning by salmon in the river below the lake occurs primarily in the sloughs and tributaries. However, the largest salmon escapement in the basin occurs in the Chillegan and Igitna rivers upstream of the lake, where approximately 41,000 sockeye spawn. Lake Chakachamna is the primary rearing area for these fish. The McArthur River system is similar to the Chakachatna River below the lake, where most salmon spawning occurs in the tributaries. Fish from both river systems use Noaukta Slough. Estimated salmon populations for the Lake Chakachamna basin are presented in Table 3-13, and the relative importance of this area to overall sport fishing is presented in Table 3-12.

Table 3-13. Estimated Salmon Escapement from the Chakachamna Region, 1982

Species	Chakachatna	MacArthur
Chinook	2,521	3,583
Coho	2,599	4,729
Chum	1,920	29
Sockeye	43,637	52,400
Pink	8,263	19,777

Source: Bechtel (1983).

3.5.5 Terrestrial Communities

3.5.5.1 Plant Communities

The following descriptions of vegetation occurrence near sites identified for the combined hydro-thermal scenario are based primarily on Figure 3-16. Along the Tanana River near the Johnson alternative site the vegetation is mostly bottomland spruce-poplar forest; farther away from the Tanana River floodplain and along the Johnson River, the vegetation is mostly upland spruce-hardwood forest. However, there are also smaller areas of lowland spruce-hardwood forest and low shrub, muskeg bog, as well as moist tundra and alpine tundra at the higher elevations.

Bottomland spruce-poplar forest types predominate along the Talkeetna River near the Keetna alternative site. These forests grade into upland spruce-hardwood forests away from the floodplain. At higher elevations above the river the vegetation consists of moist tundra types (i.e., mesic sedge-grass tundra and mat and cushion tundra) similar to those found on the benches above the Susitna River canyon.

Forested areas near the Snow alternative site are mostly coastal western hemlock-Sitka spruce forest; however, cottonwoods and willows probably dominate the river valleys and floodplains. Tall shrub communities, dominated by alder, grade into alpine tundra types above the tree line.

Vegetation along the Nenana River near the Browne alternative site is mostly bottomland spruce-poplar forest. Farther from the river the vegetation grades into lowland spruce-hardwood communities. About 10 mi (16 km) upstream from the dam site, upland spruce-hardwood forest communities predominate along the river. At higher elevations the vegetation grades into moist tundra and alpine tundra.

The vegetation on the steep slopes surrounding Chakachamna Lake can be generally classified as tall shrubland with alpine tundra and bare rock at higher elevations. The Chakachatna River canyon and the floodplains of rivers flowing into Chakachamna Lake are also covered by tall shrub communities. Large, low-shrub bogs are found on flat, poorly drained areas as the topography flattens out to the upper Cook Inlet coastal plain. Sedge-grass coastal marshes cover most of the area within 1 mi (1.6 km) of Cook Inlet, as well as some areas along the McArthur River. Intermediate between the coastal marshes and the bogs are poorly drained areas of black spruce forest. These areas differ from the bogs in the lack of floating vegetation mats and the absence of black cottonwood (Bechtel, 1983).

Vegetation in the vicinity of Nenana, the lower Beluga River, the Chuitna River, and Anchorage, where thermal units for this scenario would probably be sited, have been described in Sections 3.3.5.1 and 3.4.5.1.

3.5.5.2 Animal Communities

Common mammals in the Chakachamna area are moose, black and brown bear, coyotes, and gray wolf. River otter, barren-ground caribou, and wolverine are occasionally encountered during field surveys. Moose are common throughout the area, principally in habitat associated with drainages into Chakachamna Lake and the Chakachatna and McArthur River riparian habitats. Moose are abundant in the coastal marsh riparian habitat at the mouths of the rivers and less abundant in upland alder thickets on the slopes above Chakachamna Lake. Black and brown bear are abundant in the areas above Chakachamna Lake and just downstream. High altitude, riparian habitat supports the most bear. Bear become less common in downstream habitats along the Chakachatna and McArthur rivers. Gray wolf are commonly found in high altitude riparian habitat. Coyote are distributed over all habitats, and are abundant in coastal marsh habitat. Coastal marsh riparian habitat supports the greatest diversity of birds. Trumpeter swan, Canada goose, marsh hawk, bald eagle, sandhill crane, and several species of gulls are commonly found in coastal marshes. This habitat also supports an abundance of ducks. Bald eagle nests are concentrated in the marsh habitat of Noaukta Slough and the lower Chakachatna and McArthur rivers. Trumpeter swan nests are most dense in an area from Noaukta Slough to Blockade Glacier along the McArthur River.

The wildlife species in the area of the Browne site are typical of those found in the central portions of the Railbelt. Important big game include moose, caribou, black and brown bear, and Dall's sheep. Moose concentrate in the general area during fall and winter. In winter in particular, moose tend to concentrate in riparian habitat along the Nenana River. Caribou range throughout the area, and winter concentrations are found along the Nenana. Dall's sheep concentrations are found in the highlands above the Nenana River some 10 mi (16 km) south of the Browne site. Brown and black bear range throughout the area. Several miles to the south, an area intensively used by brown bear is located around the entrance to Denali National Park and Preserve. Furbearers occur along the Nenana River but do not appear to be very common. Although waterfowl use the area along the Nenana River, densities tend to be low. A major flyway occurs through the area, parallel to the Nenana River. Common raptors include sharp-shinned hawk, rough-legged hawk, American kestrel, and golden eagle.

The wildlife species of the Keetna area are typical of those found in the middle Susitna drainage. The site is located in an area of fall and winter concentrations of moose. Caribou range throughout the region, and winter concentrations occur around the potential dam site. Concentrations of Dall's sheep are well removed, some 25 mi (40 km) to the southeast. Black and brown bear also range through the area. The brown bear fishing area at Prairie Creek is upstream of this site. This is not a major waterbird use area.

The riparian habitat in the Snow River supports moose and other wildlife. Upstream and downstream of the potential dam site are areas of fall and winter moose concentration. Mountain goat and Dall's sheep occupy the steep slopes above the site. Black and brown bear and wolf range across the area. Waterfowl use the vicinity of the site for a nesting and molting area during spring and summer.

Moose and caribou range throughout the area of the Johnson site, and a fall concentration area for moose is located to the southwest along the Johnson River. A bison calving area is located downstream of the site, along the Tanana River. Black and brown bear are also present. Low densities of waterfowl use the area for nesting and molting.

The wildlife populations of the Nenana, Chuitna River, and Anchorage areas--potential sites of coal-fired units under this alternative--have been described previously.

3.5.6 Threatened and Endangered Species

Development of coal-fired power generation facilities in Nenana would occur in the vicinity of peregrine falcon habitat situated north of the Tanana River. Although this area is not currently used by peregrine, several historical nesting locations are known to exist northeast of Nenana. No other threatened or endangered species of plants or wildlife would be associated with the combined hydro-thermal generation scenario (see Sec. 3.1.6).

3.5.7 Recreation Resources

Dedicated recreation sites in the general area of the Johnson River include the Tok River, Moon Lake, Clearwater and Donnelly Creek State Recreation Sites, and the Quartz Lake and Harding Lake State Recreation Areas (Park Planning Section, 1982). River touring on the Tanana River is available on a commercial basis.

Accessibility by a major trail affords opportunities for a wide range of trail-related activities and dispersed recreation in the otherwise remote area of the Keetna alternative. Sport hunting and fishing, and river running are among the more popular activities (Alaska Dept. of Natural Resources, 1982).

Campsites, boat launch and other ancillary facilities, as well as several hiking trails are maintained by the U.S. Forest Service in the area of the potential Snow alternative (Alaska Northwest Publishing, 1983). Private establishments along the Seward Highway provide tourist accommodations, as well as guide and other services for local recreation opportunities.

The Nenana River affords opportunities for river touring and other water-based recreation in the Browne area. A developed wayside area, as well as private establishments, provide accommodations for travelers of the Parks Highway (Alaska Northwest Publishing, 1983). Other local outdoor recreation consists of dispersed activities, primarily hunting and fishing.

Summary discussions relative to recreation resources of Chakachamna (Beluga and Chuitna river areas), Chuitna River, Anchorage, and Nenana areas are presented in Sections 3.3.7 and 3.4.7.

3.5.8 Socioeconomic Factors

Locations of the five potential hydropower facilities are shown in Figure 3-11. The socioeconomic environment of the Johnson site would include the communities of Tok, Delta Junction, and metropolitan Fairbanks; the Keetna environment would include Talkeetna, the Railbelt, and the metropolitan areas of Anchorage and Fairbanks; the Snow socioeconomic environment would include the city of Seward and the Eastern Peninsula section of the Kenai Peninsula Borough; socioeconomic environment of Browne would be the communities of Healy, Nenana, Fairbanks, and northern Mat-Su Borough; and the Chakachamna site would be in the Tyonek area. The thermal units in this scenario would be a subset of those described in Sections 3.3.8 and 3.4.8. Their socioeconomic environments would include Nenana, Healy, metropolitan Fairbanks, the northern Railbelt, the Tyonek area, and metropolitan Anchorage. Healy, Nenana, Paxson, the entire Railbelt, Talkeetna, Anchorage, and Fairbanks are described in Section 3.1.8. The Tyonek area and the northern Kenai Peninsula are described in Section 3.3.8.

The Snow hydropower alternative would be located near the southeastern coastline of the Kenai Peninsula. The nearest population center to the site is Seward, which is the largest population center on the Eastern Peninsula of the Kenai Peninsula (1982 population of 1,828). The population of the Seward Census Division, which includes Seward and the eastern coastal areas of the Kenai Peninsula, has increased by 31% since 1970, to a 1982 total of 3,500 (Kenai Penin. Bor. Resour. Dev. Off., 1983).

Seward is a home rule city and thus has power to tax its citizens, to provide education and other community services, and to plan and zone. Areas around it are served by departments provided through Seward Service Area taxes. Seward is the southern terminus of the Alaska Railroad and of Highway 9 from Anchorage, and is a cargo port. Primary industrial bases for Seward are fishing and processing for fish and timber. The Eastern Peninsula is a popular tourist attraction, and tourism provides an important part of the economic base of the whole area. However, Federal, state, and local government employ about 20% of the working population in the Seward Census Division. The total labor force in 1982 was 1,622. The unemployment rate is volatile, and at 14.7% in 1982, is usually higher than in the rest of the borough or in the state as a whole. Wages from government employment made up over 40% of the total wage payments in 1980. The 1980 per-capita income was $11,967, slightly higher than for the rest of the borough, but the cost of living in Seward is also higher (Kenai Penin. Bor. Resour. Dev. Off., 1983; Alaska Office of Management and Budget, 1983).

In 1982, just under 70% of housing in the city of Seward was in single family units, with almost all the remaining 30% in apartment units (App. N, Table N-11). Less than 1% was in mobile homes. Vacancy rates are not available. Nearly all Seward households are on city water and sewer systems. Seward has one hospital, one mental health clinic, and its own fire and police departments. The Eastern Peninsula has four elementary schools and one high school; one of the elementary schools and the high school are in Seward.

The Johnson hydropower alternative site is just north of the Alaska Highway about 140 mi (220 km) southwest of Fairbanks. The largest communities in the area are Delta Junction to the northeast of the site and Tok to the southwest. Tok is a small, unincorporated community at the intersection of the Alaska Highway and the Tok cut-off of the Glenn Highway, about 70 mi (110 km) southeast of the site. Tok's 1980 population was 750, up 250% since 1970. The town is primarily a service center for tourists and highway vehicles using the Alaska Highway. Thus, employment is seasonal for many residents. In 1982, an average of 11,620 passengers per month entered Alaska at the Tok Station, almost 33,000 in June alone (Kenai Penin. Bor. Resour. Dev. Off., 1983). There are several motels, three commercial campgrounds, elementary and high schools, a public health clinic, a fire department, a State Trooper station, and small airfield, which serves private and chartered planes. Services are provided by the state (Alaska Northwest Publishing, 1983; U.S. Bureau of the Census, 1973).

Two small native communities, Tanacross (1982 population of 117) and Dot Lake (1982 population of 67), are located on the Alaska Highway between Tok and the Johnson site. Tanacross has an airstrip and is the site of a fireguard station for the area. Dot Lake has a few lodging units and a few tourist-related services. One lodge is located about 30 mi (50 km) northwest of the site on the Alaska Highway.

Delta Junction, an incorporated community (1982 population of 1,044) at the merger of the Alaska and Richardson Highways, is about 40 mi (64 km) farther northwest on the Alaska Highway. It has full community services, including a fire station, a health clinic staffed by a physician's associate, and schools. The town's commercial operations are tourist-oriented. The area around Delta Junction is used for agriculture, primarily growing of barley (Alaska Northwest Publishing, 1983).

Between Delta Junction and Fairbanks are a number of lodges, motels, and other tourist facilities and one community, North Pole (1980 population of 928), located just south of Fairbanks (Alaska Northwest Publishing, 1983).

3.5.9 Visual Resources

The visual characteristics of the Chakachamna Lake area include steep mountainous terrain, vegetated uplands, and coastal wetlands. Chakachamna Lake, Chakachatna River Canyon, and the headwaters of the McArthur River are located in narrow glaciated valleys that are surrounded by steep and rugged mountainous terrain (Bechtel, 1983). Extended views from along the lake offer scenic vistas of glaciers descending into the lake. The Chakachatna River descends from the lake and goes through a twisting canyon surrounded by steep mountainous terrain.

The landscape character of the Browne area is mainly defined by the braided Nenana River Valley and its tributaries and the Alaska Mountain Range, which includes Mt. McKinley. The area includes scattered small lakes, bog areas, wetlands, and numerous islands within the broad floodplain. A number of small human development areas occur in the Railbelt corridor. Views are essentially oriented to the mountains of the Alaska Range and high foothill areas.

The Keetna area is located in the lower half of the Talkeetna River Basin. Major landforms include the Talkeetna Mountains, located to the northeast. The vegetation near the project site is predominately upland spruce-hardwood forest. Two scenic areas located in the area include Sentinel Rock and Granite Gorge (Exhibit E, Vol. 8, Chap. 10, p. E-10-13).

The Snow River is one of the Kenai Peninsula's major river drainage systems. The region is characterized by glacially carved valleys, rugged, snow-capped mountain ridges, and a variety of vegetation types. Large glacial icefields are located in the Kenai Mountains northeast of the Snow site.

The dominant landform in the Johnson area is the Alaska Range. Johnson River is located in a glaciated "U"-shaped valley. The braided river flows toward the broad valley of the Tanana River, which is bordered by the Alaska Range and rounded, gentle ridges to the south and slopes of the Yukon-Tanana Upland area to the north.

The landscape character for the Nenana area is described in Section 3.4.9. The Chuitna River and Anchorage landscapes are described in Section 3.3.9.

3.5.10 Cultural Resources

Cultural resource sites are unknown in most of the areas that would be affected by the combined hydro-thermal scenario. No sites are currently recorded for the Johnson, Keetna, or Chakachamna alternative dam sites. The area of the alternative Snow River site possesses several historic sites, however, and the Browne site contains over 50 archeological and historic sites, many of which appear likely to be significant. No sites are known in the Beluga combined-cycle and Anchorage combustion-turbine siting locations, but seven archeological and historic sites are recorded in the Nenana area (Smith, personal communication*). Site-specific surveys would be necessary in all areas to properly assess existing cultural resources.

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*Smith, T.A. (Office of History and Archaeology, Alaska State Division of Parks). Oral communication to J.F. Hoffecker (Argonne National Laboratory), March 24, 1984.

REFERENCES FOR SEC. 3

Alaska Department of Commerce and Economic Development. 1983. 1983 Long Term Energy Plan. Working Draft. Division of Energy and Power Development.

Alaska Department of Environmental Conservation. 1979. Water Quality Standards. Juneau.

Alaska Department of Fish and Game. 1973. Alaska's Wildlife and Habitat. Vol. I. Juneau.

Alaska Department of Fish and Game. 1978. Alaska's Wildlife and Habitat. Vol. II. Juneau.

Alaska Department of Fish and Game. 1983. Susitna Hydro Aquatic Studies, Phase II Basic Data Report. Vol. 4. Aquatic Habitat and Instream Flow Studies, 1982. Prepared for the Alaska Power Authority. Anchorage.

Alaska Department of Labor. 1983. Alaska Planning Information. Juneau. 160 pp.

Alaska Department of Natural Resources. 1982. Land Use Issues and Preliminary Resource Inventory. Vol. 1: Planning Background Report. Prepared in cooperation with the Matanuska-Susitna Borough, Alaska Department of Fish and Game, and Transportation and Public Facilities of the Kenai Peninsula Borough. 199 pp.

Alaska Geographic Society. 1981. Alaska National Interest Lands - The D-2 Lands. Alaska Geographic. Vol. 8, No. 4. Anchorage.

Alaska Northwest Publishing Co. 1983. The Milepost 1983. Alaska, Western Canada. 35th ed. Anchorage. 496 pp.

Alaska Office of Management and Budget. 1983. Alaska Statistical Review 1982. Vol. II. Office of the Governor, Division of Strategic Planning. 179 pp.

Associated Press. 1983. Gorsuch: subsistence "constitutional". The Anchorage Times. March 10, p. B-3.

Bailey, R.G. 1978. Description of the Ecoregions of the United States. U.S. Department of Agriculture, Forest Service, Intermountain Region. Ogden, UT. 77 pp.

Bechtel Civil and Minerals, Inc. 1983. Chakachamna Hydroelectric Project Interim Feasibility Assessment Report. Vol. 1, Sec. 1-10, Appendices to Sec. 4.0 and 8.0, and Vol. II, Appendix to Sec. 6.0. Prepared for the Alaska Power Authority. Anchorage.

Bredthauer, S. and B. Drage. 1982. Task 3, Hydrology: River Morphology. Prepared by R&M Consultants, Anchorage, for Acres American Incorporated. Buffalo, NY.

Campbell, A. 1983. Steady growth rate increases Mat-Su land values. The Anchorage Times. March 23, p. B-1.

Chapman, D.L. 1982. Daily Flow Statistics of Alaskan Streams. NOAA Technical Memorandum NWS AR-35. United States Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service. Anchorage. 57 pp.

Commonwealth Associates, Inc. 1982. Anchorage-Fairbanks Transmission Intertie, Alaska Power Authority, Environmental Assessment Report. Prepared with assistance from DOWL Engineers and Kevin Waring Associates.

Darbyshire & Associates. 1980. City of Bethel Comprehensive Development Plan. Vol. III. The Bethel Economy: Present and Future.

Dixon, E.J., G.S. Smith, R.C. Betts and R.M. Thorson. 1982. Final Report, Sub-Task 7.06. Cultural Resources Investigations for the Susitna Hydroelectric Project: A Preliminary Cultural Resources Survey in the Upper Susitna River Valley. Prepared by University of Alaska Museum, Fairbanks, for Acres American, Inc. Buffalo, NY. 1011 pp.

Dixon, E.J., G.S. Smith, M.L. King and J.D. Romick. 1983. Final Report 1982 Field Season, Sub-Task 7.06. Cultural Resources Investigation for the Susitna Hydroelectric Project: Cultural Resource Survey in the Middle Susitna River Valley. Prepared by University of Alaska Museum, Fairbanks, for Acres American, Inc. Buffalo, NY. 346 pp.

Dixon, E.J., G.S. Smith, W. Andrefsky, B.M. Saleeby, C.J. Utermohle and M.L. King. 1984. Susitna Hydroelectric Project: 1983 Field Season Cultural Resources Investigation (3 volumes). Prepared by University of Alaska Museum, Fairbanks, for Alaska Power Authority. Anchorage.

DOWL Engineers. 1983. Matanuska-Susitna Borough Comprehensive Development Plan. Draft. Prepared for Matanuska-Susitna Borough.

Dwight, L.D. 1981. Susitna Hydroelectric Project, Reveiw of Existing Water Rights in the Susitna River Basin. Prepared for Acres American Incorporated. Buffalo, NY.

Edgar, D.E., L-J. Onesti and G.M. Kaszynski. 1982. Alaskan Coal: Resources and Environmental Constraints. ANL/LRP-18. Argonne National Laboratory for U.S. Department of Energy. 131 pp.

Ender, R.L. 1980. Mat-Su Housing and Economic Development Study: Survey Findings. Prepared by Policy Analysts, Limited, for Alaska Department of Community and Regional Affairs, with Matanuska-Susitna Borough, Cook Inlet Native Association, and Mat-Su OEDP, Inc.

Federal Energy Regulatory Commission. 1983. In the matter of Alaska power authority, Docket No. Project 7114, Vol. 1. Public Scoping Meetings, June 20-23, 1983.

Frank Orth & Associates, Inc. 1982. Alaska Power Authority Susitna Hydroelectric Project. Environmental Studies Final Report. Subtask 7.05: Socioeconomic Analysis. Prepared for Terrestrial Environmental Specialists, Inc., and Acres American, Inc.

Frank Orth & Associates, Inc. 1983. Susitna Hydroelectric Project Subtask 4.5: Socioeconomic Studies. Draft Final. Projection Assumptions, Methodology and Output Formats. Prepared for Harza-Ebasco and the Alaska Power Authority. 94 pp.

Grogan, R.L. 1983. Letter and comments from R.L. Grogan, Associate Director, Alaska Office of the Governor, to L. Crawford, Alaska Power Authority, regarding Susitna Hydroelectric Project Application. 18 November.

Hoffman, D.G. 1983. Village economies. The danger of village economies based on government spending. Alaska Native News. July, pp. 15-17.

Irvin, G. 1983. Letter from G. Irvin, Natural Resources Director, Rural Alaska Community Action Program, to B.A. Payne, Argonne National Laboratory. August 5.

Kenai Peninsula Borough Resource Development Office. 1983. Situation and Prospects. Kenai Peninsula Borough. 121 pp.

Matanuska-Susitna Planning Department. Undated. MSB Population Projections (Amended). 1 p.

McKendrick, J., W. Collins, D. Helm, J. McMullen and J. Koranda. 1982. Susitna Hydroelectric Project, Environmental Studies, Subtask 7.12: Plant Ecology Studies, Phase I Final Report. Prepared by University of Alaska Agricultural Experimental Station, Palmer, for the Alaska Power Authority. Anchorage. 124 pp.

Mills, M.J. 1979. Alaska Statewide Sport Fish Harvest Studies. ADF&G Federal Aid in Fish Restoration. Volume 20. F-9-11, SW-I.

Mills, M.J. 1980. Alaska Statewide Sport Fish Harvest Studies 1980. Alaska Department of Fish and Game. Federal Aid in Fish Restoration. Volume 21. F-9-12, SW-I. 65 pp.

Mills, M.J. 1981. Alaska Statewide Sport Fish Harvest Studies - 1980 Data. ADF&G Federal Aid in Fish Restoration and Anadromous Fish Studies. Volume 22. F-9-13, SW-I.

Mills, M.J. 1982. Alaska Statewide Sport Fish Harvest Studies. ADF&G Federal Aid in Fish Restoration. Volume 23. F-9-14, SW-I.

Myers, E.F. Undated. Comments on Northern Alaska Environmental Center to the Federal Energy Regulatory Commission Respecting the Proposed Susitna Hydroelectric Project, FERC Project No. 7114.

National Park Service. 1982. Index. National Park System and Related Areas. U.S. Government Printing Office. Washington, DC. 94 pp.

Neiland, B.J. and L.A. Viereck. 1977. Forest types and ecosystems. pp. 109-136, In: Symposium Proceedings North American Forest Lands at Latitudes North of 60 Degrees. University of Alaska. Fairbanks.

Park Planning Section. 1982. Alaska State Park System: South Central Region Plan. Alaska Division of Parks, Department of Natural Resources. 153 pp.

Park Planning Section. 1983. Master Plan for the Proposed Willow Creek State Recreation Area. Division of Parks, Alaska Department of Natural Resources. 86 pp.

Reeder, B., S. Goldsmith, K. White and G. Knapp. 1983. MAP Model Regional Base Case Projections 1980-2010 for use in OCS Lease Sale 87 (Diapir Field) Impact Analysis. Prepared by Institute of Social and Economic Research, University of Alaska, Fairbanks, for Minerals Management Service, Alaska OCS Office. 19 pp.

R&M Consultants. 1981. Susitna Hydroelectric Project. Hydrology Water Quality in 1980.

R&M Consultants and L.A. Peterson and Associates. 1982. Water Quality Effects Resulting from Impoundment of the Susitna River.

Schallock, E.W. and F.B. Lotspeich. 1974. Low Winter Dissolved Oxygen in Some Alaskan Rivers. Report No. EPA-660/3-74-008. U.S. Environmental Protection Agency. Washington, DC. 33 pp.

Selkregg, L.L. 1974. Alaska Regional Profiles. Vol. I. Southcentral Region. The University of Alaska, Arctic Environmental Information and Data Center. Anchorage. 255 pp.

Selkregg, L.L. 1977. Alaska Regional Profiles. Vol. VI. Yukon Region. The University of Alaska, Arctic Environmental Information and Data Center. Anchorage. 346 pp.

Simmerman, N.L. 1983. Alaska's Parklands, The Complete Guide. The Mountaineers. Seattle, WA. 336 pp.

Stenehjem, E.J. and J.E. Mitzger. 1980. A Framework for Projecting Employment and Population Changes Accompanying Energy Development. Vols. I and II. Report ANL/AA-14. Argonne National Laboratory. Argonne, IL.

Terrestrial Environmental Specialists, Inc. 1982a. Susitna Hydroelectric Project, Environmental Studies, Subtask 7.08: Recreation Planning, Phase I Report. Prepared in cooperation with the University of Alaska for Acres American Inc. Buffalo, NY. 39 pp.

Terrestrial Environmental Specialists, Inc. 1982b. Susitna Hydroelectric Project, Environmental Studies, Subtask 7.07: Land Use Analysis. Phase 1 Report. Prepared for Acres American, Inc. Buffalo, NY.

Trihey, E.W. 1982. Instream Flow Assessment for the Proposed Susitna Hydroelectric Project. Prepared for Acres American Incorporated. Buffalo, NY. 108 pp.

U.S. Bureau of Land Management. 1981. Final Environmental Impact Statement, Proposed Outer Continental Shelf Oil and Gas Lease Sale, Lower Cook Inlet/Shelikof Strait.

U.S. Bureau of Land Management. 1982. Final Environmental Impact Statement, Proposed Outer Continental Shelf Oil and Gas Lease Sale 71, Diapir Field. U.S. Department of the Interior.

U.S. Bureau of the Census. 1973. 1970 Census of Population. Vol. 1: Characteristics of the Population. Part 3: Alaska. U.S. Department of Commerce.

U.S. Bureau of the Census. 1980. 1980 Census of Population. Characteristics of the Population, Number of Inhabitants, Alaska. PC80-1-A3. U.S. Department of Commerce.

U.S. Department of the Interior. 1980. Protection of Eleven Alaskan Streams. Heritage Conservation and Recreation Service. Washington, DC. 139 pp.

U.S. Geological Survey. 1979. Water Resources Data for Alaska. USGS Water-Data Report AK-79-1. National Technical Information Service. Springfield, VA.

Van Cleve, K. and L.A. Viereck. 1981. Forest succession in relation to nutrient cycling in the boreal forest of Alaska. pp. 185-211, In: D.C. West, H.H. Shugart, and D.B. Botkin (eds.), Forest Succession: Concepts and Application. Springer-Verlag. New York.

Van Cleve, K., C.T. Dyrness, L.A. Viereck, J. Fox, F.S. Chapin III and W. Oechel. 1983. Taiga ecosystems in interior Alaska. BioScience 33:39-44.

Viereck, L.A. and C.T. Dyrness. 1980. A Preliminary Classification System for Vegetation of Alaska. Forest Service Technical Report PNW-106. Pacific Northwest Forest and Range Experiment Station General, U.S. Department of Agriculture. 38 pp.

Yarzebinski, J. 1983. Economic Base Study, Anchorage, Alaska, 1983. Draft. Prepared by Department of Community Planning, Research Section, and Anchorage Economic Development Commission for the Municipality of Anchorage. 109 pp.

4. ENVIRONMENTAL IMPACT

4.1 PROPOSED PROJECT

4.1.1 Land Resources

4.1.1.1 Geology and Soils

During the Susitna construction phase, Watana reservoir slope stabilities would be affected by the changing groundwater regimes in the reservoir vicinity and by the thawing of the permafrost deposits present throughout the Watana area. Solifluction, skin flows, and bimodal failures would occur and would be most likely on north-facing slopes between the dam site and Vee Canyon where frozen basal tills are present. Seismic activity in the area would increase the magnitude and frequency of such failures.

Soil erosion would occur throughout the reservoir area as a result of construction activities, e.g., vegetation stripping, construction camp and village development, excavation of borrow sites, and road construction. The Applicant proposes to control erosion by restricting vegetation stripping activities wherever possible, promoting rapid revegetation of disturbed areas around construction sites, locating facilities on gentle slopes when possible, and using revetments, desilting ponds, and berms wherever feasible. These and other measures would reduce, although not prevent, erosion losses.

Permafrost thaw would result in differential settlement of soils and sediment flows. Because the temporary construction camp and village, the airstrip, and numerous site roads would be located in areas of permafrost, the Applicant proposes to use insulating bases to prevent permafrost thaw.

Although the Watana/Devil Canyon reservoir complex would be among the world's largest, reservoir-induced seismicity would be unlikely because no faults with recent displacement are known to occur in the immediate reservoir vicinity and because the Applicant proposes to fill the reservoir at a slow, steady rate.

During the operation phase, Watana reservoir slope instabilities would be related to seasonal fluctuations in the reservoir level. Thawing of the permafrost deposits would result in initial slope instabilities that would lessen with time. Seepage in the Watana relict channel would be greatest when the reservoir was filled. Grouting would be used if seepage losses were found to be excessive. Because of the over-consolidated nature of the relict channel deposits, liquefaction of these deposits when saturated would not be likely. Many of the areas susceptible to erosion during the construction period would be inundated by the reservoir, but erosion losses would continue along roads, the airstrip, and the permanent village.

In the area downstream from Devil Creek, the reservoir shoreline would be in contact with steep bedrock cliffs, and slope instabilities would be due to small rock falls. Upstream, beaching and other slope failures would increase as the thickness of unconsolidated materials along the shoreline increased. There are no permafrost deposits in these areas. Small seasonal drawdowns of the Devil Canyon reservoir would further reduce the potential for slope instability. The Applicant has calculated that approximately 2,500 acres [1,000 hectares (ha)] of land adjacent to the Devil Canyon reservoir would be affected by some form of slope instability.

Because of the steep and narrow configuration of the Devil Canyon, the total area cleared of vegetation for the Devil Canyon facility would be only 15% of that cleared for the Watana development. The thinness of the overburden in the Devil Canyon impoundment area also would result in reduced cumulative erosion losses relative to the Watana development. During the operation phase, all Devil Canyon construction facilities would be dismantled and the areas would be revegetated to reduce erosion losses.

No agricultural soils or known mineral resources would be inundated by the Watana/Devil Canyon reservoirs.

Liquefaction failures, problems related to permafrost thaw, and landslides might occur in the unstable, unconsolidated geologic materials that are present along the proposed access road route between the Denali Highway and the Devil Canyon dam site, as well as the Dams-to-Gold Creek rail access. The Applicant, however, proposes to avoid such deposits that might be found during geotechnical investigations during access route development. Removal of vegetation during construction of this access road would result in increased erosion, soil compaction, and alteration of surface drainage patterns, which could result in liquefaction and permafrost thaw. Erosion losses would be controlled by such methods as the use of desilting ponds and revetments. Permafrost thaw would be controlled by providing adequate drainage, promptly revegetating disturbed areas, and using insulating granular fill under road beds.

The Applicant proposes to reduce borrow-site requirements for road development through maximum use of side-borrow and cut-and-fill techniques. Because of the increased access provided by the development of the Denali Highway to Devil Canyon access route, off-road traffic would increase in the project area. Increased traffic, in turn, would increase soil erosion in the affected areas.

Construction of the rail extension between Devil Canyon and Gold Creek and related facilities would disturb about 118 acres (48 ha) of vegetation and soils. On a unit-length basis, soil disturbances and construction material requirements would be less for the rail access than for the road because of the narrower clearance width required for the rail line.

No known mineral resources or agriculturally suitable soils would be affected by the proposed access route.

In order to minimize impacts associated with construction of the Dams-to-Gold Creek segment of the proposed transmission line (such as vegetation clearing and road construction), the Applicant has proposed that the transmission corridor follow the Watana-to-Gold Creek access road route. The transmission line impacts thus would be similar in nature to those for construction of the access route.

About 1,540 acres (620 ha) of vegetation would be cleared for the transmission corridor between the Watana dam and Gold Creek. Because the low vegetation and organic mat along the route would be left intact, soil erosion losses would be localized, occurring primarily from construction of transmission towers, relay buildings, and control stations.

Between Willow and Fairbanks, the transmission line would parallel an existing transmission corridor and existing access routes and highways for much of its length. Right-of-way development along this segment would entail widening of the existing corridor and would result in less disturbance of soil and vegetation than would the development of a new right-of-way. Unstable, unconsolidated geological deposits along the proposed route become increasingly more continuous to the north, thus increasing the potential for construction difficulties and soil failures. Limited areas of land suitable for agriculture occur at the northern end of this transmission route segment, but the total area that would be occupied by transmission towers or impacted during tower construction would be small. Between Willow and Port MacKenzie, the transmission right-of-way would also cross small areas of soils suitable for agriculture.

4.1.1.2 Land Use and Ownership

Construction of the Watana dam and associated power-generation and transmission facilities (e.g., substation), the impoundment area, the construction camp and village, and the permanent settlement would produce a significant change in the character and use of the land in the upper and middle Susitna River Basin. The remote, largely undisturbed area would become one of increased human activity and development. Land that is now used primarily for dispersed recreational activities, subsistence activities, and small mining operations would become more highly developed for hydroelectric power generation, resulting in induced residential, commercial, recreation, and natural resource development. Construction activities and the associated noise around the Watana dam and reservoir project area would adversely affect use of the area for recreational and subsistence purposes. The proposed dam and reservoir would inundate about 36,000 acres (14,600 ha) of land within the Susitna River Valley. The Watana impoundment would inundate only six structures--a hunting lean-to, four cabins (two no longer in use), and a collapsed shack. The construction camp, permanent and temporary village, and airstrip at the Watana site would cover about 370 acres (150 ha).

Development of the Watana project would require the transfer of ownership of substantial areas of Federal, Native, and private lands to the State of Alaska. These transfers would occur either through actual purchase or right-of-way easement agreements. The Talkeetna Mountain Special Use District (managed by the Mat-Su Borough) would require permits for specified developments such as roads. Specific values for land required for the project have not been established, and it is anticipated that land values would not be determined until the land acquisition process for the project was started.

The remote and natural character of the land in the upper and middle Susitna River Basin area would continue to change during the operation of the Watana dam and the establishment of a permanent town. The permanent townsite, which would be located north of the dam, would occupy about 90 acres (36 ha). The town would consist of a central area with about 20 buildings, plus a hospital, 93 single and multifamily dwelling units by 1992 (125 units by 2001), a water and sewage treatment plant, and a landfill.

The capacity of much of the land in the Watana project area to support concentrated, high-density, human development appears to have moderate to severe limitation due to such physical constraints such as slope, soil, drainage, and load-bearing capacity. Pressures for human settlement near the Watana dam site and permanent town could increase due to demand for increased recreation services (e.g., supply stores, outfitters). Increased human activity and development at the town and increased recreation activities on and surrounding the Watana reservoir would cause further fundamental changes in the land use in the area and result in degradation of vegetation and increased pressure on hunting and fishing resources in the upper and middle Susitna River Basin area (see Secs. 4.1.5 and 4.1.7).

The newly created project road and rail access would allow for easier access and exploitation of timber and mineral resources in the area. Additionally, increased opportunities for resource exploration and extraction activities might result from the availability of support services at and around the permanent Watana settlement. Such activities also could result in additional pressures for development of commercial and industrial support services at the Watana dam settlement. The actual level of additional resource development that might occur in the Susitna Basin area as a result of project operation would depend on such factors as the extent and type of access into the area, final land ownership and management patterns, resource market demands, labor supply, development constraints, and the actual quality and quantity of mineral resources found within the basin.

Development of the Watana project probably would cause increases in the values of properties located near the permanent town, adjacent to the reservoir and access roads, along the Denali and George Parks Highways, and in the communities of Talkeetna, Cantwell, and Gold Creek. Future land values would depend in part on the amount of land made available by the major landowners, parcel size, location in relation to access, natural resources located on the property, and the type of development planned.

The construction and operation of the Devil Canyon dam and associated facilities, the impoundment area, and the construction camp and village would cause land use impacts similar to those discussed above for the Watana development and would produce further changes in the use and character of land in the upper and middle Susitna River Basin area.

Construction of project access roads and a rail spur would mean that the largely undisturbed Devil Canyon area of the Susitna River area would become accessible to automobiles, trucks, and heavy equipment vehicles. As would be the same for the Watana development, land that is now used primarily for dispersed recreation, subsistence, and small mining operations would be made accessible for large-scale hydropower development and its associated facilities.

Construction of the project access roads and rail spur would result in the destruction of vegetation and slumping and erosion of soils during the construction period. The proposed 40-mile (mi) [67-kilometer (km)] gravel access road between the Denali Highway and the Watana site would require about 630 acres (255 ha) of land. Pullouts and trailheads would be constructed along the route to permit viewing and access into the interior region of the basin. The 37-mi (60-km) Watana-to-Devil Canyon access route would require about 400 acres (162 ha) of land. A high-level suspension bridge would extend across the Susitna River below the dam site and connect the access road with the terminus of the rail spur from Gold Creek. The 12-mi (20-km) rail extension from Gold Creek to the Devil Canyon site would require about 72 acres (29 ha). Increased development would be expected in the vicinities of the Gold Creek and Cantwell areas, which would become staging areas for transportation of construction materials to the Watana and Devil Canyon dams and their support facilities (also see Sec. 4.1.8). If public use of the rail facility was not allowed, land development along the rail spur would be limited.

Most of the significant impacts to and changes in land use patterns that would result from construction of the access facilities would continue for as long as the access routes were open and usable. Previously remote areas in the vicinity of the Watana and Devil Canyon developments would be accessible for recreation, mineral exploration, harvesting of timber, and settlement. Although these changes could be of positive commercial value, all would produce increased pressure on, and in many cases degradation of, the natural resources of the basin. This increased accessibility could also be expected to result in increase land values in the newly opened areas.

As is the case for other project-related features, construction of the various power transmission facilities would contribute to significant changes in the use and character of the land in the affected areas. In many cases, land that now is used primarily for dispersed low-density activities, such as recreation, would be cleared for the transmission line right-of-way, and adjacent areas might be made more accessible. In some cases, the lines would extend through developed areas. Construction activities and the associated noise created during clearing of the transmission line rights-of-way, construction of tower structures, and stringing of transmission wires could adversely affect any residents or recreationists near the proposed transmission line route. A minimum standard access road would be created along the entire length of the route for maintenance purposes. Routine maintenance activities should not adversely impact surrounding land uses. However, float plane flight patterns could be adversely affected where the transmission lines extended near lakes used for takeoff and landing (e.g., Big Lake area). Flight patterns could also be adversely impacted at Healy, the Golden North Airport, and Gold Creek where landing strips are located less than 1 mi (1.6 km) from the proposed route of the transmission lines.

As would be the case for other project features, transfers of ownership or control of Federal, Native, and private lands to the State of Alaska would be required for development of the transmission system. These transfers would occur either through actual right-of-way purchase or easement agreements. Because of the present low-intensity use and undetermined land values along much of the proposed transmission line route, it is not anticipated that there would be significant impact to adjacent land values along most of the route. However, the resale value of existing residential or recreational lands adjacent to the transmission line route might be limited.

The 45-mi (72-km) long Dams-to-Gold Creek transmission line segment would require a 300-foot (ft) [90-meter (m)] wide right-of-way between the Watana and Devil Canyon dams and a 510-ft (155-m) right-of-way from Devil Canyon Dam to Gold Creek. Total right-of-way requirements would be 1,500 acres (600 ha) of land. The new right-of-way within the remote and natural area of the upper and middle Susitna River basin would allow increased recreation access into the area, affecting hunting, fishing, trapping, and other recreation activities.

The 330-mi (530-km) transmission line route between Fairbanks and Anchorage would occupy a 300-ft (90-m) right-of-way between Gold Creek and Fairbanks and a 400-ft (120-m) wide right-of-way from Gold Creek to Anchorage. However, between the Healy and Willow substations, the route would parallel the 110-ft (34-m) wide Anchorage-Fairbanks Transmission Intertie corridor for about 170 mi (265 km) and require only 190 ft (58 m) of new right-of-way between Gold Creek and Fairbanks and 290 ft (88 m) between Gold Creek and Anchorage. Because of the existence of the Intertie line, only incremental impacts on land use would be expected. From Healy to the northern terminus at Ester Substation (90 mi, or 145 km) and from Willow to the southern terminus at Anchorage [70 mi (113 km)], entirely new transmission line right-of-way (300 ft and 400 ft, or 90 and 120 m, respectively) would be necessary. Total right-of-way requirements for the northern and southern segments and the adjacent Intertie segment would be approximately 10,200 acres (4,100 ha).

Land use conflicts could occur where concentrations of residential development occur--such as in the communities of Ester, Nenana, Healy, Cantwell, Talkeetna, Willow, and Anchorage--and in other, more sparsely settled residential areas that would be immediately adjacent to the transmission line corridor. Conflicts also could occur where sections of the transmission corridor would extend across land that has been designated for village selection within the boundaries of Doyon, Ltd., and lands owned by CIRI. As discussed in Section 4.1.9, the presence of the cleared right-of-way and tower structures would constitute an adverse aesthetic impact at adjacent residences and recreational areas, such as the Denali State Park. The proposed transmission route would extend across or parallel numerous trails--including the Iditarod Trail, seismic survey lines, and tractor and pioneering off-road vehicle trails--and would cross 5 mi (8 km) of the Susitna Flats State Game Refuge. Approximately 29 mi (47 km) of existing or proposed agricultural sale lands would be traversed by the transmission line corridor between Fairbanks and Anchorage (Exhibit E, Suppl. Information, Sec. 9, Item 7). Total land acreage impacted due to construction, tower placement, and access requirements would depend on the amount of land actually developed for agricultural use, final right-of-way alignment (e.g., along fence lines or across fields), and type of agricultural use (e.g., pasture or row crops). However, it is anticipated that the total amount of potential farmland that would be used for tower placement would be minimal, on the order of 15 to 26 acres (6 to 11 ha).

The proposed transmission route would cross about 10 mi (16 km) of the U.S. Air Force Clear M.E.W.S. Military Reserve near Anderson, and would also extend close to Elmendorf Air Force Base lands and cross about 18 mi (29 km) of the Fort Richardson Military Reserve near Anchorage. Adverse impacts to Air Force land could result from transmission line locations, design, and tower height in relation to flight activities, communications, and security. In addition, the presence of the transmission line corridor could affect training, maneuvers, and base security at Fort Richardson.

4.1.2 <u>Climate, Air Quality, Noise</u>

Any impact of hydroelectric plant construction and operation on ambient weather conditions would be very minor. Land clearing, paving, and erection of buildings would change surface albedos and heat capacities over small areas. The air immediately over these areas may often be slightly warmer than in the surrounding areas, during both day and night. The surface area of the reservoirs at Watana and Devil Canyon would be too small to lead to any significant differences in measured meteorological variables beyond the reservoir boundaries. The reservoir surface would also be frozen in the winter, lessening further any changes between land and water conditions. Neither the increased ambient surface temperature nor the increased relative humidities over small portions of the site would be expected to have any noticeable effect on offsite weather conditions. For this reason, the impact of the hydroelectric project on weather conditions would be considered nil.

Four air quality impacts would be present during construction of Watana and Devil Canyon dams: (a) fugitive dust emissions, (b) diesel generator exhaust emissions, (c) emissions from incinerators at the construction camps, and (d) ice fogs caused by condensation of emitted water vapor under very cold weather conditions. Each impact will be discussed in turn.

At the Watana site, the largest sources of fugitive dust would be road dust raised by truck traffic and wind-blown dust from storage piles. The quantities of fugitive emission releases were computed by the Applicant using EPA-recommended methodologies. The areas of potential release would all be within the site boundary, yet fugitive emissions might be transported by the wind outside the site boundary. Construction at Devil Canyon would be mainly in the riverbed, resulting in very small amounts of fugitive releases.

The Applicant has made an acceptable worst-case calculation of the downwind concentration of fugitive dust at the Watana dam site. That scenario placed a storage pile in a straight line 3 mi (4.8 km) long by 220 ft (67 m) wide running east to west. Vehicular traffic was placed parallel to the storage pile on a roadway 2 mi (3.2 km) long by 50 ft (15 m) wide. Using meteorological data from the Watana Climate Station, a worst day was chosen, one which would tend to maximize the 24-hr concentration. The EPA-approved model ISCST was run and it was found that a concentration of 627 micrograms per cubic meter ($\mu g/m^3$) was predicted to occur at a point 1,300 ft (400 m) from the storage pile. This value exceeds the Alaska 24-hr maximum total suspended particulates (TSP) standard of 150 $\mu g/m^3$ (not to be exceeded more than once per year). Although that point is likely to be inside the project boundary, it raises the possibility that exceedences of the regulations could occur for points outside the site boundary, depending on the relative location of the storage pile and roadway.

It is not clear at present whether the Susitna project would be subject to "Prevention of Significant Deterioration" (PSD) review on TSP since (a) it is not definite that there would be a release of some criteria pollutant with emissions above the trigger level of 250 tons per year [225 metric tons (MT)] per year, and (b) it has not yet been determined by the Alaska Department of Environmental Conservation whether construction emissions for this plant fall within the exemption for releases of a temporary nature.

Twelve temporary diesel generators would be installed onsite to provide 10.3 MW of power for the first three years of construction. These generators would consume 723 gallons (2,740 liters) per hour of No. 2 diesel fuel. The generators are planned for use continuously throughout the entire year. No. 2 diesel fuel is a low sulfur oil considered high quality and low polluting. It is within standards set in state regulations on the maximum sulfur content allowable in a fuel.

The Applicant has computed the emissions from these generators based on EPA emission factors and engineering calculations. None of these pollutants exceeds the 250 tons (225 MT) per year trigger level that would require a PSD application. In any case, the Applicant applied the EPA-approved PTPLU model using data recorded at the Watana Weather Station on July 18, 1981. Predictions provided an estimate of the maximum 1-hr concentration of each pollutant in $\mu g/m^3$. For SO_2, the maximum 3-hr average (estimated by the Staff from the maximum 1-hr prediction of the Applicant) is 11.6 $\mu g/m^3$. The PSD increment for 3-hr maximum SO_2 concentrations is 512 $\mu g/m^3$. The predicted 24-hr maximum for TSP is 0.6 $\mu g/m^3$, whereas the PSD limit is 37 $\mu g/m^3$. As can be seen, the maximum predicted ground-level concentrations are quite small compared with PSD increments.

The Applicant's calculations were made with meteorological data from only one day; however, that day was specifically chosen because of its high persistence in wind direction, which would tend to maximize an impact for a 24-hr averaging period. Based on this comparison, air quality impacts from these diesel generators should be minimal in terms of Alaska or EPA air quality standards.

Incinerators would be used to burn garbage at the temporary camps for workers. The State of Alaska has particulate and opacity regulations on such small incinerators. The particulate emissions may not exceed 0.15 grains per cubic foot (340 mg/m^3). Opacity is a measure of the density of the stack plume on a percentage basis from 0 to 100. For such incinerators, visible emissions (excluding condensed water vapor) may not reduce visibility through the exhaust effluent by greater than 20% for a total of more than three minutes in any one hour. Pollutant emissions from incinerators depend to a great degree on how they are operated. It is important to control combustion conditions to minimize carryover of unburned material or to prevent blowing too much air through the incinerator, thereby leading to the emission of too many particulates. State regulations should ensure efficient operation of the temporary incinerators.

Ice fogs are a potential problem in regions of Inland Alaska, especially at Fairbanks. When the air cools to extremely low temperatures (-30°F to -40°F, or -34°C to -40°C), the water vapor in the air condenses, forming ice crystals around particulate matter nuclei in the air. The temporary diesel generators would produce several tons of water vapor per hour. The exhausts of the diesel generators would be 20 ft (6 m) off the ground, and the buoyant nature of the plume should tend to keep it and the ice fog aloft under low wind conditions. The increase in particulate matter in the air during plant construction could enhance ice fog formation. However, in very cold conditions, even if natural ice fog conditions do not occur, a visible plume would persist with ice crystals present.

The State of Alaska through the Alaska Department of Environmental Conservation states in its Air Quality Regulations that "the Department will, in its discretion, require any person proposing to build or operate an industrial process, fuel burning equipment, or incinerator, in areas of potential ice fog to obtain a permit to operate and to reduce water emissions." The diesel generators should be located and the exhaust directed, as much as possible, so as to avoid potential ice fog impacts causing visibility problems on roads.

Watana and Devil Canyon construction would have very similar air quality impacts except that the fugitive dust problem would not be expected to be significant at Devil Canyon because construction would be largely within the riverbed area. No calculations for fugitive dust release were prepared by the Applicant for Devil Canyon. The calculations described above represent a worst-case situation for the entire project construction area.

During the operation of the Watana and Devil Canyon dams, there would no longer be fugitive emissions due to construction activities. The diesel generators would be removed as well. The permanent village would contain small incinerators that would be regulated by the state for the opacity of the stack plume and the emission of particulates. Furthermore, a workers village would be at the Watana site only.

During construction at Watana and Devil Canyon, the sources of noise would be largely from blasting, drilling, and truck and bulldozer operations. The intermittent nature of the blasting operations should lessen any annoyance. Nearby towns are sufficiently distant and the construction period temporary so that annoyance to residents in the area should be minimal.

The operation of the plant would involve the use of transformers that would emit tonal noise at 120, 240, 360, and 480 Hz frequencies. This noise should not impact nearby residents because the powerhouses are located in a deep valley, and the noise can travel up the valley but will be greatly attenuated horizontally to the location of the nearest town. No impact is expected from the transformers.

No audible noise should result from the 138-kV transmission lines. However, noise from the 345-kV transmission lines contains both broadband and tonal characteristics. Crackling sounds characterize the broadband nature of the noise; superimposed on this noise is a 120-Hz tone that sounds like the hum of a transformer. In fair weather, audible noise from broadband and tonal sound should extend only about 50 ft (15 m) from the transmission lines. In foul (rainy) weather, annoying sound could extend approximately 500 ft (150 m) from the lines. At approximately 2,000 ft (600 m), the noise should be inaudible.

4.1.3 Water Quantity and Quality

4.1.3.1 Surface Water Resources

4.1.3.1.1 Flow Regime

The natural flow regime of the Susitna River would be significantly changed by the proposed project during both its construction/filling and operational phases. The Watana reservoir would be operated in a store-and-release mode, resulting in a general increase in low-flows during the winter months (November-April) and a decrease in peak-flows during the summer months (May-October). The greatest impacts would be concentrated in the reach between Devil Canyon and the Susitna/Chulitna confluence near Talkeetna. Flow reductions would be most severe during the three-year period when Watana reservoir was being filled.

Relatively little change in mainstem flows would occur while Watana dam was under construction. All flows less than 30,000 cubic feet per second (cfs) [850 cubic meters per second (m^3/s)] would be routed through diversion tunnels without impoundment. This would cause the dewatering of a 1-mi (1.6-km) section of the mainstem of the Susitna River. Flows between 30,000 and 87,00D cfs (850 to 2,460 m^3/s) would cause a temporary impoundment to develop above the upstream cofferdam. Flows exceeding 87,000 cfs (2,460 m^3/s) could overtop the cofferdam and cause downstream flooding if they were to occur before the height of the dam reached 1,536 ft (468 m).

Filling of Watana Reservoir would require the impoundment of 9.47 million acre-feet (ac-ft) [11.7 billion cubic meters (m^3)] from mainstem Susitna River flows over a 28- to 30-month period. Only flows between May and October would be used in filling. This process would result in a major reduction in natural flows during the summer months (Fig. 4-1). Beginning in May, all flow in excess of 6,000 cfs (170 m^3/s) would be appropriated for reservoir filling. A 6,000-cfs (170-m^3/s) release would be maintained until July 27, when it would be stepped up to 12,000 cfs (340 m^3/s) at a rate of 1,000 cfs (28 m^3/s) per day. The 12,000-cfs (340-m^3/s) release would then be maintained until September 15, after which it would be decreased to 2,000 cfs (56 m^3/s) for the month of October. During the period November to April, dam releases would be equal to reservoir inflow. The greatest changes in streamflow below Watana dam would occur in June when mean monthly flows would be decreased by 78%, 34%, and 18%, respectively, at Gold Creek, Sunshine, and Susitna Station.

Watana dam would be operated for baseload power generation until the Devil Canyon development was completed. Daily operation would be determined by the proposed rule curve for the reservoir, minimum flow requirements (Table 4-1), and power demands. Flows in excess of the minimum flow requirement and the power demand would be stored in the reservoir unless its volume was greater than the rule curve. Maximum rate of change of Watana releases would be 2,000 cfs (66 m^3/s) per day (Exhibit E, Vol. 5A, Chap. 2, p. E-2-104).* The minimum releases, expressed as discharge at the Gold Creek gaging station, would vary between 445% (March) and 22% (June) of the preproject mean monthly flows (Table 4-1). The most significant reduction in streamflow would occur during the months of June and July (Fig. 4-2); the minimum flows of 6,000 cfs (170 m^3/s) in June and 6,480 cfs (184 m^3/s) in July would be lower than any monthly flows on record at Gold Creek for these months.

Flow variability and the recurrence of low flows and high flows during project operation would be determined primarily by systemwide power demand. All estimates of operational flows are based on the Applicant's projected electrical demand for the years 2002 and 2010 (Exhibit E, Vol. 5A, Chap. 2, p. E-2-55). It is expected that operation of the Watana development alone would result in a reduction in mean annual floods at Gold Creek, Sunshine, and Sunshine Station of 60%, 32%, and 19%, respectively (Exhibit E, Vol. 5A, Chap. 2, p. E.2.108). The one-in-ten year flood would be reduced by 70%, 38%, and 23% at the same three gaging stations. At Gold Creek, this would mean a reduction of the mean annual flood from 40,000 cfs (1,100 m^3/s) to 15,000 cfs (420 m^3/s) (Fig. 4-3). More importantly, the timing of peak flows would be shifted from the time of spring snowmelt to either late summer, when rainfall would peak and the reservoir would reach its maximum pool elevation, or to winter months when power demand would be the highest. The mean annual flood at Gold Creek would be comprised of winter powerhouse discharges of 14,700 cfs (416 m^3/s) and a small amount of local runoff downstream of the dam. This winter high flow would be more than five times greater than the maximum historical monthly flows for December, January, or February.

Flow alteration resulting from the filling of Devil Canyon Dam and combined Devil Canyon/Watana operations would be very similar to the impacts of the Watana development alone. The water needed to fill Devil Canyon reservoir (1,060,000 ac-ft, or 1.34 billion m^3) would be appropriated from Watana releases in two stages, the first of which would be sufficient only to raise pool elevations to the point where dam outlet structures could be utilized and diversion tunnels sealed. This first stage would require only 76,000 ac-ft (93.7 million m^3) and last no more than four weeks, depending on the time of the year in which it occurred (Exhibit E, Vol. 5A, Chap. 2, p. E-2-148). The second stage of filling would require withholding 1,014,000 ac-ft (1.25 billion m^3) and last for five to eight weeks. During both filling phases, the minimum flow requirements for Watana (Table 4-1) would also be enforced at Devil Canyon dam. The two-stage filling process would span at least two water years, with the exact timing and impact magnitude dependent on specific construction timing.

Once the Devil Canyon reservoir was filled and its powerhouse came on line, the operation of Watana Dam would change from baseload to peaking generation. Devil Canyon Dam operation would always be for baseload generation, acting in part as a reregulation facility for the peaking releases from Watana. The daily variation of inflows to Devil Canyon reservoir is expected to cause no more than a 1-ft (0.3-m) change in water surface elevation (Exhibit E, Vol. 5A, Chap. 2, p. E-2-156). Minimum flows would remain the same as for Watana operation alone. Although monthly flows under the combined operation would be very similar to those for Watana alone, there would be a general decrease in the mean flows during the months May through August and a reduction in the year-to-year variability in flows (Fig. 4-2). Flow alteration would be less severe below the Susitna/Chulitna/Talkeetna confluence. However, although the summer flows

*Throughout this document, references to specific "Exhibits" are to the exhibits submitted to FERC as part of Alaska Power Authority's Susitna Hydroelectric Project License Application. References to specific "Appendices" (App.) are to the appendices provided in Volumes 2 through 7 of this Draft Environmental Impact Statement.

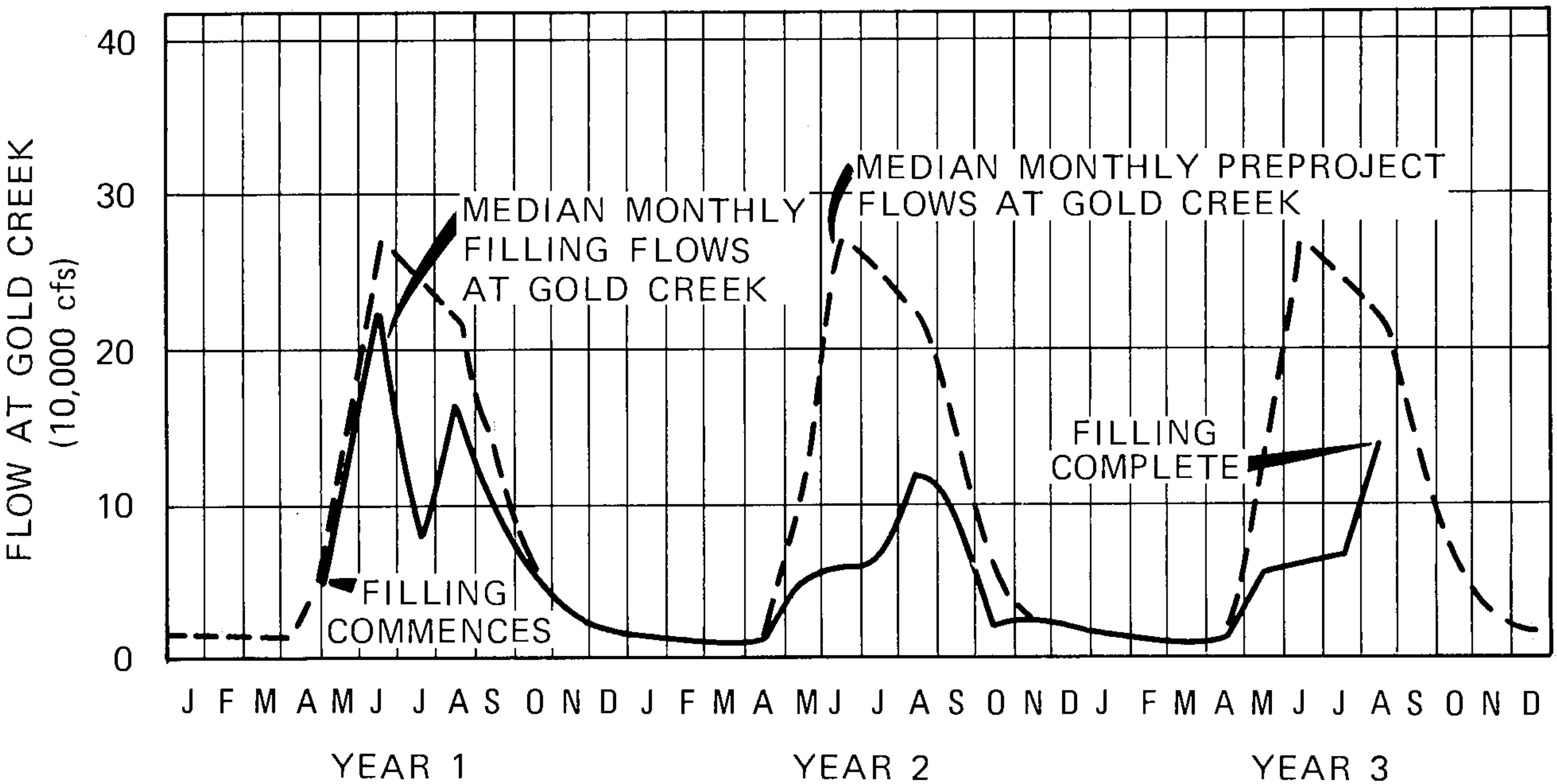

Figure 4-1. Comparison of Median (50% exceedence) Monthly Streamflow at Gold Creek before and during the Filling of Watana Reservoir. [Source: Modified from Application Exhibit E, Vol. 5B, Chap. 2, Fig. E.2.138]

Table 4-1. Minimum Flows at Gold Creek from the Proposed Project and a Comparison to Natural Flow Regime Statistics

Month	Minimum Flow At Gold Creek (cfs)	Percentage of Preproject Mean Monthly Flow	Preproject Monthly Flow Exceedence†[1] (%)
January	5,000	342	0
February	5,000	402	0
March	5,000	445	0
April	5,000	363	0
May	6,000	45	70
June	6,000	22	100
July†[2]	6,480	27	100
August	12,000	55	92
September†[2]	9,300	71	73
October	5,000	87	59
November	5,000	195	2
December	5,000	279	0

†[1] Frequency (%) at which specified minimum flow is equalled or exceeded by historical monthly flows, i.e., in September, the minimum flow of 9,300 cfs is equalled or exceeded in 73% of all Septembers on record.

†[2] Average monthly flow, including transitional minimum flows for the periods 27-31 July and 15-30 September.

Conversion: To convert cfs to m^3/s, multiply by 0.0283.

Source: Application Exhibit E, Vol. 5A, Chap. 2, Table E.2.36, and Staff analysis.

(May-October) would average only 8% less than preproject conditions, winter flows would be approximately doubled at Susitna Station (Exhibit E, Vol. 5A, Chap. 2, p. E-2-110).

4.1.3.1.2 <u>Physical Habitat Availability</u>

The flow alteration resulting from the filling and operation of Watana reservoir would lead to changes in the physical characteristics of several of the important habitat types described in Section 3.1.3. The aquatic habitats most sensitive to flow changes are the side sloughs, tributary mouths, and, to a lesser extent, the side channels. The biological significance of these changes is discussed in Section 4.1.4.

The modified flow regimes proposed for reservoir filling and operation would result in a general dewatering and isolation of side slough habitats along the Susitna below Devil Canyon. These changes would occur throughout the open water months (May-October), but they would be most severe in June and July. The average reduction in surface area in the sloughs above Talkeetna would be more than 50% during these summer months (Fig. 4-4). Side sloughs below Talkeetna would also be affected, but to a lesser degree; the average reduction in surface area would be approximately 20% in June and July (Exhibit E, Vol. 5A, Chap. 2, App. E.2.A, Table A-5).

The frequency of occurrence of various hydraulic regimes in the side sloughs (overtopping, backwater, and isolation) (Sec. 3.1.3) would also be changed. This impact can be examined by combining flow duration data with the flow thresholds for overtopping, backwater, and isolation regimes presented in Exhibit E (Vol. 5A, Chap. 2, App. E.2.A, Table A-1). Overtopping of sloughs, which occurred on average 30% to 50% of the days in June, July, and August under baseline conditions, would be essentially eliminated in the reach between Devil Canyon and Talkeetna.

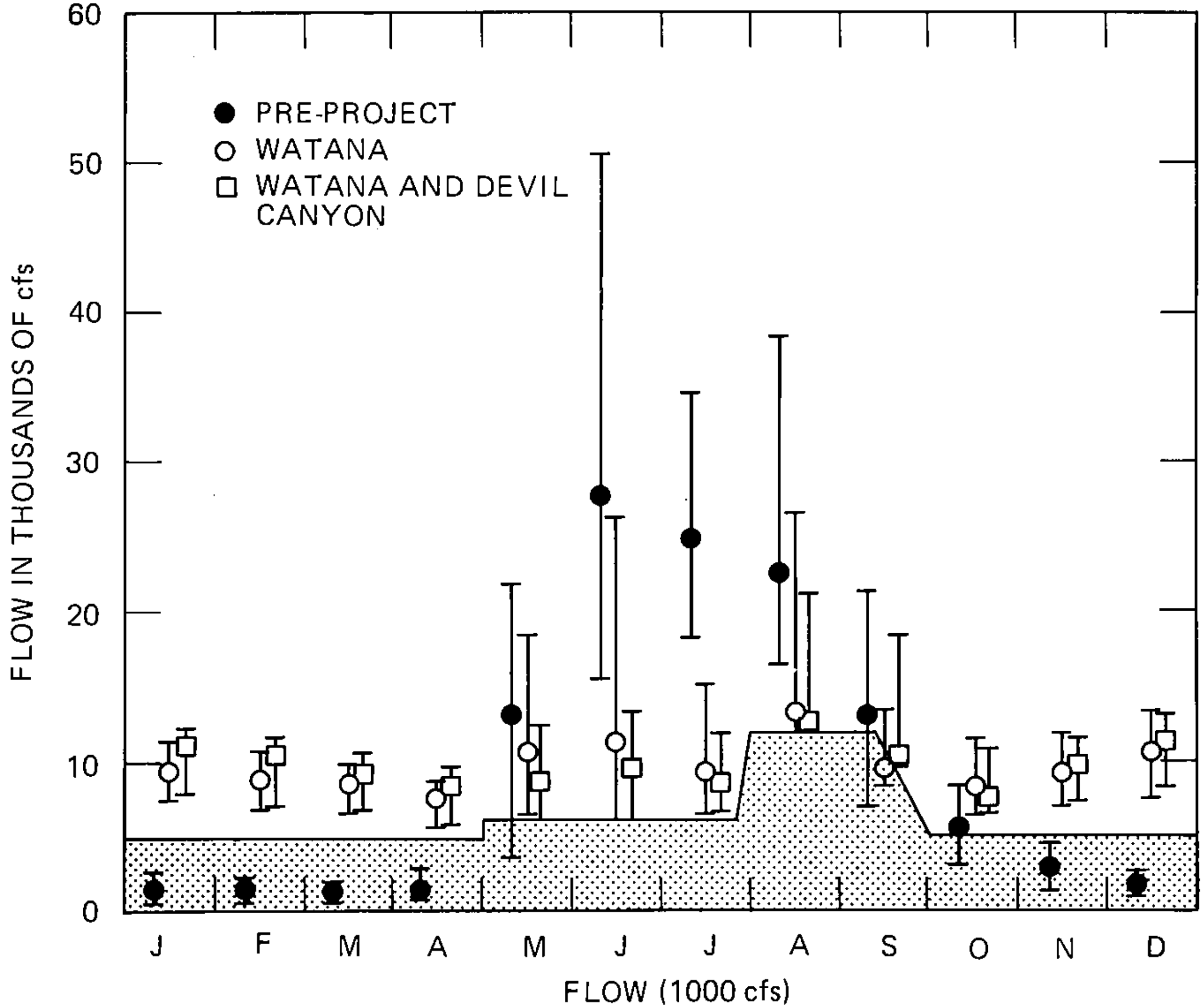

Figure 4-2. Comparison of Maximum, Mean, and Minimum Monthly Flows at Gold Creek under Preproject Conditions, Watana Operation, and Combined Watana/Devil Canyon Operation. (Shaded portion of the graph indicates proposed minimum flow requirements.) [Source: Application Exhibit E, Vol. 5A, Chap. 2, Tables E.2.24 and E.2.36]

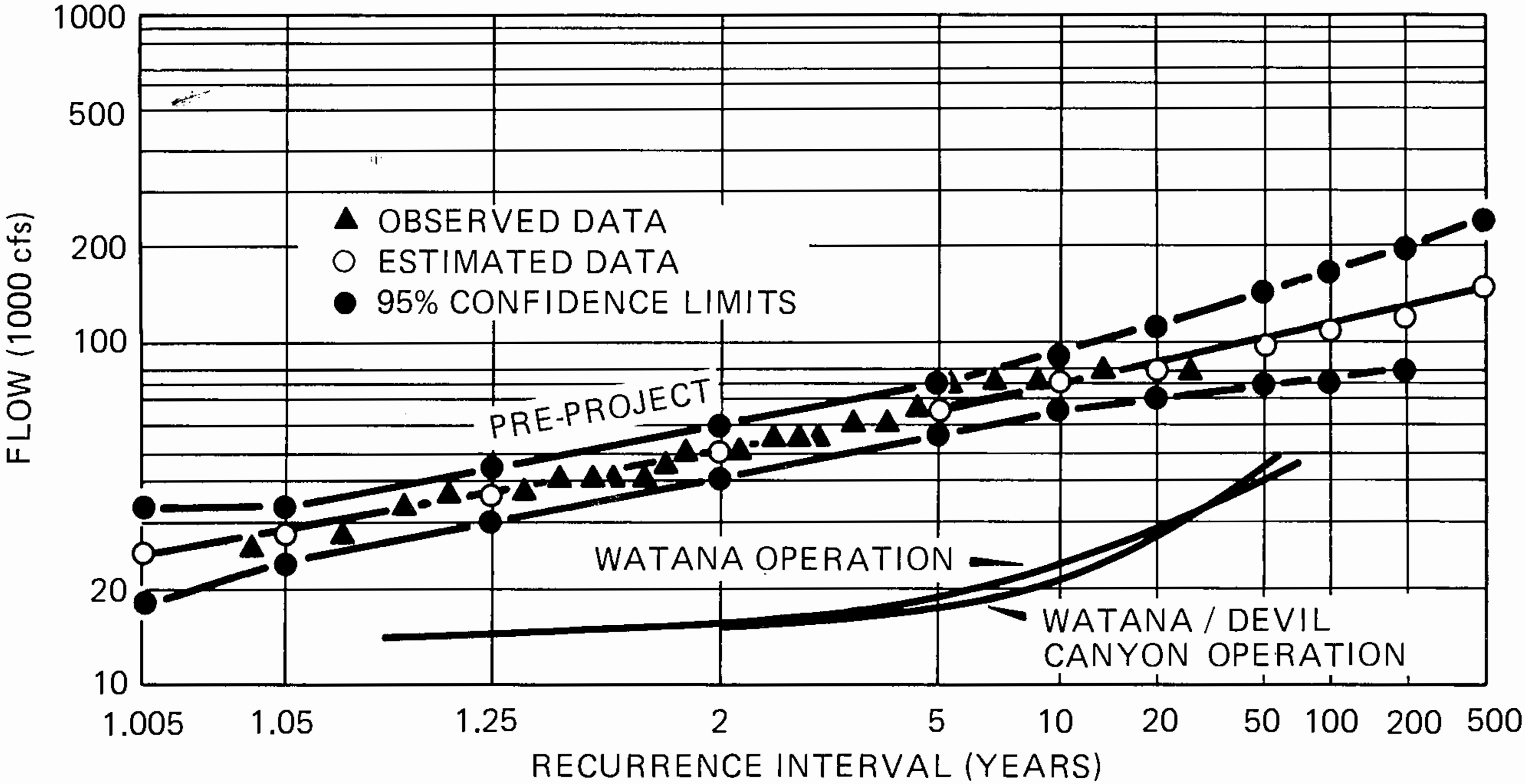

Figure 4-3. Annual Flood Frequency Curves at Gold Creek for Preproject Conditions, Operation of Watana Reservoir, and Combined Watana/Devil Canyon Operation. [Source: Application Exhibit E, Vol. 5B, Chap. 2, Figs. E.2.29, E.2.155, and E.2.186]

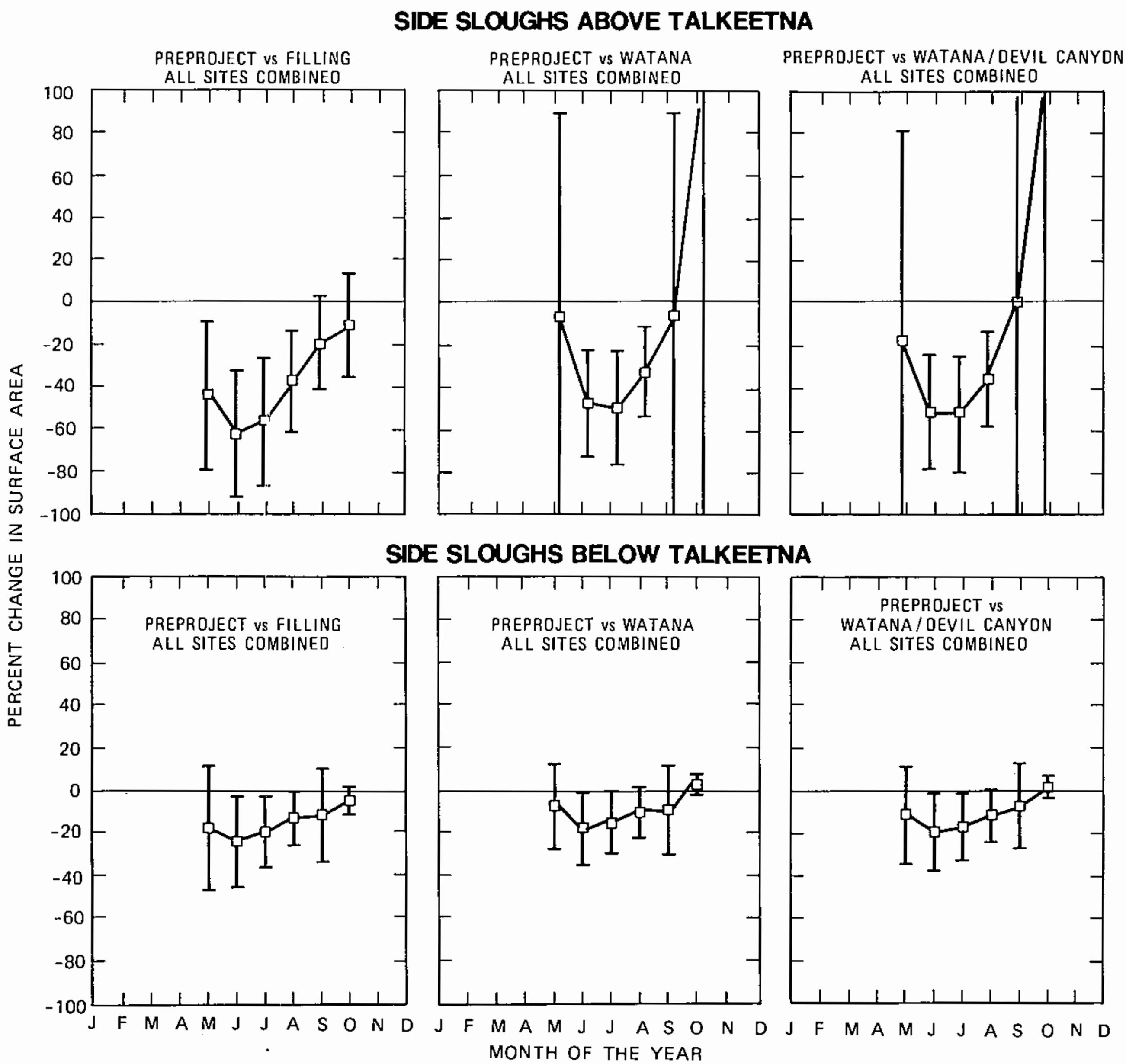

Figure 4-4. Changes in Wetted Surface Area of Selected Sloughs (nine sloughs above Talkeetna and five sloughs below Talkeetna) during Project Filling and Operation. [Source: Based on data from Alaska Dept. of Fish and Game (1983a) and flow data from Application Exhibit E]

This conclusion is based on the assumption that mean monthly flows would be approximately equal to mean daily flows under project operation. The backwater regime would persist only in June and August. Hydraulic changes would be even more severe during filling of Watana reservoir when no overtopping would occur, and the backwater regime would exist only in sloughs 8A and 9 for a short period in August.

Therefore, after project operation began, the side sloughs above Talkeetna would become almost totally dependent on surface runoff and groundwater upwelling for circulation. Natural flushing processes that occur during overtopping and that remove debris and fine sediment deposits from the side sloughs would no longer occur.

Based on salmon passage criteria established by the Alaska Department of Fish and Game (1983b) for minimum depths and distances through shallow riffles, thresholds of mainstem flows have been established which restrict access to side sloughs. Acute slough accessibility problems for salmon would persist throughout the year except during August and September in very wet years (Fig. 4-5).

The hydraulic conditions in side sloughs below Talkeetna would be affected less than those above Talkeetna because of the increased flow contributed by the unregulated Chulitna and Talkeetna rivers. The frequency of overtopping at Rabideaux Slough [occurring at 65,000 cfs (1,800 m^3/s)] would decrease from 20% to 60% of the days in June, July, and August to 0% to 10% under operational flows. The backwater regime would increase in frequency of occurrence from 40% to 80% of the days in June, July, and August to 90% to 100%.

The decrease in mainstem flows during reservoir filling and operation would cause a reduction in water surface elevation of the Susitna River at tributary mouths below the dam. However, tributary flows would not be directly affected. The stage changes have been estimated to be -3.5 to -7.6 ft (-1.1 to -2.3 m) during annual flood events and -0.5 to -4.0 ft (-0.2 to -1.2 m) during mean monthly flows (R&M Consultants, 1982a). Stage reductions of this magnitude could lead to perching of the tributary mouths, reduced depth, increased scour, and eventual backcutting of the tributary beds. Perching might hinder upstream salmon migration (Sec. 4.1.4) and backcutting might result in erosion of the foundations of railroad bridges south of Gold Creek.

Nineteen tributaries were examined for potential perching and erosion problems (R&M Consultants, 1982b). Of these, Jack Long, Sherman, and Deadhorse creeks were the only tributaries identified as having potential fish passage problems during operational flows. Access to Indian River and Portage Creek, the two most important tributaries for salmon spawning, is not expected to be reduced because these rivers have natural flows sufficient to provide adequate depth-of-passage for adult salmon (Trihey, 1983).

Although erosion of bridge foundations is a naturally occurring problem, it would be aggravated by Watana operations in some areas. Three tributaries, Skull Creek and two unnamed creeks at River Mile (RM) 123.9 and RM 101.1, might be subjected to enough backcutting and degradation to endanger the railroad bridges on the southern bank of the Susitna River. Combined operation of Watana and Devil Canyon dams would result in changes in habitat availability very similar to operation of Watana alone.

Other habitat types, including side channels and mainstem, would be less affected than the side sloughs and tributary mouths. Some of the side channels would become classified as side sloughs under the lower postproject flow regime if an upstream berm were present. Main channel habitat would be decreased in area but still would be available (see next section).

4.1.3.1.3 Channel Stability and Sediment Transport

During Watana construction, impacts on river morphology would be concentrated around the dam and borrow sites. Borrow sites above the dam would be inundated by the Watana reservoir. Sites below the dam within the Susitna floodplain would be subjected to localized instability and erosion during the period between Watana construction and Devil Canyon construction. However, these sites would be inundated once Devil Canyon dam was constructed.

During filling and long-term operation of the Watana reservoir, sediment transport would be greatly reduced in the Susitna River below the dam. Bedload movement would be very low over this reach because of the armor layer and the reduced flows. In isolated areas where bed material size was in the coarse gravel range (i.e., somewhat smaller than in most of the river between Devil Canyon and Talkeetna), bed material movement might occur. These localized areas of degradation are at RM 124 (below Skull Creek), RM 131 to 133 (near Sherman), and near the confluence with the Chulitna River. The lack of suspended sediments transported into this reach would significantly reduce siltation in calmer areas such as the side sloughs. Tributary streams, including Portage Creek, Indian River, Gold Creek, and Fourth of July Creek, would extend their alluvial fans into the river.

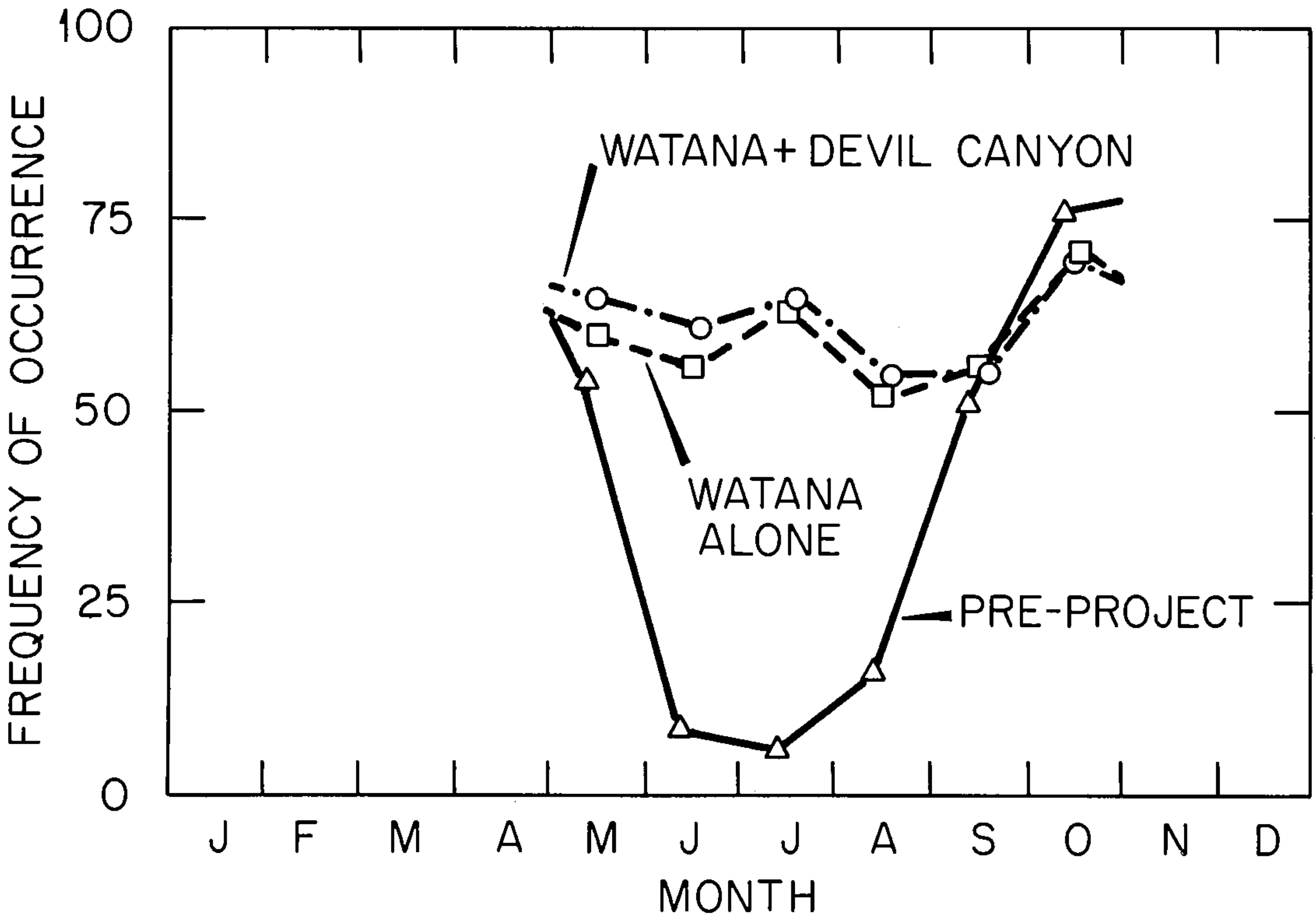

Figure 4-5. Frequency of Occurrence of Acute Access Limitations for Salmon to Nine Side Sloughs above Talkeetna. [Source: Based on data from Application Exhibit E and Alaska Dept. of Fish and Game (1983b)]

The Susitna River main channel would become better defined, with a narrower channel above Talkeetna due to the reduction in peak flows. The main channel river pattern would evolve toward a tighter, better-defined meander pattern within the existing banks. The extent of channel reduction can be estimated using the regime theory of hydraulic geometry (Leopold and Maddock, 1953) and the following empirical equation (Parker, 1981):

$$W_{post}/W_{pre} = (Q_{post}/Q_{pre})^{0.441}$$

where:

W_{post} is postproject bankfull width,

W_{pre} is preoperational bankfull discharge,

Q_{post} is the postproject bankfull discharge, and

Q_{pre} is the preoperational bankfull discharge.

If bankfull discharge is represented by the mean annual flood, this relationship predicts that bankfull width after Watana began operation would be 33% less than the preproject width. The dewatered portion of the river channel would eventually be colonized by vegetation (see Sec. 4.1.5).

In winter, substantial differences in channel stability might occur as ice processes were altered by changes in flow and temperature regimes. Above the Chulitna River, the effects of ice forces during breakup on the river morphology would be reduced because of higher flows, higher river stages, and warmer water temperatures. Although an ice cover could form as far upstream as Devil Canyon, the rapid rise in streamflows that initiates ice movement at breakup under natural conditions would be eliminated.

In the sloughs, regulated flows would eliminate essentially all overtopping of the upstream gravel berms. Movement of sand and gravel bars in the sloughs would be minimized. Debris jams and beaver dams, which previously were washed out by high flows, would remain in place, with resultant ponding in those sloughs not maintained as part of the fisheries mitigation program. Vegetation encroachment in the sloughs and side channels might also occur as the high flows and associated scour events were reduced.

At the Chulitna-Susitna confluence, the Chulitna River would be expected to expand and extend its alluvial deposits. Reduced summer flows in the Susitna River might allow the Chulitna River to extend its alluvial deposits to the east and south, encroaching on the open-water leads into the Susitna (R&M Consultants, 1982c). Downstream from the Susitna-Chulitna confluence, the preproject mean annual bankfull flood would now have a recurrence interval of five to ten years. This would tend to decrease both the frequency and amount of bed material movement. Consequently, changes in braided channel shape, form, and network would become less frequent. A trend toward relatively stabilized floodplain features would begin, but this would occur over a long period of time, perhaps several decades (R&M Consultants, 1982c).

The morphological processes described for Watana operation would continue to occur because flows from Watana reservoir operation would be unchanged during construction of the Devil Canyon dam. The most significant impacts from construction would be at the dam site, as the rapids at the upper end of Devil Canyon would be blocked off and about 1,100 ft (330 m) of the Susitna River between the upstream and downstream cofferdams would be dewatered. No impacts to the morphology of the Susitna River are anticipated from borrow site excavation since there are no borrow sites located below Devil Canyon dam. Although borrow site G is south of and adjacent to the Susitna River (Fig. 2-6), no mining activities would be undertaken in the riverbed. Cheechako Creek would be rerouted to facilitate efficient borrow excavation. Consequently, it would be channelized to the eastern boundary of the borrow site.

Average monthly flows during Watana/Devil Canyon operation would be similar to those of Watana operation, although an additional redistribution of the flow would occur (Fig. 4-2). The change in Watana reservoir operation during the first few years after Devil Canyon came on line would decrease the ability of the reservoir system to absorb high flows. Consequently, the occurrences of high flows capable of initiating gravel bed movement in the Susitna River above Talkeetna would be increased slightly. Project impacts previously described for Watana impoundment and operation would remain relevant except that river bed stability would tend to decrease since the larger return period flood flows would have been increased.

Development of the access routes to Watana dam and Devil Canyon dam would not significantly change any surface runoff, tributary flows, or main channel flows.

Power line construction would not result in any significant changes in water quantity.

4.1.3.2 Water Quality

4.1.3.2.1 Dam Development

The primary water quality issues for the Watana and Devil Canyon dam projects are the impact of construction, filling, and operation on suspended solids and turbidity in the Susitna River and in the two reservoirs; the impact of project operation on nitrogen gas saturation in the Susitna River downstream of the dams; the impact of project construction and operation on nutrient levels and productivity in the Susitna River and in the reservoirs; the impact of project reservoir filling and operation on salinity in the upper portion of Cook Inlet resulting from seasonally altered freshwater flows in the Susitna River; and the impact of filling and operation on water temperature in the Susitna River and in the Watana and Devil Canyon reservoirs.

SUSPENDED SOLIDS

Construction activities for Watana would cause increases in the concentration of suspended solids in the impounded reach, and for some distance downstream during the construction period (Sec. 2.1.3). Increases in suspended solids from erosion in disturbed areas might persist after construction until the disturbed areas were stabilized by revegetation, but the effect on water quality is expected to be negligible. These increases would result primarily from the excavation of gravel and rock from the borrow sites within and adjacent to the Susitna River. The concentration of suspended solids in the Susitna River at Gold Creek is predicted to increase from an average summer level of 730 parts per million (ppm) under preproject conditions to almost 900 ppm from dredging during the summer construction periods (May-August). This calculated increase in suspended solids is most likely an overestimate, however, because not all of the material in the silt-clay size range would be entrained, and not all of the material that was entrained would remain in suspension. In any case, the predicted increase in suspended solids at Gold Greek due to dredging for Watana construction is within the natural range of variation in the concentration of suspended solids for the summer period. Because of the naturally high concentrations of suspended solids during summer, no significant adverse impact is anticipated from the increased concentration of suspended sediments resulting from the excavation of borrow sites.

Increased concentrations of suspended solids in the Susitna River, and in small streams in the project area, would also result from the processing and deposition of borrow material, from vegetation clearing, from runoff at concrete processing areas and batch plants, and from the construction of cofferdams and diversion tunnels. The proposed mitigative measures described in Section 2.1.12 should minimize the runoff and entrainment of suspended solids resulting from most of these activities. However, some temporary, localized increases in suspended solids would undoubtedly occur during the construction of Watana. Although the exact magnitude of these increases cannot be predicted, they would not be expected to be large nor to have any long-term adverse impacts on water quality in the Susitna River.

Construction activities for Devil Canyon would cause temporary increases in the concentration of suspended solids in the Susitna River in the area to be impounded and for some distance downstream. These increases would, however, be less than those occurring during the construction of Watana because of less use of borrow sites within the Susitna River. No significant adverse impact on suspended solids in the Susitna River is anticipated as a result of the construction activities for Devil Canyon.

As Watana reservoir began to fill, water velocities within the impoundment would decline, resulting in the settling and retention of suspended solids in the reservoir. Based on the predicted trapping efficiency for suspended solids transported into Watana from upstream, the concentration of suspended solids at the outlet of Watana during the first filling period (June-October) would be reduced by 40% in June and by approximately 90% in October relative to the concentration in the Susitna River at the upstream end of the reservoir. These predicted reductions in suspended solids are, however, considered by the Staff to be overestimates because the empirical data used to predict trapping efficiency are not from reservoirs in which glacial flour, which has a low settling velocity, dominates the load of inflowing suspended solids. In addition, water released from Watana during the first year of filling would be passed through the low-level outlet. This would likely result in a lower trapping efficiency than that predicted because sluicing operations such as this tend to reduce the trapping efficiency relative to that in comparable reservoirs with surface discharges (Brune, 1953). By the end of the second filling year, the predicted trapping efficiency of Watana would be the same as that at full pool level under operating conditions.

During the first winter of filling, the concentration of suspended solids at the outlet of Watana would exceed that in the Susitna under preproject conditions. This winter increase would result from the outflow of suspended solids retained in the reservoir during the first summer of filling. Because of the sluicing operation during the first year of filling, the predicted concentration of suspended solids at the outlet of Watana during winter would exceed 50 ppm, a fourfold increase in suspended solids at Gold Creek relative to the average preproject concentration in winter. During the second winter of the filling period, the trapping efficiency would approximate that of the full pool (operational) efficiency, when suspended solids at the outlet of Watana are less than 50 ppm.

Additional suspended solids would be introduced into the reservoir during and after the filling of Watana due to shore erosion and to landslides resulting from slope instability. The increase in suspended solids within and downstream of Watana due to these processes cannot be predicted. As discussed in Appendix H, the contribution of bank erosion and bank slumping to suspended solids in Watana reservoir and in the Susitna River downstream are expected to (1) be maximal during and immediately after filling, (2) occur primarily during summer when wave action occurs, and (3) decline in importance when stable shorelines develop as the reservoir ages. The net effect of shore erosion and bank slumping on suspended solids downstream of Watana would be to increase the concentration above that predicted by using the trapping efficiency for sediments transported into Watana from upstream. Erosion and slumping, however, are not expected to increase the summer levels of suspended solids above that of the preproject summer levels. Because of the naturally large seasonal variation in suspended solids in the Susitna River, the increased concentrations resulting from project filling would not be expected to adversely affect water quality downstream of the dam.

Because of the short time required for filling of the Devil Canyon reservoir, it is not anticipated that the filling phase would adversely affect suspended solids in the Susitna River relative to that caused by the operation of Watana.

During Watana operation, the reservoir would act as both a source and a sink for suspended sediments in the Susitna River, depending on the time of year. During the summer, the reservoir would act as a net sink for sediments; in the winter it would act as a net source for sediments to the Susitna River downstream of the dams relative to preproject concentration. This winter increase would be due to the smaller size fractions of suspended solids carried into the Watana reservoir during the summer remaining in suspension and being transported out during winter. Because of the long detention storage time of water likely to occur in Watana (1.74 years) and the low settling velocity of the small particles, the reservoir would remain turbid throughout the winter, providing the Susitna River with a continuous source of suspended solids. Use of the minimum predicted trapping efficiency (94%) for Watana reservoir and the average summer concentration of suspended solids in the Susitna River at Vee Canyon of 799 ppm (U.S. Geological Survey, 1982) as the output results in a calculated average concentration in winter at the outlet of Watana dam of approximately 50 ppm. This compares to an average preproject concentration in winter at Gold Creek of 12 ppm. Thus, taking into account that this is probably a conservative overestimate of the outlet concentration for Watana dam, there would be approximately a fourfold increase in suspended solids in winter at Gold Creek as a result of Watana operation compared to the mean level under preproject conditions. Because this predicted increase is within the range of natural variation in suspended sediments at Gold Creek during winter, no adverse, long-term impact on water quality would be expected.

Some additional increase in suspended solids downstream of Watana dam would occur during winter as a result of increased bank erosion. With the formation of ice cover, the river stage necessary to pass the increased winter flows resulting from Watana operation would be greater than that for open-water conditions. This increased staging downstream of the Watana project would result in bank erosion, causing an increase in the concentration of suspended solids in the Susitna River compared to preproject winter conditions. It is anticipated that the erosion caused by the increased staging in winter would occur primarily in the vicinity of the ice front and would move upstream as freeze-up occurs. The magnitude of increases in suspended solids resulting from such bank erosion cannot be quantified, but it is anticipated that it would be relatively small and localized compared to the increase resulting from the winter releases of suspended solids from Watana reservoir. Some sedimentation of the eroded bank deposits would occur in downstream areas and might adversely affect the survival of incubating salmon eggs in side channels by reducing the intragravel flow of water. No adverse, long-term impact on water quality from increases in suspended solids resulting from bank erosion in winter is anticipated.

During summer, the trapping efficiency of the reservoirs would be less than for winter because of greater induced mixing by wind, thermal inputs, and hydrologic inputs and outputs. In addition, shore erosion and bank slumping would contribute to the concentration of suspended solids at the outlet of Watana. However, since the natural (preproject) concentration of suspended solids in the Susitna River is maximum in summer (Fig. 3-9), sedimentation in Watana reservoir would be expected to result in a net decrease in the concentration of suspended solids in the Susitna downstream of the dams during summer compared to the average preproject summer levels. Based on the trapping efficiency for suspended sediments entering Watana from upstream, the predicted concentration at the outlet of Watana during summer would range from 80 to 176 ppm (mg/L). This range of predicted concentrations compares to an average summer concentration of suspended solids measured at Gold Creek of 740 ppm, a four- to ninefold reduction in suspended solids at Gold Creek in summer with Watana in operation compared to preproject conditions.

Thus, there would be a net benefit of Watana operation during summer in terms of reducing the concentration of suspended solids and turbidity downstream of the dam. Although shore erosion and bank slumping would contribute to the concentration of suspended solids at the outlet, thereby reducing the apparent trapping efficiency, the importance of these processes as sources of suspended solids in Watana would be expected to decline as the reservoir aged and as stable shorelines developed.

Operation of Devil Canyon would result in additional, but small, reductions in suspended solids at Gold Creek during the summer compared to that for Watana operation alone. Concentrations of suspended solids at Gold Creek in winter should, however, be less with Devil Canyon in operation than for Watana operation alone because of the additional trapping of sediments released from Watana. The incremental effect of Devil Canyon operation on suspended solids at Gold Creek during summer would be expected to be small because of the lower trapping efficiency of this reservoir. This is because the detention storage time would be shorter (58 days) and because the average particle size of suspended sediments entering Devil Canyon from Watana would be less than that of sediments entering Watana, with a resultant lower settling velocity.

GAS SUPERSATURATION

Supersaturation of water with nitrogen gas is possible below high-head dams such as Watana and Devil Canyon as a result of the entrainment of air in discharges. Supersaturation occurs when aerated flows are subjected to pressures greater than 30 to 40 ft (9 to 12 m) of head, which forces excess nitrogen gas into solution. This can occur when water is subject to the high pressures that occur in plunge pools or at large hydraulic jumps. Therefore, nitrogen saturation in the Susitna River would not be affected during the construction phase of the Watana or Devil Canyon projects.

Intake, penstock, turbine, tailrace, and low-level outlet facilities at Watana and Devil Canyon, which would be used during operation, are designed to minimize entrainment of air. In addition, releases from the turbines at both dams would have a subsurface discharge that should not entrain air. Turbine discharges, however, could be supersaturated with nitrogen during summer as a result of warming of surface waters in the reservoir and withdrawal of the water before it equilibrated with the atmosphere (Harvey, 1967). Because of the high turbidity in the reservoirs, warming of water below the depth of wind mixing would be minimal. Thus, assuming there was no air entrainment in water passing through the turbines, the level of saturation in turbine releases would be less than 110%. Discharges from the low-level outlet during reservoir filling and from turbines during operation, therefore, would not be expected to increase nitrogen saturation in the Susitna River to levels exceeding the Alaska Department of Environmental Conservation (ADEC) (1979) statute of 110% of saturation.

The outlet facilities, which would be used for augmentation and excess flows at Watana and Devil Canyon, are designed to discharge peak flows with a recurrence interval of up to 1 in 50 years. The outlet facilities at both dams would be equipped with fixed-cone discharge valves that would be installed at the downstream end of the outlet manifold. They are designed to dissipate the hydrostatic head, thereby reducing air entrainment and supersaturation of nitrogen. It is assumed that the fixed cone valves would operate as designed to prevent nitrogen saturation of water discharged from the outlet facilities to levels greater than 110%. Thus, releases of water from the outlet facility at Watana and Devil Canyon would not be expected to cause nitrogen saturation levels in excess of the ADEC statute downstream.

During the initial phase of filling Devil Canyon, the diversion tunnel would be used to release water until the water elevation reached 1,135 ft (344 m). Nitrogen supersaturation downstream of Devil Canyon during this period would be minimal (<110%) because of the lack of a plunge pool in which air entrainment occurs. After the water elevation in Devil Canyon reached 1,135 ft (344 m), and for the remainder of the filling period, discharges from the reservoir would be through the outlet facility. Assuming the cone valves operated as designed, nitrogen supersaturation in excess of the ADEC statute of 110% would not occur downstream of Devil Canyon during filling.

The emergency spillways proposed for the Watana and Devil Canyon facilities are designed to discharge flows with a predicted recurrence interval greater than once in 50 years. Although the spillways are designed with a flip lip, discharges from the emergency spillway would be into a plunge pool. It is likely that nitrogen supersaturation would occur during discharges from the emergency spillway. Based on the observed decay rate of nitrogen in the Susitna River downstream of Devil Canyon (Peratrovich and Hutchinson, 1982), nitrogen supersaturation from emergency spillway flows at Watana Dam and Devil Canyon would persist for several miles downstream. As a consequence, adverse impacts on fish from nitrogen supersaturation in the Susitna River during these emergency spillway discharges would be likely. It should be emphasized, however, that the predicted recurrence interval of such an impact is relatively long (once in more than 50 years).

Except for periods of emergency spillway discharges, Watana and Devil Canyon operation would reduce the nitrogen supersaturation problem in, and downstream of, Devil Canyon by reducing the recurrence interval of high flows above which supersaturation in excess of the Alaska water quality statute (110% of saturation) (Alaska Dept. of Environmental Conservation, 1979) occurs naturally in Devil Canyon. Under preproject conditions, mean monthly flows during June through August at Watana exceed the threshold discharge (~16,000 cfs) at which nitrogen supersaturation in Devil Canyon is greater than the statute level. With Watana in operation, this threshold discharge would never be exceeded at Watana under predicted minimum and average monthly flow conditions, and would be exceeded in only two months of maximum flow years with Watana in operation, compared to four months under preproject conditions (Exhibit E, Vol. 5A, Chap. 2, Table E.2.43). Thus, there would be a net benefit to operating Watana in terms of reducing the natural recurrence of nitrogen supersaturation in and below Devil Canyon to levels exceeding the Alaska statute for water quality. The operation of Devil Canyon would essentially eliminate the natural occurrence of nitrogen supersaturation in excess of the ADEC statute in and below Devil Canyon by preventing the high flows at which the statute is exceeded.

NUTRIENTS

The primary water quality issues concerning nutrients are the impact of construction and operation of Watana and Devil Canyon facilities on nutrient levels in the Susitna River downstream of the project and in the reservoirs, and the resulting trophic status in these systems. Construction activities would not be expected to have any significant adverse or beneficial impacts on nutrient levels in the Susitna River. Proposed mitigative measures (described in Sec. 2.1.12) would minimize or prevent any point-source inputs of nutrients from sewage treatment facilities and construction facilities.

Because reservoirs with surface discharges can act as nutrient traps, it is possibile that operation of Watana and Devil Canyon might reduce nutrient inputs to the Susitna River downstream of these dams, thereby altering the trophic status of the lower reaches of the river.

While the trapping of suspended solids by the reservoirs could improve conditions for primary production downriver in the summer, the concentration of suspended solids would still remain at levels that restrict light penetration, thereby limiting primary production. Thus, any effect of nutrient retention by Watana and Devil Canyon on nutrient loading downstream would not be expected to result in any significant adverse effect on the trophic status of the Susitna River downstream of the project because the system would be limited by light rather than by nutrients. Furthermore, the effect of reduced nutrient loading as a result of reservoir operation would be localized because incoming tributaries downstream of the dam would contribute nutrients to the Susitna River.

The trophic status of clearwater reservoirs and lakes has been assessed using nutrient loading rates and hydraulic flushing rates (Peterson et al., 1982). Phytoplankton production and biomass in Watana and Devil Canyon reservoirs are expected to be low, typical of that in oligotrophic lakes. It is anticipated that phytoplankton production and biomass in Watana would be somewhat lower than that predicted from nitrogen and phosphorus loading rates alone because of light limitation caused by high turbidity; nuisance blooms of algae would not occur in either reservoir.

SALINITY

Although the Susitna River is the major contributor of fresh water to Cook Inlet and, thus, has a major influence on the salinity of water in the upper portion of the Inlet, 81% of the Susitna River flow entering Cook Inlet is contributed by tributaries located downstream of the Watana and Devil Canyon sites. The potential for the Watana project operation to affect salinity in Cook Inlet is therefore substantially lessened by the fact that the flow in tributaries that account for most of the freshwater inputs to Cook Inlet would not be affected by the project. To quantify the effects of salinity of altered freshwater inputs to Cook Inlet resulting from project operation, the Applicant used a numerical estuarine model (Smith, 1977, 1982). This model simulates salinity at various locations in Cook Inlet on a seasonal basis, using different freshwater flows into the estuary.

During construction of Watana, freshwater discharges in the Susitna River would not be altered. As a result, salinity in Cook Inlet would not be affected during the construction phase. Simulations of preproject and postproject (Watana filling and Watana operation) conditions show that the salinity changes during filling relative to preproject levels would be relatively small and would vary seasonally. These changes would not be expected to have any adverse impacts on biota in Cook Inlet.

With Watana in operation, the salinity at node 27, located near the mouth of the Susitna River, would be lower during the period of minimum flow (October through April) than preproject levels. This would be due to the increased flows in the Susitna relative to preproject flows. The maximum predicted decrease in salinity at node 27 is approximately 1.4 ppt (parts per thousand) and would occur in April, when the preproject salinity is approximately 20 ppt.

During summer, when preproject flow in the Susitna River is at its annual maximum, the operation of Watana would reduce flows, resulting in a salinity increase in Cook Inlet. The maximum salinity increase predicted to occur in Cook Inlet at node 27 as a result of Watana operation is approximately 0.7 ppt. This would occur in June when the preproject salinity at node 27 is approximately 10 ppt. These predicted salinity changes would not be expected to have any adverse effects on aquatic organisms in Cook Inlet since they are within the the range of natural variation in salinity resulting from annual fluctuations in freshwater flows. In addition, as indicated in Section 3.1.3, the use of upper Cook Inlet by aquatic organisms is minimal, except as part of a migration route into or out of the Susitna River. This is due to the large tidal fluctuations, high turbidity, and unstable fine substrates, all of which tend to reduce the quality of the upper part of Cook Inlet as a habitat for estuarine organisms.

Changes in salinity at node 27 in Cook Inlet from the operation of Devil Canyon would be negligible relative to those with Watana in operation. This is because Devil Canyon would be operated as a baseload plant. Hence, changes in flow in the Susitna River relative to those for Watana operation alone would be negligible. Flow alterations from Devil Canyon operation thus would not adversely affect the salinity in Cook Inlet.

OTHER WATER QUALITY IMPACTS

There are other potential impacts of construction and operation of the Susitna Project on surface water quality. Relative to the issues previously discussed, these are minor sources of impact, however, and would not result in any significant degradation of water quality. The sources include accidental spills of petroleum products (e.g., fuel, oil, hydraulic fluids, antifreeze) from construction and maintenance equipment, reduction in dissolved oxygen resulting from the discharge, or inundation, of materials with a high biochemical oxygen demand (BOD), and the contamination of surface waters by other materials used in construction (e.g., concrete).

All state and Federal regulations governing the prevention and reclamation of accidental spills of petroleum products, including the development of a spill prevention and containment plan, would be adhered to on this project. Thus, reasonable precautions would be taken to prevent or minimize the contamination of surface waters by petroleum products.

Wastewater from construction camps would be treated with a secondary treatment facility prior to its discharge into surface waters. This secondary treatment would reduce the BOD and total dissolved solids to levels acceptable to the Alaska Department of Environmental Conservation (1979) and the U.S. Environmental Protection Agency. No adverse effects on water quality should result from these treated wastewater discharges.

Some reductions in dissolved oxygen in Watana and in Devil Canyon Reservoir would occur as a result of the inundation of soils and vegetation with a high BOD. The area affected, however, would be restricted to a zone within and just above the reservoir bottom. This should have no long-term adverse effects on dissolved oxygen levels in the reservoirs or in the Susitna River downstream of the dams.

Contamination of the Susitna River by concrete would be minimized by appropriate mitigative measures (see Sec. 2.1.12). These would include the use of holding ponds for concrete wastes, neutralizing wastes from these ponds prior to their discharge into surface waters, and disposal of waste concrete in rock disposal areas away from surface waters or allowing it to harden before disposal. No significant degradation of water quality in the Susitna River would be expected from concrete contamination.

4.1.3.2.2 Access Routes and Transmission Facilities

The construction of access routes to Watana and Devil Canyon project sites and to material and disposal sites would result in some water quality degradation in nearby streams. These impacts would result from accidental spills of petroleum products, the erosion of disturbed soil with subsequent increases in suspended solids and turbidity, and the clearing of riparian vegetation, resulting in increased water temperature from increased solar radiation at stream surfaces. These impacts would be localized and would not cause any long-term degradation of water quality in streams along the access routes. With proper routing, design, construction, maintenance, and mitigative measures, few water quality impacts would occur from the subsequent use of the access routes.

It is anticipated that construction of transmission lines would result in some localized increases in suspended solids and turbidity in streams as a result of instream activities, erosion from vegetative clearing along transmission corridors, and siting of transmission towers. A second potential impact on water quality would be from the contamination of streams with petroleum products and from accidental spills and leaks from construction and maintenance equipment. With proper design and construction practices, few erosion problems would occur during the construction and maintenance of transmission lines. Mitigative measures proposed by the Applicant (Sec. 2.1.12) would also minimize water quality problems due to petroleum product spills during the construction and maintenance of transmission lines.

4.1.3.3 Temperature

4.1.3.3.1 Reservoirs

During the early stages of Watana filling, there would be little change in the thermal structure upstream of the dam. As the reservoir became deeper and more static, a seasonal vertical thermal structure would develop and persist after filling was complete. During the winter months, Watana reservoir would be near isothermal at 39°F (4°C), with a thin layer of colder water at the surface. As air temperatures warmed into the summer, the reservoir would develop a greater thermal structure, with a warm layer (about 50°F to 54°F, or 10°C to 12°C) near the surface, decreasing linearly to 39°F (4°C) near mid-depth. Much of Watana reservoir would be at 39°F (4°C) year-round. Vertical temperature gradients that exist during the summer would be relatively weak. As a result, vertical mixing is expected in areas with large shears, such as the powerhouse intake and the river inflow region. Intermittent mixing could occur over much of the reservoir during the summer as a result of forcing by meteorologic events.

The thermal evolution of the Devil Canyon reservoir would be similar to that of Watana reservoir; however, the shorter residence time expected for water passing through this reservoir would likely produce a thermal structure less pronounced than for Watana.

4.1.3.3.2 Mainstem Susitna River

Water temperature downstream of the dams would be influenced by the magnitude and temperature of the dam discharge, river morphology, and surface heat transfer.

Watana dam design includes multilevel intake structures that allow selective withdrawal over a range of depths. During the initial phases of the Watana filling, the reservoir would be shallow and exhibit little thermal structure. Consequently, discharge water would parallel preconstruction water temperatures. As the reservoir deepened, a thermal structure would develop. There would be a period during filling when a weak vertical thermal structure would exist; however, the reservoir would not be sufficiently full to allow the upper level intake to be used. As a result, discharge water would be somewhat cooler during the summer and warmer during the winter as compared with preconstruction conditions.

During the final stages of Watana filling and during Watana operation, the upper-level intake would be used to regulate discharge termperatures in order to more closely simulate preconstruction temperatures. The Applicant has estimated operational discharge temperatures ranging from about 51°F (10.5°C) in the summer to about 35°F (1.5°C) in the winter (Exhibit E, Vol. 5B, Chap. 2, Figs. E.2.174 and E.2.175). The extent of the control expected by the Applicant is believed to be overly optimistic. The Staff believes that the vertical thermal structure in Watana reservoir would be too weak to allow effective selective withdrawal. The selective withdrawal process is shown schematically in Figure 4-6. In the absence of any vertical thermal structure [Fig. 4.6(a)], the intake would withdraw water over a significant vertical extent. In the presence of a vertical thermal structure, the effectiveness of selective withdrawal would depend upon the sharpness of the metalimnion (commonly referred to as the thermocline) and its position relative to the intake. For a well-defined thermocline that is considerably deeper than the intake, only warm epilimnotic water would be withdrawn [Fig. 4-6(b)]. For a sharp thermocline at a depth near the intake, the intake-induced flow would displace the thermocline upward, resulting in the withdrawal of predominantly epilimnotic water, but also some cold hypolimnotic water [Fig. 4-6(c)]. The thermal structure in Watana reservoir is expected to be too weak to remain stable under withdrawal-induced shear, so that water having a range of temperatures would be withdrawn [Fig. 4-6(d)]. Consequently, Watana discharge temperatures would be warmer during the winter and colder during the summer than under preconstruction conditions. Discharge temperatures are expected to be near 39°F (4°C) or less during the winter. Summer discharge temperatures would be highly transient, depending on short-term dam operation and local meteorological conditions. As a result, summer discharge temperatures cannot be quantified at this time but could range from 41°F (5°C) to 50°F (10°C).

Filling of the Devil Canyon impoundment would occur over a period of several months. As a result of this short filling time, Devil Canyon discharge temperatures would not differ significantly from water temperatures occurring under Watana operation alone.

The Applicant has estimated that under combined Watana/Devil Canyon operation, Devil Canyon discharge temperatures would range from about 46°F (8°C) to about 38°F (3.5°C) (Exhibit E, Vol. 5B, Chap. 2, Figs. E.2.215 and E.2.216). As in the case of Watana operation alone, outflow temperatures from the Devil Canyon dam would be regulated via selective withdrawal through multilevel intakes. The thermal structure of the Devil Canyon reservoir would be weaker than for the Watana reservoir. Consequently, it is expected that the multilevel intake would offer very little control over outlet temperature. As a result, winter outlet water temperatures are expected to be near 39°F (4°C), and summer outlet temperatures, although unquantifiable at this time, are expected to be somewhat colder than those estimated by the Applicant.

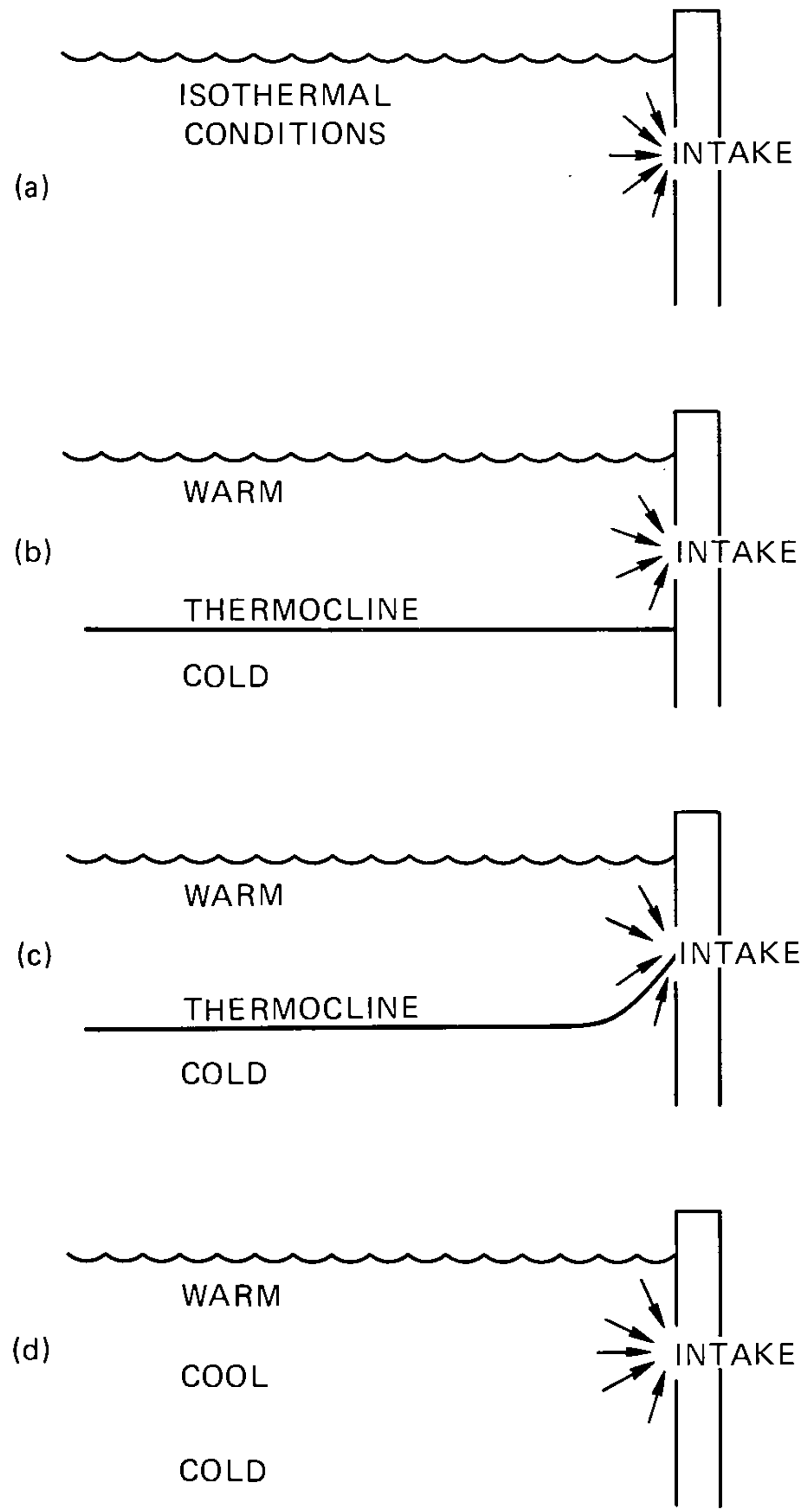

Figure 4-6. Schematic Diagram of Intake Flow Field under (a) Isothermal Conditions, (b) Strong Stratification and a Deep Thermocline, (c) Strong Stratification and a Shallow Thermocline, and (d) a Weak Vertical Temperature Gradient.

Downstream mainstem water temperatures have been simulated for combined dam operation using an analytic thermal model described in Appendix H. Two cases are analyzed, one for conditions typical of late fall/early winter and the other for mid-summer conditions. For both of these cases, outlet temperatures estimated by the Applicant were used. Figure 4-7 shows a plot of temperature versus downstream position from the Devil Canyon dam to the Chulitna confluence for the late fall/early winter case. This plot indicates that the warmer discharge water [39.2°F (4°C)] would rapidly cool with downstream location and reach 32°F (0°C) within 15 river miles of the Devil Canyon dam. Under mid-summer conditions, water would be discharged at a temperature near its equilibrium value, 46°F (7.75°C), and no warming between the dam and the Chulitna confluence is predicted.

Under fall and winter conditions, the combined operation of the Watana and Devil Canyon dams would produce insignificant changes in the downstream temperature profile of the mainstem Susitna River. During spring and summer conditions, the thermal inertia of the reservoirs would produce a delay in the warming of the river, and the cooler discharge temperatures would result in the mainstem water being cooler during this entire period. It is likely that during the spring and summer, the entire downstream reach of the river would be cooler than preoperational conditions. Only minor temperature differences are expected downstream of the Chulitna confluence; however, water temperatures cooler by as much as 4°F (2°C) could occur between the Chulitna confluence and the Devil Canyon dam.

For Watana operation alone, downstream water temperatures are expected to be similar to those anticipated under combined operation.

4.1.3.3.3 Sloughs

Three mechanisms can influence the water temperature in sloughs: surface heat transfer, groundwater discharge, and any hydraulic connection, either surface or subsurface, with the mainstem Susitna River. In this discussion, groundwater discharge is taken as subsurface water with origins other than the mainstem Susitna River. Some subsurface water reaching the sloughs could come from the river. This water would be at or near the temperature of the river water. During the winter low flows, the upper end of the sloughs are closed, making these sloughs backwater areas with only a weak downstream surface hydraulic connection with the mainstem. Consequently, during the winter, changes in downstream water temperatures resulting from reservoir filling and dam operation would have little thermal impact on winter water temperatures in sloughs. The influence of mainstem water temperature on sloughs is most significant during summer months, when berms at the upstream ends of sloughs are overtopped. Overtopping would be significantly reduced in frequency during project operations (see Sec. 4.1.3.1). The correspondingly reduced river elevation could also reduce subsurface flows from the mainstem into the sloughs.

This would enhance the influence of surface heat transfer and groundwater discharge on slough water temperatures. Slough water temperatures tend to be increased by surface heat transfer, but decreased by groundwater discharge. Insufficient data are available on the magnitude of groundwater discharge and mainstem infiltration to sloughs, and, therefore, the effects of the proposed project on slough water temperatures cannot be quantified.

4.1.3.4 Ice Processes

Operation of the proposed dams would significantly affect ice processes in the Susitna River. Higher winter flows would delay the onset of ice formation and would likely cause a thinner ice cover and greater ice-induced staging than under preoperational conditions. Warmer winter discharge water temperatures would likely cause a small portion (less than 15 river miles) of the Susitna River immediately downstream at the Devil Canyon dam to remain ice-free. Lower spring river flows would tend to delay the ice breakup process, but this would be balanced by the warmer dicharge water temperatures from the dams, which would tend to accelerate the onset of ice breakup. As a result of the reduced spring flows, the breakup process would be considerably less violent than under preoperational conditions, with the full breakup cycle occurring over a longer period (perhaps days to weeks longer) and much of the ice cover decaying in place.

Ice breakup has a profound influence on the morphology of the Susitna River. After filling of Watana commenced, the effect of ice breakup on river morphology would be significantly reduced. The reduction in ice-related scour, along with reduced operational summer flows would change the morphological character of the Susitna River--particularly between the Devil Canyon dam and Talkeetna--rendering it more stable, similar to rivers in more temperate climates.

Once filling of Watana was complete, the impoundment would be expected to ice over in winter. As air temperatures increased in the spring and summer, the ice should decay in place. Ice formation and decay in the Devil Canyon impoundment would be similar to that expected for the Watana impoundment.

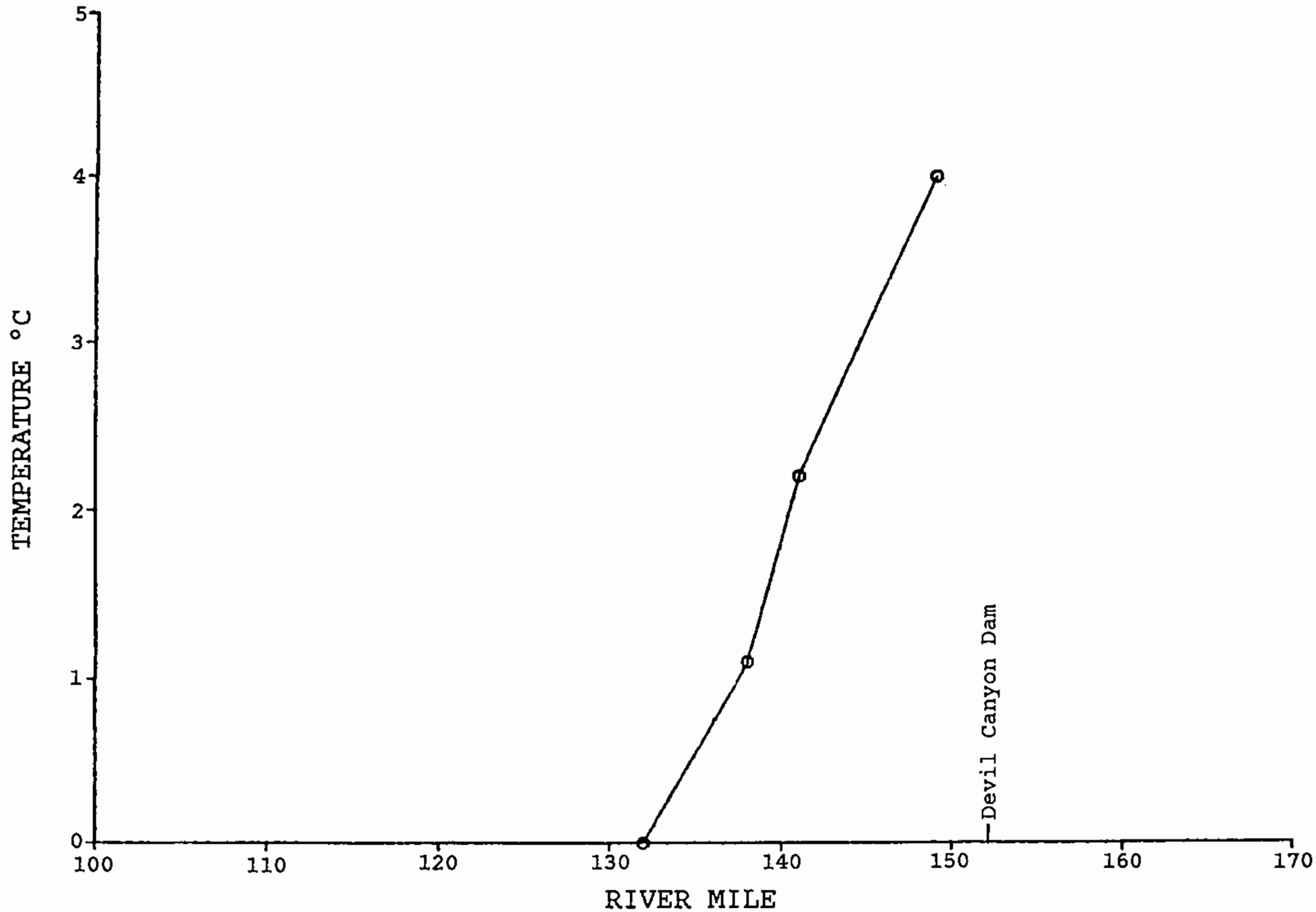

Figure 4-7. Predicted Downstream Water Temperature Resulting from Combined Dam Operation under Late Fall/Early Winter Conditions.

4.1.3.5 Groundwater

Construction of the proposed dams would have no impact on groundwater. Once filling of the reservoirs was completed, the proximity of relatively warm reservoir water to shallow permafrost zones could result in some melting of permafrost. This water would move through the soil in a downstream direction and would be discharged to the Susitna River downstream of the dams. Although the magnitude of this discharge cannot be quantified, it is expected to be limited to areas immediately downstream of the dams. Further downstream, the proposed project would have no direct impact on groundwater. The reduced downstream flows during filling of the reservoirs and during dam operation might result in a reduction in mainstem infiltration to the sloughs. Therefore, the project would result in groundwater discharge having enhanced importance in the thermal structure of sloughs.

4.1.4 Aquatic Communities

4.1.4.1 Plant and Invertebrate Communities

Watana and Devil Canyon facility development (including main dam and cofferdam construction, in-channel dredging, and deforestation) would introduce additional silt into the Susitna River, but the quantities are estimated (Sec. 4.1.3.2) to be nominal compared to already high levels in the open-water construction season. During later stages of filling and normal reservoir operation, the major consequences of impounding the Susitna River with Watana and Devil Canyon dams would be reduction in summertime turbidity and stabilization of flows, changes that the Staff judges could significantly increase benthic aquatic plant and invertebrate productivity and thus food availability for fish. Increased benthic algae and invertebrate production on the submerged riverbed would occur concurrently with a decrease in wetted surface area due to reduced summer flows during both filling and operation of the dams (Sec. 4.1.3.1).

Because of the overwhelming influences of the unregulated Chulitna and Talkeetna rivers on both flow and turbidity, the Staff has concluded that no detectable change in aquatic plant and invertebrate communities would result downstream of the confluences in the open-water season. Within the reservoirs, phytoplankton production in general is expected to be moderately low due to oligotrophic water quality (Sec. 4.1.3.2) and seasonally high silt loading. The poorly developed benthic invertebrate community in the Susitna and the higher populations found in clearwater tributaries would be removed by inundation. There would be gradual replacement by benthic species typical of reservoirs and development of reservoir zooplankton.

The zooplankton community that can be expected to develop in the reservoirs may be an important supplement to invertebrates in the Susitna River below the dams. The reservoirs are expected to be oligotrophic, however, so zooplankton populations may not be extensively developed. The sparse riverine community of benthic invertebrates in the reaches of the Susitna to be inundated by the Watana and Devil Canyon reservoirs is expected to be replaced by an equally sparse community of oligochaetes, chironomids, pisid clams, and benthic cladocerans. Biomass would be restricted by large fluctuations in water elevation (affecting littoral zones) and heavy sedimentation rates (affecting deep zones).

Increased turbidity and siltation associated with stream crossings by access routes and power transmission facilities would result in some degradation and loss of habitat utilized by benthic algae, periphyton, and invertebrates. Some changes in species composition might occur locally. These impacts would occur primarily during the construction phase of the stream crossings.

4.1.4.2 Fish Communities

4.1.4.2.1 Dam Development

Project construction from site preparation through reservoir filling would impact fishery resources primarily through additions of silt, elimination of riverine habitat for resident species (much of which would be converted to lake habitat), changes in downstream temperature, and reductions in summer flows. Silt addition during construction of Watana dam is judged to be a minor increase to an already high glacial silt load in most of the open-water season (Sec. 4.1.3.2). Entry of eroded bank materials (from which the heaviest particles would deposit rapidly) and impacts to riverine fish populations beyond the local construction site are expected to be minor.

Riverine habitat now utilized by resident fishes would be permanently lost at the Watana dam construction site and permanently transformed to lake habitat between the dam and just downstream of Vee Canyon as the reservoir filled. The alteration would include lower reaches of several tributary streams.

The FERC scoping process revealed concern that water quality alterations caused by impoundment of the river by Watana dam (and later, Devil Canyon dam) could cause significant disorientation of adult spawners in the years immediately following closure. Experiences at other hydroelectric projects on Pacific coastal rivers suggest that this potential problem may be minimal, even though quantitative methods to evaluate it are not available. Migrations into tributaries more than a few kilometers downstream of new dams are usually not interrupted.

During filling of Watana reservoir, temperatures in the Susitna above Talkeetna might be sufficiently low in June-September to retard entry of migrating adult salmon and prevent normal access and spawning by many fish during the filling years. Pink, chum, and coho salmon spawning areas in the mainstem are expected to be adversely affected by the flows proposed in the filling schedule for Watana reservoir. Decreased mainstem flows would result in decreased depths and velocities in some side-channel habitat and complete dewatering of other side-channel habitat. This is expected to alter or eliminate the availability or suitability of some of the currently used spawning habitat.

Slough habitats between Watana dam and Talkeetna are expected to be the spawning habitat type most significantly affected by filling flows. In the absence of mitigative measures, filling flows are expected to cause access problems for returning adult chum and sockeye salmon. For salmon that did gain access, the spawning area within the sloughs would be reduced because of lower mainstem flows. Accessibility of tributaries to adult salmon is not likely to be a problem at the filling flows, especially at Portage Creek and Indian River, which are the two most productive salmon tributaries upriver of Talkeetna.

Below Talkeetna, flow reductions might reduce the area of spawning habitat, since this habitat tends to be located on the lateral margins of the mainstem and in side-channel areas. Spawning in sloughs and tributaries below Talkeetna is not expected to be significantly affected during filling of Watana reservoir.

During reservoir filling, the normal winter ecology of salmonids would likely persist into summer in the Devil Canyon to Talkeetna reach of the Susitna River due to the abnormally cold [40°F (4°C)] releases from Watana. It is likely that there would be an insignificant amount of salmon fry growth in the Devil Canyon to Talkeetna reach during the summers of Watana filling. Downstream of the confluence with the Chulitna and Talkeetna rivers, growth rates of juvenile salmon and resident species would also be suppressed by cool temperatures. The Staff estimates a reduction in accumulated June-September growth in this reach by about 50% to 60% compared to potential growth at preproject temperatures (Table 4-2).

Numerous issues have arisen regarding maintenance of fish populations, especially salmon, in the Susitna River in the face of operating the Susitna Hydroelectric Project. This section emphasizes those issues. The discussions are organized according to major life stages of anadromous fish: upstream migration and spawning of salmon, incubation, juvenile rearing, and salmon emigration.

Between Devil Canyon and Talkeetna, the primary impacts on salmon spawning during the operation phase of the proposed project would be similar to, but less severe than, those discussed for the construction phase. The decreased summer flows would cause passage problems for adult salmon entering slough spawning habitats and would reduce the area of suitable spawning habitat within the sloughs. If unmitigated, and assuming that access to and availability of suitable spawning habitat are presently limiting salmon production, decreased summer flows would reduce the number of chum, sockeye, and pink salmon spawning in the sloughs upstream from Talkeetna. Accessibility of tributaries to adult salmon is not likely to be a problem during June through September during the operation phase, especially at the two most productive salmon tributaries upriver of Talkeetna--Portage Creek and Indian River.

Downriver from Talkeetna, operation of Watana alone is expected to have less of an impact on spawning in all habitat types relative to upriver areas. This is because on the downriver areas the primary water-related variables influencing spawning (i.e., flow, temperature, turbidity, and siltation) would be changed to a lesser extent relative to preproject conditions.

Review of available temperature predictions for the Susitna with Watana dam operating and the circumstances of reported migrative effects elsewhere indicates little potential for impedance of migration from the Susitna into tributary streams during reservoir operations.

Cone valves that are proposed for the outlet facilities to dissipate momentum should reduce the likelihood of supersaturation values exceeding 110%. There are no similar controls proposed for the spillway, and its use, albeit infrequent, can be expected to cause extensive fish mortalities

Table 4-2. Change in Potential Summer Growth of Juvenile Salmon in the Talkeetna-to-Mouth Reach Due to Filling of Watana Reservoir and Operation of Watana and Devil Canyon Dams†[1]

Month	Preproject	Watana Filling	Watana + Devil Canyon Operator
Temperature (avg. °F) in Lower Susitna			
June	52	43	44
July	52.7	44	45
August	52	45	46
September	46.5	42	43
Accumulated June-September growth (ounces)	0.19	0.063	0.070
Reduction from preproject growth (%)		-58	53

†[1] Calculations were based on assuming growth at mainstem temperatures and estimating temperatures by simple dilution. Accumulated growth was calculated on basis of an initial 0.2 g fry that developed at weight-specific rates published for sockeye salmon. Average monthly temperatures for the reach were calculated from average temperature and flow data for the Chulitna and Talkeetna rivers and the projected minimum flows in the Susitna River during filling and operation of both dams. Temperatures for the Susitna River assume maximum downstream warming from release temperatures (4°C during filling). Warming from Talkeetna to the mouth has not been considered, but would change little due to the project.

in the river downstream. Supersaturation in excess of the 110% tolerance threshold for most fish can be expected during use of the spillway. High mortalities are expected for fish of all ages that are present in the mainstem for an indeterminate distance between the dam site and the junction with the Chulitna and Talkeetna rivers where dilution will occur.

The conclusion was reached by the Alaska Department of Fish and Game, Fisheries Rehabilitation Enhancement and Development Division, that upriver expansion of anadromous salmon populations to areas above Devil Canyon was not practicable in the absence of the Susitna project. The Staff thus concludes that loss of upriver salmon potential would not be a significant project impact. With Watana dam alone, reduced flows in Devil Canyon would probably allow salmon access to several creeks previously used rarely, if at all, including Cheechako, Chinook, and Devil creeks. The additional spawning area could be significant.

Changes in river flow and temperature during this time can be expected to have some impact on incubation success through the mechanisms presented below.

Because the Sustina River is used for mainstem and slough spawning by all Pacific salmon species except chinook, power peaking would put spawning areas at risk. The proposed limitation of water releases to those of a baseload operation constitutes an effective fish conservation measure compared to a peaking mode of operation. Some redd dewatering might occur in winter above Sherman during reservoir operations due to reduced ice staging. The flow stabilization would reduce stranding of fry caused by freshet flows in summer.

Considering the uncertainties in estimating actual incubation temperatures, the preliminary analysis has focused on altered river temperatures and the potential shifts in incubation rate patterns that they would cause. The major potential incubation impact of the Susitna project would be acceleration of development rates by warmer temperatures in autumn and winter (Figs. 4-8, 4-9). Under predicted river temperature regimes, corrected for warming and/or cooling as discharges traverse the Devil Canyon to Talkeetna reach, early spawning pink and chum salmon (mid-July) could complete development to the emergence stage by mid to late October with Watana alone, rather than early spring. Winter survival would likely be negligible. Later-spawning salmon would be affected only slightly.

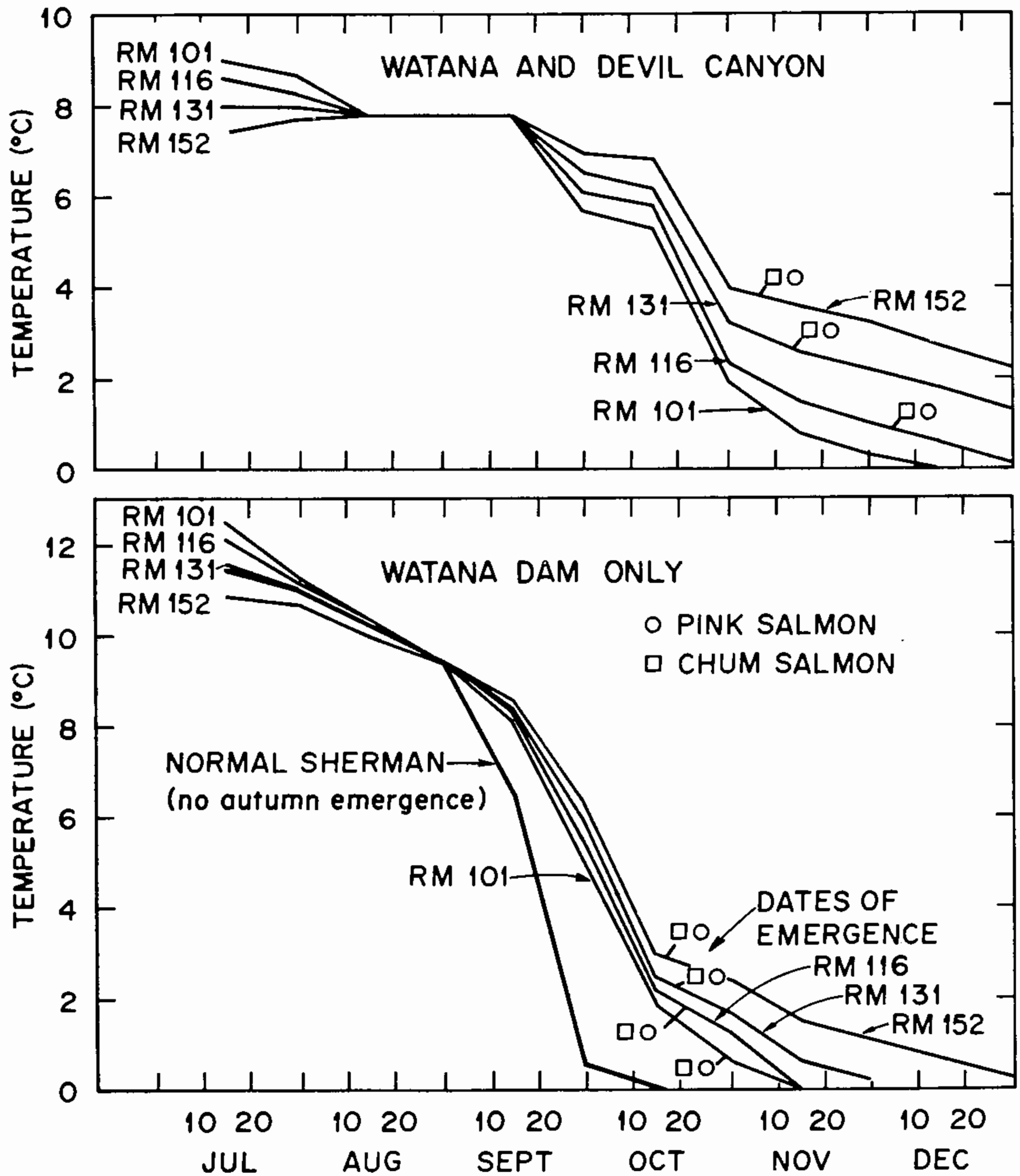

Figure 4-8. Predicted Early Emergence of Pink and Chum Salmon. Calculated for conditions during falling mainstem temperatures (°C) in autumn from eggs spawned on July 15 at four locations in the Susitna River between Devil Canyon outlet (RM 152) and the Chulitna junction (RM 101) and incubated at mainstem river temperatures.

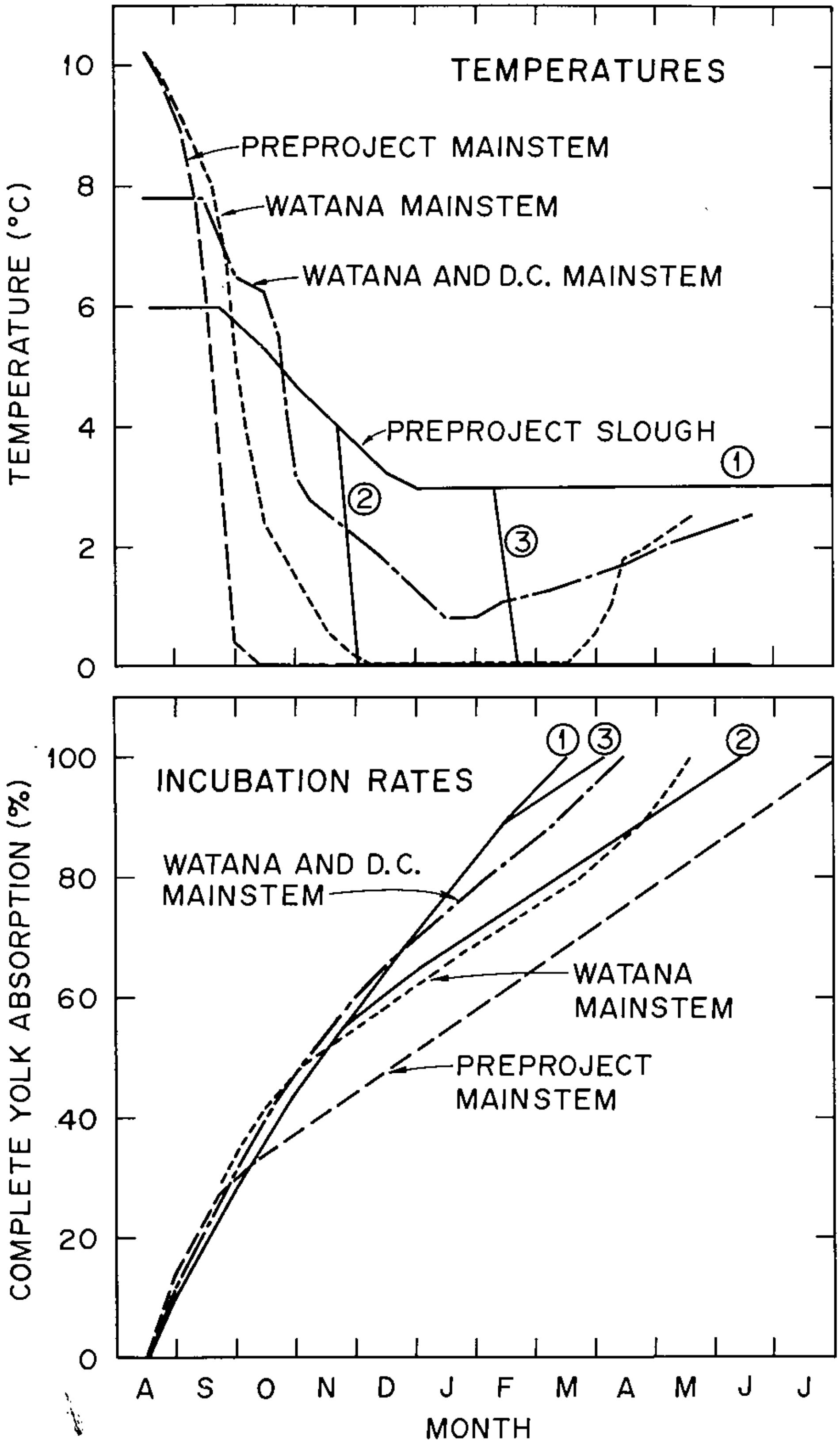

Figure 4-9. Incubation Rates for Chum Salmon Embryos Spawned On August 15 under Different Temperature Scenarios. [Preproject mainstem at Sherman, Sherman mainstem with Watana dam alone, Sherman mainstem with Watana and Devil Canyon dams, and intergravel in a slough without overtopping (1), and with two representative overtopping dates: November (2) and February (3).] [Source: Mainstem temperatures were developed by the FERC Staff from Application. Slough temperatures and regression equations for incubation rate modeling from Wangaard and Burger (1983)]

The thermal effects on egg incubation estimated for Watana reservoir alone due to warm autumn temperature would be somewhat reduced with both dams in operation in spite of additional prolongation of warmer temperatures into the late autumn by Devil Canyon dam. Early spawning pink and chum salmon could produce emerging fry in November-December with both dams in operation (Fig. 4-8). Later-spawning fish would be more affected than with Watana alone. Operation of Watana and Devil Canyon dams would yield mainstem fall and winter temperatures in the Devil Canyon-to-Talkeetna reach that approximate preproject temperatures in spawning gravels of sloughs (Fig. 4-9). This could, in conjunction with progressive elimination of silt gravels, enhance mainstem spawning and incubation success.

Siltation is the principal nemesis of incubating eggs in river gravels, as several studies have shown an inverse relationship between the amount of sediment in spawning gravels and emergence success of salmon and trout fry. Winter silt loads resulting from operation of the Susitna reservoirs would have the potential of reaching levels detrimental to downstream redds. Analogies with existing glacial lakes such as Eklutna, however, suggest that residual turbidity from operation in winter would not be detrimental.

The expectation of changed growth is of particular concern for juvenile salmon of all five species that develop in the river for varying lengths of time prior to and during their seaward migration. It is known that larger fish at time of entrance to the ocean have a higher likelihood of surviving to adulthood. The results indicate little alteration of presently achievable growth when Watana dam alone is in place (Fig. 4-10). With Watana dam alone, warming of the river in autumn generally would compensate for somewhat delayed (but similar) summer peak temperatures in determining the cumulative annual growth of those species that remain all year (chinook, coho). If chum, pink, and sockeye salmon continued to migrate out of this reach of river by the end of July, their growth could, however, be reduced by about one-third, with some reduction in survival. Altered temperatures, and thus growth rates, in the Susitna following dam construction would likely favor the species most capable of growing best in cooler water (which appear to be sockeye and pink salmon).

Potential growth of juvenile salmon downstream of Devil Canyon and Watana dams would markedly decrease when both dams were in operation (Fig. 4-10, Table 4-2). Annual growth potentially might reach only about 50% of preproject levels. The species that emigrate in their first summer might accumulate only about one-third of their normal riverine growth. Although the modest changes in growth with Watana dam alone would probably be undetectable, the more striking changes associated with both dams operating could have important implications for survival of the emigrating juvenile salmon.

Major consequences of impounding the Susitna River would be reduction in summertime turbidity and stabilization of flows, changes that could significantly increase benthic productivity and thus food availability for fish fauna (Sec. 4.1.4.1). Zooplankton originating in an upstream reservoir can be an important supplement to food resources for downstream salmonids, and might become important in the post-impoundment Susitna. However, this increase might be reduced by Devil Canyon dam development, due to the summer temperature reductions (Sec. 4.1.3.3). The projected temperature reductions might be sufficiently severe to retard growth of benthic food organisms.

The degree to which increased fish food availability per unit area in the Susitna during project operation would offset the effects of a decrease in wetted perimeter and reduced water temperatures is a matter of speculation. Because thermal changes with Watana alone would be relatively small, it is likely that overall productivity of the Susitna from the dam to Talkeetna would rise, and juvenile salmon production should increase. Undoubtedly, the reduction in turbidity and flow stabilization offer important management opportunities for Susitna River salmon.

Woody debris (trees, stumps, logs, brush) at certain locations in the Susitna currently creates small pools and backwater areas that are used by young salmon for resting and feeding. Blockage of upstream sources of this debris and reductions in peak flows that erode wooded riverbanks could lead to depletion of such debris in the river above the Chulitna confluence by progressive washout downstream, and thus degradation of rearing habitat.

Elevation of winter temperatures in the reaches downstream of the dams would be a project modification that might affect the behavior and survival of overwintering fishes. The temperature alteration would be most pronounced close to a dam outlet, and it would be moderated downstream by low air temperatures and cold tributary inflows. If a 5°C (41°F) threshold for inducing behavioral changes that has been seen elsewhere is germane to Susitna populations (presently untested), then even the most elevated temperatures in winter would still be below this threshold, and a normal annual behavior cycle would occur. The pronounced lag in autumnal cooling, however, would delay onset of inactivity.

Generally warmer winter temperatures in the Susitna River below Watana dam might result in an earlier breakup of river ice, warmer river temperatures earlier in the season, and potential

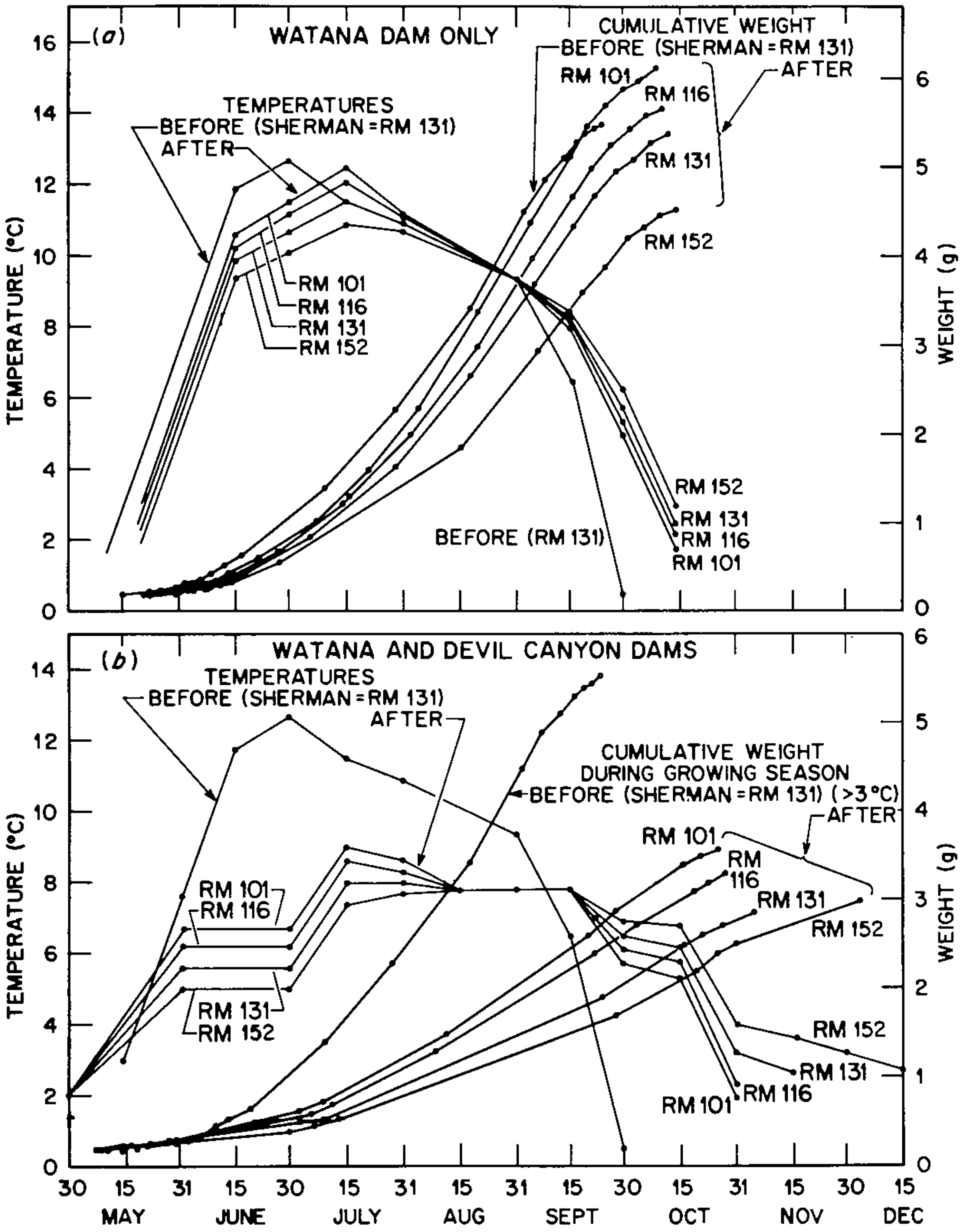

Figure 4-10. Temperature and Cumulative Growth for Juvenile Sockeye Salmon in the Susitna River between Devil Canyon and Talkeetna, Before and After the Project. (Sockeye salmon is assumed to adequately illustrate effects on the salmon species.)

advancement of the timing of smolt out-migration. It seems reasonable to conclude that advancement of river temperatures in spring could result in a concomitant advancement of outmigration of juvenile salmonids. This advancement could be detrimental for the populations involved because of the negative effects (reduced survival) of early entrance to cold coastal waters.

Potential shifts might occur because of different directions or degrees of response to dam-induced environmental changes. Such shifts could be important for fisheries in both the river and in Cook Inlet. As the project impacts are better defined and quantified, and as the fish populations are better understood, projections about relative advantages might be made. The state of basic knowledge and ecological theory related to competitive processes does not allow predictions beyond speculation at this point. If unanticipated shifts in relative abundance were shown by postproject monitoring, additional mitigative measures might be necessary to restore preproject relationships.

Habitat potential for fish in Watana and Devil Canyon reservoirs would be limited by cold temperatures, low productivity, high silt loads in summer months, and large drawdown that would prevent development of a littoral zone (Sec. 4.1.3). The Applicant evaluated the annual drawdown cycle of Watana reservoir in relation to fish spawning. Winter dewatering and spring flooding (Sec. 4.1.3) are both of concern for successful reproduction in the reservoir.

In addition to year-round resident fishes, Watana reservoir would be expected to provide important new overwintering habitat for fishes that occupy tributaries and the Susitna upstream of the Oshetna River.

Kokanee (landlocked sockeye salmon) is the most abundant fish in many large subalpine lakes and reservoirs of western North America, and it could provide a valuable salmonid fish species for Devil Canyon and Watana reservoirs and tributaries above Devil Canyon. Chakachamna Lake currently provides rearing for a large number of juvenile sockeye salmon. Establishment and maintenance of a Kokanee population in Watana reservoir could provide a pelagic component of the fauna comparable to the Scandinavian roach and a viable alternative to Alaska Department of Fish and Game proposals to open the upper Susitna to anadromous salmon stocks through fish passage facilities at Devil Canyon. Limiting factors would be the capability of the turbid Watana reservoir to sustain zooplankton and impaired reproduction along the reservoir shoreline (although the upper Susitna and tributaries should provide abundant spawning habitat).

Devil Canyon reservoir would offer favorable habitat to fish populations, although low productivity levels would be anticipated due to cool temperatures, nutrient limitation, and small amount of spawning area. Dolly Varden, Arctic grayling, rainbow and lake trout, burbot, whitefish, and longnose suckers could be expected, paralleling trends projected for Watana reservoir.

In summary, projected changes in the flow and temperature regimes downriver of the two proposed dams have been identified above as having potentially negative impacts on the salmon stocks utilizing the Devil Canyon to Talkeetna reach of the Susitna River for spawning and rearing. The Staff has analyzed historical flow, temperature, and commercial catch data for the years 1950-1982 to determine if there has been an obvious influence of low flows in summer or of low or high temperatures in summer or winter on year-class strength for any of the five salmon species.

For each species, using the appropriate lag between year of flow when spawning occurred and year of catch of the progeny by the commercial fishery, the mean commercial catch for low-flow years was compared with that for high-flow years. There were no statistically significant differences, indicating that over the range of flows occurring during July, August, and September from 1950-1981 there is no strong evidence that year-class strength for any of the five species is adversely affected by low flows during the spawning period. An important caveat for this analysis is that the average flows at Gold Creek for the low-flow years were all above 12,000 cfs (340 m^3/s) whereas the proposed project flows at Gold Creek during July, August, and September are 6,480, 12,000, and 9,300 cfs (180, 340, and 260 m^3/s), respectively. There is no sound basis for judging the validity of extrapolating the results of this analysis to these lower flows.

Considering the potential cumulative impact of changes in flow, temperature, and turbidity regimes on all stages of the salmon life cycle from inmigration of adults through outmigration of smolts (and mitigation of unacceptable losses due to gas supersaturation during project operation), the Staff expects the following changes. Salmon production above Talkeetna for all five species would be greatly reduced during the second and third years of filling of Watana reservoir. However, the lost production in this reach for these two years would likely be at least partially offset by increased production that would occur in other systems because salmon that normally would have continued to migrate up the Susitna River would select the warmer water of the Talkeetna River. All five salmon species would be expected to increase their use of the Devil Canyon to Talkeetna reach of the Susitna River again when Watana started operating, although the rate of return to higher production levels would vary among the five salmon species, depending on the life cycle and on the strength of the year classes returning in the years immediately following the filling of Watana. In the case of pink salmon, no imprinted adults might be available to come back since both odd-year and even-year stocks would be impacted during the second and third years of filling, and thus recovery to higher production levels would likely take longer than for the other species.

It is not possible to assess whether the Susitna Hydroelectric Project would result in an average, long-term decrease or increase in populations of salmon presently spawning in the Susitna River Basin. However, it is likely that there would be at least short-term decreases in salmon stock sizes due to construction of Watana and Devil Canyon dams and filling of Watana reservoir. These decreases would result from substantial changes in flow, temperature, and turbidity regimes. Based on the Staff's analysis, the magnitude of any decrease, especially in light of the various mitigative measures to be implemented (Sec. 2.1.12), would not be great. No combination of impacts has been projected that would reduce by as much as 50% any of the five salmon populations spawning in the Susitna River and tributaries above its confluence with the Talkeetna and Chulitna rivers, although the chum and sockeye stocks are likely to be more affected than the chinook, coho, and pink salmon stocks. Conversely, it is not reasonable to expect that the proposed project, even in combination with extensive mitigative measures, would result in an increase by as much as 50% of any of these five salmon populations.

It is not possible to quantify the direct impact of the project on the commercial, sport, or subsistence fisheries, except that, other factors being equal, changes in catch would be approximately proportional to decreases or increases in the size of the spawning stocks. Other factors, however, would not be equal with and without the project. As discussed in Section 4.1.8, the project would tend to promote economic and population growth. These changes, in turn, would inevitably increase fishing effort by the commercial, sport, and subsistence fisheries. The effect of this increased fishing effort is relatively easy to predict based on case histories for numerous other fish stocks all over the world. Increasing exploitation would eventually result in decreasing fishery resources unless there was increasing intervention of fishery management practices. This long-term and indirect impact of the project is likely to mask any direct impacts of the project on downstream habitat and the size of the fish populations this habitat can support.

4.1.4.2.2 Access Routes and Power Transmission Facilities

There are two environmetal impacts to be assessed for fish communities in streams and lakes in the vicinity of the proposed access routes. The greatest source of adverse impact on fish communities would be the increased accessibility of these streams and lakes to fishing pressure via the network of access routes. By subjecting these streams to increased fishing pressure, many of the larger, older fish would be removed from the population, altering the age structure and possibly reducing reproductive potentials.

Another impact associated with access roads and railroads, as identified by the Applicant and the various agencies concerned with fishery resources, would be the effect on resident fish populations, grayling in particular, of increased turbidity and siltation associated with stream crossings. The bases for this concern are that there would be approximately 100 stream crossings and that increased turbidity and siltation at these crossings would likely result in degradation and loss of habitat, especially habitat presently used for spawning and rearing of juveniles.

Assuming effective mitigative actions to avoid long-term alterations of streams at crossings, the major impact is expected to be increased fishing pressure. Cooperative regulation of fishing activities or fish removal by project Staff and the Alaska Department of Fish and Game might mitigate these impacts as well.

4.1.5 Terrestrial Communities

4.1.5.1 Plant Communities

Potential impacts to terrestrial plant communities and wetlands from construction of the proposed Susitna project can be divided into three categories: (1) the direct removal of vegetation, (2) indirect vegetation loss or damage, and (3) alteration of plant communities. The first category generally constitutes the most severe impacts and is the most quantifiable. The second and third categories are not mutually exclusive in that indirect vegetation loss or damage often results in alteration of plant communities.

Construction of the proposed Watana and Devil Canyon dams, impoundments, and related facilities and of proposed access facilities would result in the direct removal of about 44,000 acres (17,800 ha) of vegetation, or about 1.3% of the vegetated area within the upper and middle Susitna Basin (Table 4-3). Of this amount, 36,000 acres (14,600 ha) would be forest. This area represents about 4.2% of the forested areas within the upper and middle Susitna Basin. More specifically, about one-third of the paper birch forest and 10% of the mixed conifer-deciduous forest types in the upper and middle Susitna Basin would be lost. Less than 1% of the tundra and shrubland types in the upper and middle basin would be removed. Areal estimates of specific

Table 4-3. Acreages of Permanent and Temporary Vegetation and Wetland Removal Due to the Proposed Susitna Project and Acreages of Vegetation and Wetland Disturbed by Proposed Power Transmission Corridors

Facility and Type of Loss	Affected Acreage by Vegetation Type†[1] Forest	Shrubland	Tundra	Total Vegetated Area	Potential Wetland Acreage Affected†[1,2]
Permanent Removal					
Watana Total	27,000	4,400	210	31,000	28,000
Dam and impoundment	27,000	4,200	210	31,000	28,000
Permanent village and airstrip	0	110	0	110	130
Devil Canyon Total	5,700	170	27	5,900	4,200
Dam and impoundment	5,700	170	27	5,900	4,200
Access	190	700	210	1,100	740
Total Permanent Removal	33,000	5,200	440	38,000	33,000
Percentage of Basin Total†[3]	(3.8%)	(0.3%)	(<0.1%)	(1.1%)	(1.5%)
Temporary Removal†[4]					
Watana Total	2,600	2,400	190	5,200	4,200
Camp and village	0	240	0	240	240
Borrow areas (A,D,E,F,H,I)	2,400	1,300	190	3,900	3,200
Construction work areas	200	840	0	1,000	720
Devil Canyon Total	1,100	52	0	1,200	450
Camp and village	190	0	0	190	0
Borrow areas (G,K)	340	52	0	390	140
Construction work areas	580	0	0	580	310
Total Temporary Removal	3,700	2,500	190	6,400	4,600
Percentage of Basin Total†[3]	(0.4%)	(0.2%)	(<0.1%)	(0.2%)	(0.2%)
Total Vegetation Removal	36,000	7,700	640	44,000	37,000
Percentage of Basin Total†[3]	(4.2%)	(0.5%)	(0.1%)	(1.3%)	(1.7%)
Vegetation Disturbance†[5]					
Transmission Line Corridors	6,600	3,400	1,700	12,000	7,600

†[1] Values rounded to two significant figures; acreages do not add up to totals due to rounding errors.

†[2] Extremely liberal estimates based on correlation of vegetation types to wetland types of Cowardin et al. (1979) as presented in Appendix J, Table J-5 (see also Sec. J.1.2.1.5).

†[3] Acreage of vegetation or wetlands lost converted to percentage of that vegetation or wetland type for the upper and middle Susitna Basin (see App. J, Tables J-7 and J-12).

†[4] The use of the word temporary implies that the area would eventually be rehabilitated.

†[5] Acreages presented are areas that would be crossed by the corridors.

Conversion: To convert acres to hectares, multiply by 0.405.

vegetation types that would be removed for each dam and impoundment, related facilities at each site, and the various access routes are presented in Tables J-18, J-19, J-22, J-23, and J-26 of Appendix J.

Areas cleared for construction camps and villages, construction roads, contractor work areas, and borrow areas at both sites would cover a total of about 6,400 acres (2,600 ha), or 15% of the total 44,000 acres (17,800 ha) of vegetation removed (Table 4-3). Estimates of the total acreages of specific vegetation types that would be cleared for construction of these facilities are presented in Tables J-19 and J-23 (App. J). Because these facilities would only be required during construction of the dams and impoundments, the potential for establishment and growth of vegetation on the areas occupied by these facilities would only be temporarily lost. According to the schedule presented in Exhibit E (Vol. 6A, Chap. 3, pp. E-3-276 - E-3-277), temporary facilities and borrow areas would be removed and/or regraded and rehabilitated by the end of the construction and reservoir-filling period. General rehabilitation procedures planned by the Applicant have been described in Appendix J (Sec. J.3.1.3) and Exhibit E (Vol. 6A, Chap. 3, pp. E-3-279 - E-3-281).

If soils can be adequately restored on rehabilitated areas, it is likely that at least some vegetation would reestablish rather rapidly because of the disturbance-adapted nature of subarctic plant species and communities (Chapin and Chapin, 1980; Van Cleve and Viereck, 1981). However, in most (if not all) instances, it would be readily apparent for some time that the area had been disturbed. The rate at which plant communities in rehabilitated areas replace the original pattern of lost vegetation or blend in with surrounding communities would depend on the rates of plant reestablishment and succession on the rehabilitated site and in surrounding areas, and these rates can vary with numerous factors (see App. J, Sec. J.2.1.1.1). Based on the rates of plant succession reported for floodplains and glacial moraines and those observed following fires (Viereck, 1966; Viereck and Schandelmeier, 1980; Van Cleve and Viereck, 1981), it might be 150 years or more before the original vegetation types removed from some areas (generally those occupied by later successional stages) were replaced with similar plant communities. On the other hand, replacement of later successional stands by earlier seral stages might be beneficial for wildlife because early seral stages generally provide more high-quality forage than do later seral stages (Wolff, 1978; Wolff and Zasada, 1979).

Many of the vegetated areas that would be cleared can be considered wetlands. However, it is difficult to accurately predict the actual acreages of various wetland types that would be removed because the Applicant has not conducted a detailed wetlands mapping program. Lacking better information, the Staff has made extremely liberal estimates of potential wetlands that would be lost (Table 4-3) by correlating vegetation types to the wetland types of Cowardin et al. (1979) (see App. J, Table J-5 and Sec. J.1.2.1.5). About 24,000 acres (9,700 ha) of the potential wetlands that would be removed are palustrine forested, needle-leaved evergreen types; this acreage represents over 3% of that type within the upper and middle Susitna Basin. Only about 300 acres (120 ha) of palustrine or lacustrine emergent, persistent, and less than 50 acres (20 ha) of palustrine forested, broad-leaved deciduous wetland types would be removed, but these areas account for about 2.5% and over 4%, respectively, of these types within the upper and middle Susitna Basin. Areal estimates of specific wetland types that would be removed for each dam and impoundment, related facilities at each site, and the various access routes are presented in Tables J-20, J-21, J-24, J-25, and J-27 in Appendix J.

Although the land areas where temporary construction facilities and borrow areas had been located would be physically rehabilitated, it is impossible to predict whether wetlands that originally occurred in these areas would be restored. (See App. J, Tables J-21 and J-25, for areal estimates of specific wetland types that would be cleared for construction of these facilities.) Since localized drainage patterns and terrain might often be affected or purposefully changed during construction of project facilities and access roads and during excavation of borrow areas, the potential for and the feasibility of reestablishing wetland conditions must be considered on a case-by-case basis. Conversely, construction-related changes in local drainage patterns might also result in creation of new wetland areas nearby (Berg, 1980). The Applicant has indicated that efforts would be taken to avoid wetlands wherever possible during construction activities and to minimize potential major alterations to drainage patterns through proper engineering design (Exhibit E, Vol. 6A, Chap. 3, pp. E-3-256 and E-3-290).

The 12,000 acres (4,900 ha) of vegetated area to be crossed by the proposed power transmission corridors (Table 4-3) represent a worst-case estimate of vegetation that would be impacted. The Applicant has indicated that clearing of vegetation from the rights-of-way would be selective, with total removal generally confined to tower sites, access trails, and temporary construction facilities. Vegetation within the rights-of-way would be cleared to various maximum heights, but in general at least ground-layer vegetation would be left intact. Herbicides would not be used (Exhibit E, Vol. 6A, Chap. 3, pp. E-3-270 - E-3-271). Thus, because of their overstory layer heights, forest and tall shrub types (representing about 60% of the vegetation that would be crossed by the corridors) would be most impacted by clearing. (See App. J, Tables J-28, J-30, J-32, and J-34, for more specific estimates of vegetation types that would be crossed by each corridor.) As a worst-case estimate, 7,600 acres (3,100 ha) of potential wetlands would be crossed by the proposed transmission corridors (App. J, Tables J-29, J-31, J-33, and J-35). However, the Applicant has indicated that site-specific adjustments would be made in the corridors during detailed alignment studies in order to minimize wetland and floodplain crossings (Exhibit E, Vol. 6A, Chap. 3, p. E-3-290).

Additional areas would be subjected to indirect damage (or loss) of vegetation and alteration of plant communities during project construction. However, it is impossible to quantify the acreage and identify specific vegetation types that would be thus affected. The nature of these types of impacts has been described in more detail in Section J.2.1 (App. J); the types of potential indirect effects are only briefly mentioned here.

Vegetation loss or damage could occur as a result of erosion and slumpage on slopes surrounding the impoundments (especially Watana) or other facilities (Baxter and Glaude, 1980). More localized erosion would probably occur as a result of construction-related factors, such as altered drainage patterns, blowdown of trees by increased winds due to greater fetch across cleared areas, and destabilization of soils exposed by clearing (especially in permafrost areas and in non-permafrost areas where the organic layer has been removed) (Van Cleve, 1978; Berg, 1980; Todd, 1982; Aldrich and Slaughter, 1983). Changes in drainage patterns and surface hydrology would be caused by such construction activities as clearing, ditching, road building, soil stockpiling, and borrow site excavation (Berg, 1980). Some soils might become waterlogged; others might accumulate less moisture. Soil aeration and nutrient cycling processes could also be affected. The active layer of permafrost areas might change, and cleared soils might freeze and thaw deeper and earlier than when insulated by vegetation. All such changes could foster erosion and alter the composition or productivity of nearby plant communities. Erosion- and permafrost-related impacts would be minimized, however, by the use of balloon-tire and flat-tread vehicles in construction areas and along transmission corridors (Rickard and Brown, 1974). Fugitive dust from cleared areas and borrow sites could accumulate on vegetation, cause abrasive damage, or affect the rate of snowmelt, all of which could affect plant phenology (Everett, 1980; Drake, 1981). Clearing and indirect vegetation damage might also affect the abundance of insects, decay organisms, and disease-causing agents; these changes could in turn further affect vegetation.

Although fire is a natural factor affecting plant community distributions in the region (Viereck and Schandelmeier, 1980), the frequency, duration, intensity, and area of fires might change as a result of increased human activity in the area, thereby affecting vegetation. Nonessential disturbance of vegetation due to increased human activity cannot be totally avoided. Also, use of off-road and all-terrain vehicles (ORV/ATV) would probably increase as a result of increased access and human activity in the area. Damage or alteration of plant communities due to ORV/ATV usage would probably be most severe as a result of summer use and in areas with permafrost, in wetlands or areas with high soil moisture content, on deep gravel-free soils, on slopes, and in tundra vegetation types. Plant recovery would be less likely if the organic layer was severely disturbed and root systems destroyed (Rickard and Brown, 1974; Gersper and Challinor, 1975; Challinor and Gersper, 1975; Sparrow et al., 1978).

Operation of the proposed project facilities would result in continuation of some indirect impacts to vegetation caused by increased incidence of fires; increased human access, activity, and ORV/ATV usage (especially near access roads and along transmission corridors); tree blowdown near the reservoirs; erosion and permafrost thaw, particularly near the reservoirs and access roads; and fugitive dusting along access roads. In addition, Watana and Devil Canyon operation would affect vegetation through regulation of downstream flows and mesoclimatic changes.

The regulated flows associated with project operation would affect the development of riparian plant communities downstream of the dam sites. Specific effects are difficult to predict or quantify since they would vary at particular locations depending on river morphology and distance from the dams. The following discussion of potential impacts is based on predictions of river staging, water temperatures, and ice regimes presented in Exhibit E (Vol. 5A, Chap. 2). In general, regulated flows would be higher than preproject flows in winter and lower than preproject flows in summer, and increased temperatures of water released from the dams would affect ice formation downstream of the dam sites.

With only Watana in operation, it is expected that ice formation would not occur in the Watana to Devil Canyon reach. Since summer flows would be reduced by comparison to preproject flows, vegetation would gradually establish on newly-exposed areas along banks and on islands. However, the actual areas involved would probably be relatively small because of the steep banks in this reach. With the elimination of ice scouring and major flooding events, succession of existing and newly established vegetation stands would proceed with relatively little interruption toward mature balsam poplar and white spruce forest until clearing and inundation of the Devil Canyon reservoir was begun.

In the Devil Canyon to Talkeetna reach, ice would be expected to form, although its formation would likely be delayed by several weeks, and the exact location of the end-of-winter ice front has not been predicted with certainty. Above this end-of-winter ice front, vegetation development would be similar to that in the Watana to Devil Canyon reach of the river. Where ice formation occurred, however, reduced summer flows would expose more area capable of being colonized. However, higher ice staging associated with increased winter flows could extend into these areas, affecting not only the newly developing communities but, in some locations, even some existing vegetated areas. It is difficult to predict what effects this ice staging would have because under unregulated conditions ice staging levels are often below rather than above the water surface elevations that occur during summer flows. Thus, until clearing and inundation of the Devil Canyon reservoir was begun, the width of area occupied by early- to mid-successional stages might either increase over preproject conditions or remain similar to preproject conditions.

With both Watana and Devil Canyon dams in operation, ice formation is considered unlikely between Devil Canyon and Talkeetna. Since summer flows would be reduced by comparison to preproject flows and since ice-staging effects associated with operation of Watana alone would be eliminated, an increase in vegetated area over preproject conditions would probably occur. The width of area occupied by early- to mid-successional stages would probably increase over preproject conditions initially. With time, however, succession would proceed towards mature balsam poplar and white spruce forests, and the width of area occupied by early- to mid-successional stages might eventually be decreased below preproject conditions since fewer events capable of causing vegetative recession to earlier seral stages would occur.

In the Susitna reach from the confluence of the Susitna, Chulitna, and Talkeetna rivers to the Yentna River, the channel is braided, and the Susitna contributes only 40% of the total flow. The importance of ice processes in vegetative succession is reduced except in localized areas, and the magnitude of increased Susitna winter flows would be diluted. Regulated and reduced summer flows would have some effect on the frequency and severity of flooding in this reach, but the effects would be attenuated by flows from the other rivers. Thus, early- and mid-successional stands might develop sufficiently in some areas to provide some stabilization against later floods. Although reduced summer flows and perhaps increased winter flows would probably have some effect on vegetation in this reach, it is impossible to predict whether the net effects would be increases or decreases in vegetated area or in succession rates.

In the reach from the Yentna River to Cook Inlet, bankfull flows and flooding would probably be the major factors affecting vegetative succession rates. Because of the dilution effect of the other rivers (the Susitna contributes only 20% to bankfull flows), as well as the tidal influence up to RM 20, any changes in vegetation would be difficult to attribute solely to operation of the proposed project.

The large volume of water in the reservoirs, especially Watana, would warm more slowly in spring and cool more slowly in fall than surrounding land masses. Resultant seasonal changes in air and soil temperatures near the reservoir (particularly on the southern side of Watana due to prevailing northeasterly winds) would probably affect plant phenology and perhaps cause alteration of plant communities. Moderation of diurnal temperature fluctuations by the reservoir might also affect local rainfall patterns and humidity, possibly having some effect on nearby vegetation (Baxter and Glaude, 1980).

The presence of the reservoirs also could cause increased occurrences of fog and rime ice accumulations on vegetation in surrounding areas, especially during breakup and freezeup periods (Baxter and Glaude, 1980). When rime ice accumulations are thick, branches and twigs can break, damaging vegetation. However, if plants are not severely damaged, this could have a beneficial effect for wildlife if succulent new growth is induced. Similarly, ice fogging and rime ice accumulation would be expected along the downstream floodplain in the section of the river where formation of ice would be prevented by dam outflow temperatures.

4.1.5.2 Animal Communities

A variety of impacts to wildlife would result from construction and operation of the Susitna project. Installation of facilities such as the dams, reservoirs, airstrip, and roads would permanently withdraw habitat from future use by wildlife (Table 4-3). In addition, about 50% of the habitat along the transmission line route would generally be altered from forest/woodland to early successional shrubland stages. Alteration of flow regimes below the dams would also result in alteration of riparian habitat in the floodplain of the Susitna River. The impoundments might impede movement of wildlife, especially during spring ice breakup. To a lesser degree, access routes and the transmission line right-of-way might also interfere with wildlife movements. Noise and human activities associated with project construction and maintenance might disturb species sensitive to human presence and cause them to avoid the project area, effectively restricting the amount of available habitat. Conversely, some wildlife might be attracted to centers of human activity and become nuisances.

Indirect impacts might accrue through increased accessibility of the project area and increased human presence even after the construction phase. Increased accessibility might cause increased hunting pressures along the Susitna River relative to the peripheral areas where current highways exist. Increases in hunting pressure would further exacerbate the negative impacts of the project upon wildlife resources.

More detailed discussions of potential project-related impacts follow.

Moose: Approximately 2,200 moose now range through the area of the Devil Canyon and Watana impoundments. These moose would be most directly impacted by construction, filling, and operation of the reservoirs, and another 9,000 moose might be affected indirectly due to interactions with the directly affected individuals (Ballard et al., 1983a). Moose displaced from the inundation areas and other project areas could compete more intensely for food and cover habitat in areas outside the directly impacted zones. This increased competition among moose could lead to indirect effects such as reduced nutritional status or increased morbidity and mortality of moose not directly affected by loss of habitat. Other specific impacts related to habitat loss would include:

- Loss of potential winter carrying capacity equivalent to 540 moose, about 5% of the basin-wide capacity (preliminary estimates) (App. K, Sec. K.3).

- Loss of about 10% of the major wintering and spring calving habitat within 10 mi (16 km) of the impoundment area (Figs. 4-11 and 4-12).

Increases in hunting pressure and take would likely occur as a result of increased access to the Susitna River basin above Gold Creek. The Applicant projects that a doubling in big-game hunting would result from the proposed Susitna Hydroelectric Project (Exhibit E, Vol. 8, Chap. 7, Table E-7-13). The magnitude of this impact cannot be quantified. However, increased hunting take would result in a net increase in mortality and lead to further reduction in the moose population size unless hunting regulations became more restrictive.

Construction activities would likely result in the generation of noise and visual stimuli that could disturb individual moose in the immediate vicinity of project features. These disturbances would be short-term, occurring during the period of construction (about 10 yr). During operation of the project, human use of the area would be expected to increase fourfold compared to preproject use (Exhibit E, Vol. 8, Chap. 7, Table E-7-13). This increased human presence could lead to further, longer-term disturbance of individual moose as a result of casual noise or visual stimuli as well as direct harassment. Additionally, avoidance by moose of areas of human activity could effectively reduce habitat availability. These effects would further exacerbate impacts from habitat loss and hunting pressure.

Other likely impacts would include:

- Delays of spring plant emergence due to later snowmelt and warming adjacent to reservoirs, reducing the availability of nutritious, early plant growth as forage when post-wintering moose move to the reservoir areas to recover nutritional balance in early spring.

- Impediments to movement through and across the impoundment zone, particularly during spring ice-breakup.

- Impediments to reaching riverine islands below Devil Canyon used for calving during late winter/early spring due to presence of open but frigid waters over winter. Normally these islands are accessible across ice. However, the open waters that would result from the project would generally be avoided because of the likelihood of cold stress.

- Increased mortality due to vehicle use (about 500-600 vehicles per day) of access roads during peak construction phases.

- Losses (for 10 to 30 years) of habitat to temporary project features. Rehabilitation might provide an increase in suitable forage for a period of 1 to 25 years prior to development of mature forests.

Clearing of forested areas for transmission lines and access routes might enhance moose forage availability by a factor of 5 to 20 over approximately 6,600 acres (2,700 ha). However, studies in Interior Alaska indicate that only an average of 20% of this available forage would be used by moose (Wolff and Zasada, 1979). Indeed, even with abundant available forage, moose usage might be effectively zero. During severe winters, deep snows in a cleared right-of-way could make this forage unavailable and could also restrict moose movement.

Caribou: Caribou are not abundant in most areas of the principal project features (Pitcher, 1982, 1983). Most habitat affected by the project would be forested, whereas caribou are characteristically found in more open habitats. A small number of caribou might be affected by project activities such as habitat clearing and reservoir filling. Transmission line rights-of-way might inhibit movement of caribou, but probably not on a large scale.

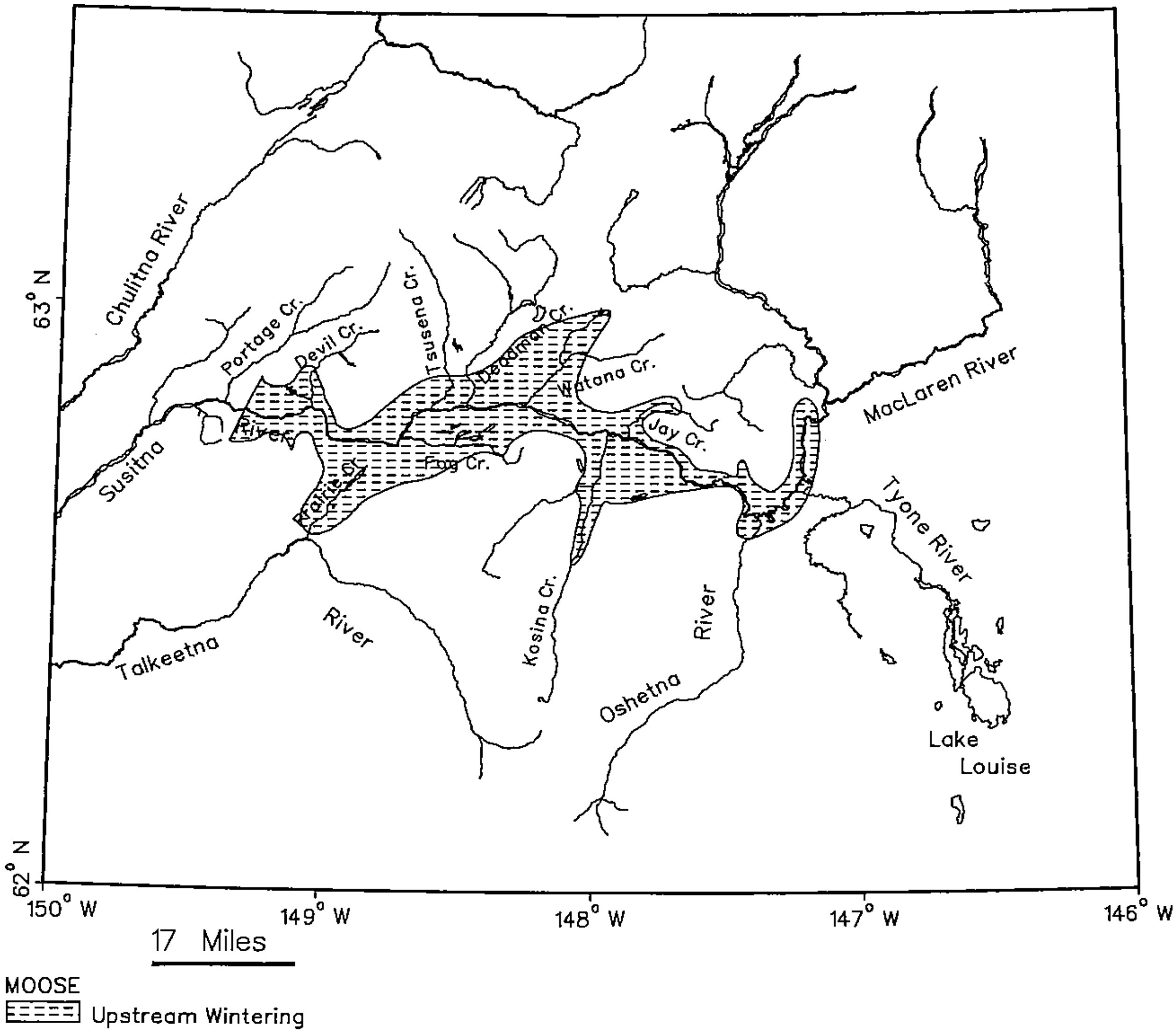

Figure 4-11. General Ranges for Moose Overwintering in Upper and Middle Susitna Basin, 1977-1982. [Source: Ballard et al., 1983a]

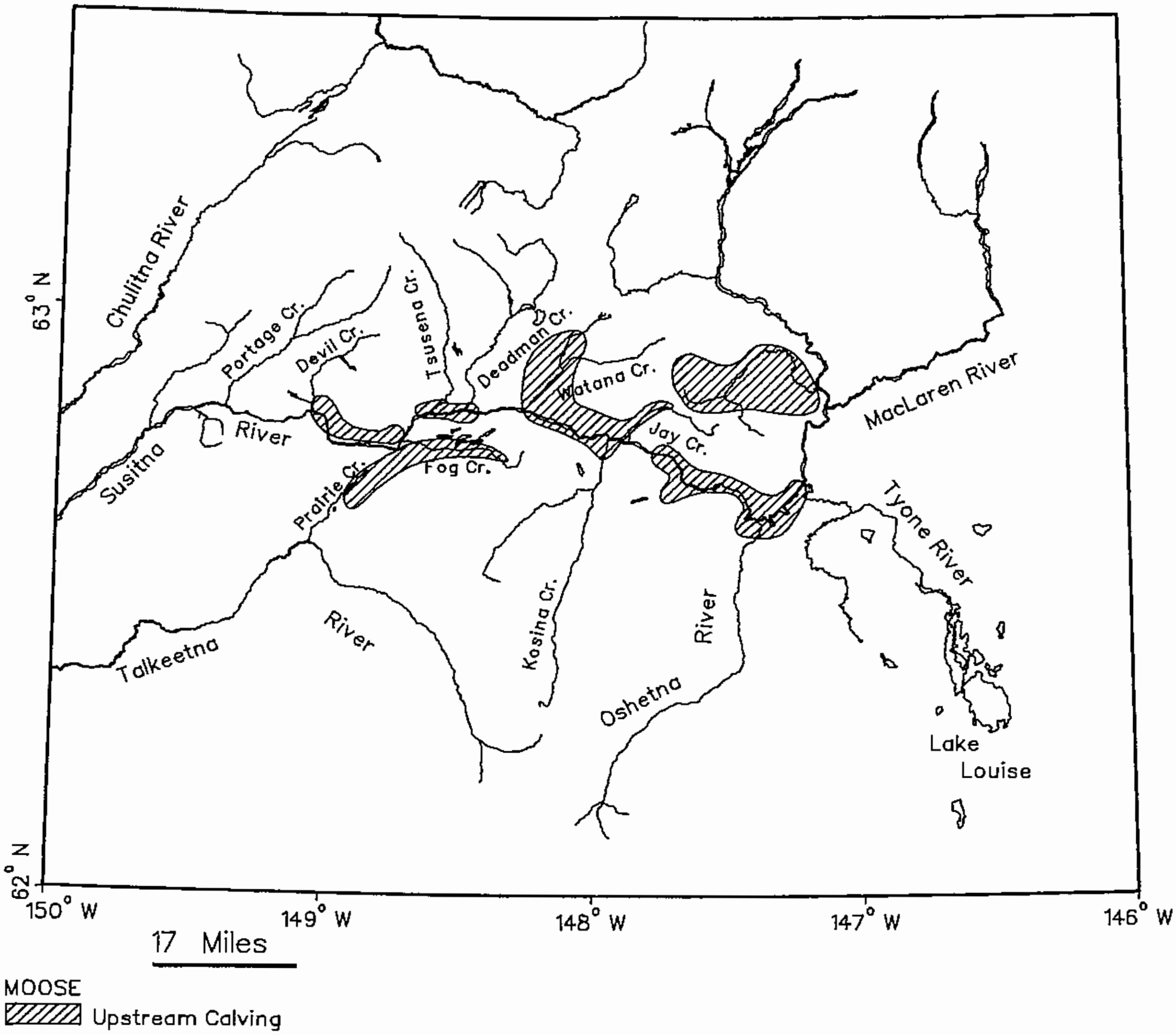

Figure 4-12. General Ranges for Moose Calving in Upper and Middle Susitna Basin, 1977-1982. [Source: Ballard et al., 1983a]

The Denali-Watana access route would bisect a migratory pathway from summer range to winter/calving range for a portion of the Nenana-Upper Susitna caribou subherd, which constitutes about 2,000 individuals and 10% of the basinwide herd (Fig. 4-13). The access road could:

- Impede movement between summering and wintering range, thus reducing the flexibility to effectively respond to varying availability of suitable habitat.

- Increase mortality (road kills) substantially during the peak construction period, when 500-600 vehicles per day might pass over the road.

The improved accessibility of the central basin would likely increase hunting demand and redistribute the areas of harvest away from current access routes. This might necessitate changes in management and regulatory policy toward caribou harvest.

Effects upon movements of the main Nelchina caribou herd in the basin would be less predictable than for the local subherd. Movements from the wintering grounds to calving grounds currently tend to skirt the projected impoundment zones. However, historical wintering ground occurs north of the Susitna River (Hemming, 1971) and future movements across the impoundments could be restricted. Thus, the impoundments could effectively restrict expansion into winter ranges north of the Susitna River by those cow caribou traditionally calving south of the river. Dispersing male caribou might also be more restricted in their ability to range into habitat north of the Susitna after wintering in the Lake Louise area, southeast of the proposed impoundment zones.

Dall's Sheep: Project features would not directly impact habitat of Dall's sheep except along Jay Creek, where the Watana impoundment would inundate the lower portion of a mineral lick (Ballard et al., 1982; Tankersley, 1983). Because the lick is heavily used by sheep even though it is outside of more typical sheep habitat, this lick is likely of major import to the Watana Hills sheep population. Although impoundment wave action might accelerate exposure of mineral soil materials, flooding would lead to extensive leaching of the lower portions of the lick, which are most heavily used by sheep at this time. Boating and float plane use of the reservoir near Jay Creek could further reduce the suitability of this lick for sheep use.

Sheep in areas around project features might also be affected by construction activities, particularly overflights by aircraft. This might be a problem principally along the proposed transmission line route through the rugged terrain south of Healy. Clearing activities near Jay Creek might affect use of the mineral lick during spring. Sheep are especially sensitive to human disturbance (Geist, 1980), but these effects would be temporary unless prolonged disturbance occurred during operation.

Brown Bear: Although brown bear range through all the habitat types of the proposed project area, they are typically found in open shrubland; thus, loss of about 39,000 acres (16,000 ha) of forested habitat probably would not represent a critical loss to brown bear. However, after emerging from overwintering dens, brown bear do use lowland habitat that would be inundated by filling of the reservoirs. This habitat apparently provides an early source of spring plant growth, overwintered berries, and moose prey concentrations due to earlier warming and snowmelt than occurs in the uplands (Miller and McAllister, 1982; Miller, 1983). Additionally, delay of warming and snowmelt caused by the influence of the reservoirs might further reduce the suitability of lowland habitat adjacent to the impoundments. Loss of such habitat would negatively impact the brown bear population within the upper and middle Susitna Basin because the early spring new growth provides a high-quality food source for recovering nutritional balance during the post-denning period.

Because many brown bear cross the projected impoundment zones as they move in response to food availability, the impoundments would impede, to some degree, bear movements. This would be most likely to occur during early spring ice breakup when bear would be moving into the reservoir areas after emerging from their dens. Movement restrictions could prevent some bear from moving into areas of high-quality food and thus lead to nutritional stress.

Brown bear might also be impacted by disturbance during construction and operation as a result of increased human presence in and access to the project areas. This could result in bears avoiding areas of high-quality food. Disturbance during winter denning could result in den abandonment; this would be most likely to occur along the Denali-Watana access route. Increased accessibility of the area would also alter the patterns of human harvest and increase hunting demand.

Although the slough fisheries resource from Talkeetna to Devil Canyon might be enhanced during project operation, brown bear fishing success below Devil Canyon could be severely restricted for the three years after initiation of filling the reservoirs. Increased accessibility to the Stephan Lake/Prairie Creek area might also reduce the suitability of this area as a bear fishery (Miller, 1983). Additionally, reduction of moose abundance would reduce the availability of prey in the basin and could result in a reduction in brown bear numbers.

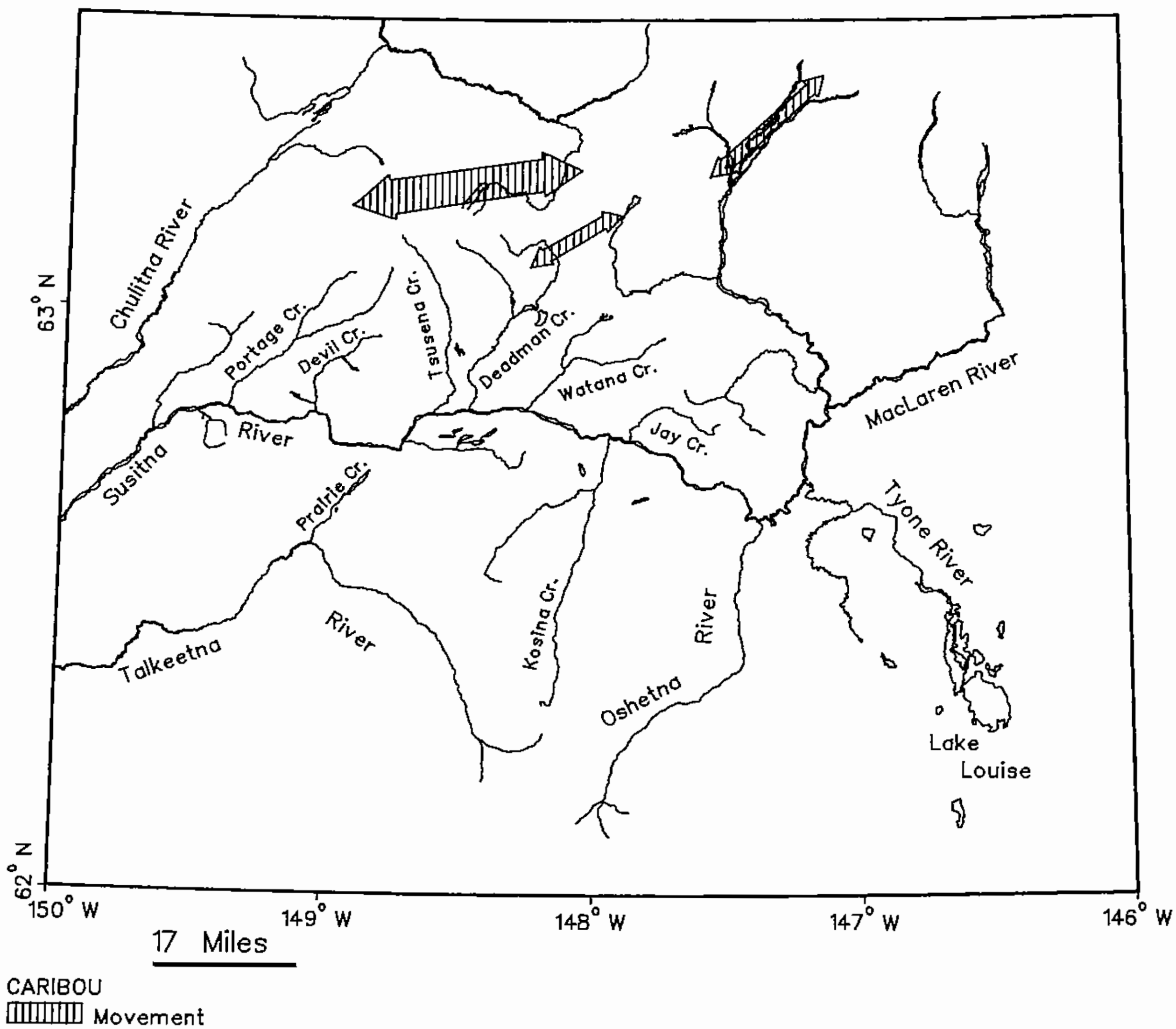

Figure 4-13. General Pathways for Seasonal Movement of the Nenana-Upper Susitna Subherd of Caribou. [Source: Pitcher, 1983]

<u>Black Bear</u>: Black bear would likely be one of the most severely impacted species in the upper and middle Susitna Basin. The availability of suitable habitat above Gold Creek is restricted to the lowland forest adjacent to the Susitna River, particularly spruce forest habitat (Fig. 4-14). Inundation of this lowland area would remove about 10% of the suitable black bear habitat within 10 mi (16 km) of the Susitna River (Table 4-3). Carrying capacity for black bear would be reduced accordingly. Loss of this carrying capacity could increase competition for the already limited habitat that would remain available to black bear in the upper and middle basin. Increased competition could result in indirect impacts such as reduced nutritional status and increased aggressive encounters. Although unquantifiable, these indirect effects would further exacerbate impacts from habitat loss.

About 55% of the known black bear dens would be inundated by reservoir filling (Miller, 1983). Availability of suitable denning locations appears to be limited, as evidenced by the high rate of reuse of dens from previous years. Loss of such a large proportion of den location would have a marked impact upon overwintering survival of the bear in the upper and middle basin. Dens provide the necessary thermal environment for reducing energy useage during overwintering when little food is consumed. Other impacts that could exacerbate these losses include:

- Delays in availability of early spring forage adjacent to the reservoirs and consequent reduction in capability to recover nutritional balance after winter.

- Increased hunting pressure and take due to the increased accessibility to the habitat along the Susitna River, resulting in increased avoidance by bear of the area of activity and mortality.

- Increased human/bear interactions, resulting in occurrence of nuisance bear and avoidance by bear of areas with disturbing human activity.

- Reduction in availability of slough fisheries for at least the duration of reservoir filling (Sec. 4.1.4.2).

- Restriction of movements required for black bear to take advantage of geographical variance in food availability.

- Increased aggressive interactions with brown bear if black bear move to more upland habitat to compensate for losses of lowland habitat.

Clearing of forest habitat along the access routes and transmission line rights-of-way would enhance forage availability. However, as with moose, it is likely that black bear would not or could not make full use of this increase.

<u>Gray Wolf</u>: Wolf would be principally impacted in the upper and middle Susitna 8asin due to loss of more than 10% of the range of two wolf packs, affecting up to about 30 individuals. About 45% of the wolf observations for these two packs were within this 10% of the range (Ballard et al., 1983b). Thus, the impoundments would probably result in disruption of the home range of at least one pack and dispersal of pack members to areas where they would come into competition with members of other packs. The principal wolf pack that would be affected appears to be the least hunted pack in the basin (Ballard et al., 1983b). This pack probably is a source of new individuals recruited into surrounding packs. Thus, impacts would be manifested in the basin-wide wolf population.

Other impacts include:

- Reduction in availability of prey, particularly moose. Although availability of prey is not currently limiting wolf populations in the basin, reduced prey availability could in turn reduce overall potential carrying capacity for wolf in the basin.

- Increased disturbance and harvesting pressure due to increased accessibility and human activity in the basin. This would result in increased wolf mortality.

<u>Furbearers</u>: Impacts to furbearers might be expected to result in (Gipson et al., 1982):

- Reduction in the rate of overwinter survival among 5 to 10 muskrats due to loss of overwintering habitat in borrow areas D and E.

- Disturbance of beaver and red fox and habitat alteration along the Denali-Watana access road during construction due to vegetation removal and alteration of drainage patterns.

- Loss of carrying capacity for the equivalent of about one wolverine due to inundation.

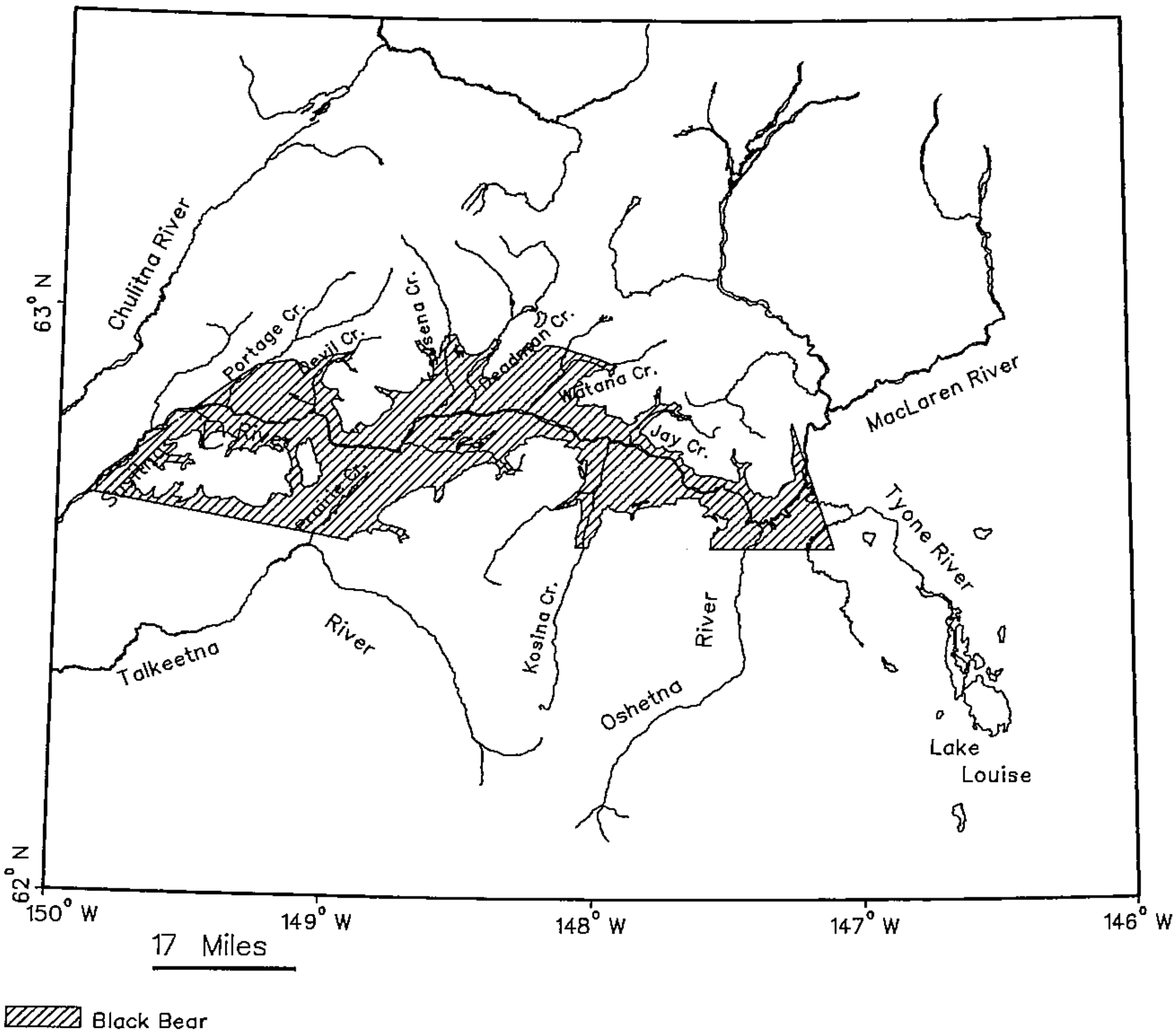

Figure 4-14. General Extent of Suitable Black Bear Habitat in Upper and Middle Susitna Basin. [Source: Miller and McAllister, 1982; Miller, 1983]

- Loss of habitat for about 150 pine marten due to inundation.

- Loss of forest habitat for other furbearers--including red fox, mink, river otter, lynx, and weasels--due to inundation.

- Increased trapping pressure and harvest due to increased accessibility of the area.

- Enhancement of beaver and muskrat habitat downstream from Devil Canyon as a result of stabilization of river flow.

Raptors and Ravens: The principal impacts to raptors and ravens would be loss of nesting locations due to impoundment construction and filling and disturbance during construction and maintenance of facilities. Specific impacts would include:

- Loss of 12 to 14 golden eagle, 4 bald eagle, 1 gyrfalcon, 2 goshawk, and 13 raven nesting locations (Exhibit E, Vol. 6B, Chap. 3, Table E-3-161).

- Disturbance of 4 golden eagle, 1 goshawk, and 6 raven nesting locations (Exhibit E, Vol. 6B, Chap. 3, Table E-3-16).

- Loss of approximately 50% of high-quality, cliff nesting habitat above Portage Creek (Kessel et al., 1982).

- Loss of some riverine foraging habitat for bald eagle and of open foraging habitat for other raptors.

- Creation of some new open foraging habitat for raptors along access and power transmission rights-of-way.

Potential for electrocution of large raptors along transmission lines would be precluded by state-of-the-art design of facilities (Benson, 1982).

Waterbirds: The major project features would be in areas of low use by waterbirds and thus there would be few impacts to such birds (Kessel et al., 1982). The transmission line below Willow would extend through areas of high densities of waterfowl, and the potential for collisions with conductors and structures would be highest along this portion of the route. However, collisions of this type make up only a small fraction of reported non-hunting mortality of waterfowl (Stout and Cornwell, 1976; Banks, 1979). Thus, collisions would be unlikely to have major impacts to regional populations. Nesting of some trumpeter swans along the transmission line route might be disrupted if construction and maintenance activities occurred during spring. Disruptions could be avoided by appropriate scheduling of activities to avoid disturbing trumpeter swans in the spring or summer.

Small Mammals and Birds: Although habitat for several thousand small mammals and birds would be affected, only a small fraction of the total populations in the region would be impacted.

4.1.6 Threatened and Endangered Species

Currently no plant taxa known to occur in Alaska are officially listed as threatened or endangered by Federal or state authorities. Therefore, no impacts to threatened or endangered plant species would occur as a result of construction and operation of the proposed Susitna project.

Among wildlife species, only the endangered American peregrine falcon might occur in the project area. Northeast of Nenana, the proposed transmission line route would pass 1 to 5 mi (2 to 8 km) of habitat that is highly suited for peregrine nesting. This habitat extends along the northern side of the Tanana River from Nenana to near Fairbanks (Fig. 4-15). The route would not pass through any peregrine nesting location. North of Nenana, the transmission line route would pass within 1 mi (1.6 km) of two historical peregrine falcon nesting locations and within 2 to 5 mi (3-8 km) of several others. Although these locations have not been used recently, peregrine in the past have occupied these sites during the summer season. Potentially, activities along the proposed right-of-way could discourage use of this area by a recovering population of peregrine falcon. The Applicant would be required to take measures to avoid disruptive activities during the nesting season and to comply with conditions established by the U.S. Fish and Wildlife Service in order to maintain suitable peregrine habitat. The Staff concludes that the proposed transmission line would not pose a threat to recovery of the American peregrine falcon.

4.1.7 Recreation Resources

Construction and operation of the proposed project would entail a broad spectrum of direct and indirect impacts on recreation resources and use patterns. Project-related effects on whitewater resources of the Susitna Basin would constitute one of more substantial of the direct impacts, while recreation demand induced by development of the proposed project would be an

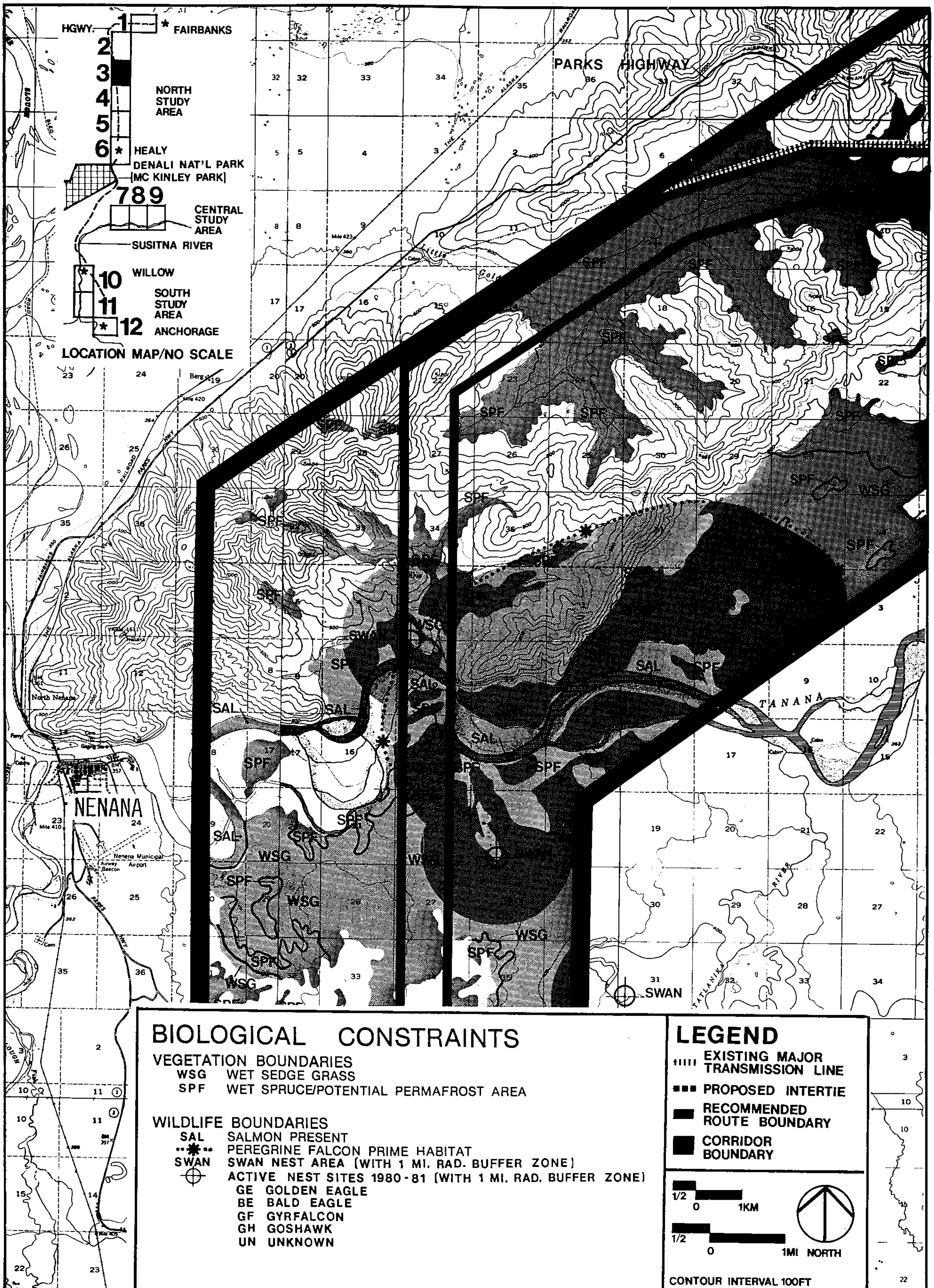

Figure 4-15. General Location of Prime Peregrine Habitat within the Proposed Transmission Line Corridor. [Source: Acres American, 1982: Map M3]

indirect effect. Other effects would include those that are perceptual in nature. For example, some individuals might forego recreation opportunities in the project area because of perceived disruption of relatively undisturbed wilderness settings. In recognition of the foregoing and other potential impacts, the Applicant proposes to implement a recreation development plan. The plan is described in Section 2.1.11, and the implications of implementing the plan are discussed in the latter part of this section.

Developed recreation resources in the vicinity of the dam sites and impoundment areas are essentially limited to three private lodge complexes and scattered cabins. Virtually all such structures are used as base stations for dispersed recreation, primarily hunting and fishing, and to a lesser extent for river travel and trail-related activities. Thus, project development would primarily impact dispersed recreation activities in a relatively undisturbed wilderness setting.

Construction activities at the Watana and Devil Canyon dam sites would result in destruction of habitat and displacement of wildlife to adjoining undisturbed areas. Similar, but more extensive, effects would result from clearing of vegetation for the 38,000-acre (15,380-ha) Watana reservoir and the 7,800-acre (3,155-ha) Devil Canyon reservoir (Exhibit A, Vol. 1, Secs. 2 and 8). Construction activities would also adversely affect fish resources. Construction of cofferdams and river diversion tunnels and dredging of the river would damage and kill fish, reduce fish reproduction, and destroy fish habitat. Additional information concerning effects on fish and wildlife resources is presented in Sections 4.1.4 and 4.1.5, respectively. In terms of effects on recreation resources, the foregoing construction impacts would entail preemption of sport hunting area and fishing sites, decreases in hunting and fishing opportunities, and increases in pressure on wildlife and fish populations in adjacent areas.

Much of the demand for increased recreation opportunities would be attributable to project personnel living in onsite housing at the Watana and Devil Canyon sites. Accommodations at both sites would include a wide range of developed recreation facilities that might somewhat alleviate pressures on local recreation resources. Further, the Applicant proposes that access routes to the dam sites not be open to the public during project construction. Thus, increased levels of sport hunting, fishing, and other recreation activities would primarily involve off-duty personnel of the work force. Nevertheless, marked competition could occur between local residents and project personnel for use of local recreation resources, particularly during the years 1988 to 1992 and 1997 to 2000, the peak construction periods for Watana and Devil Canyon, respectively (Exhibit E, Vol. 7, Chap. 5, Table E.5.25). Such competition for recreation resources would not likely be limited to the immediate project area. Some construction personnel would undoubtedly elect to commute from nearby communities. Thus, commuting personnel would compete with community residents for local recreation facilities, opportunities, and services. Tourist activities could be affected in some instances where project personnel lease or rent all available housing (see Sec. 4.1.8).

The nearest major public recreation site to the project area is Denali State Park, at closest distance about 10 mi (16 km) from the Devil Canyon project boundary. A rail spur would be built from Gold Creek to a railhead near the Devil Canyon site to support construction activities at the Devil Canyon site. Since the rail spur would not be a particularly convenient commuter route, it is likely that most construction personnel would opt for onsite housing at Devil Canyon. It is also likely that project personnel would not appreciably disrupt recreation use patterns at Denali State Park or other major recreation resource areas. However, competition for use of small recreation sites such as the Brushkana Campground would be severe.

The closure of the Watana dam in 1991 and the Devil Canyon dam in 2001 (Exhibit C, Vol. 1, Figs. C.1 and C.2) and the subsequent filling of the two impoundment areas would result in impacts on recreation resources and activities both up- and downstream of the dams. The remaining wildlife in the impoundment areas would be displaced, resulting in increased pressure on adjacent habitats and hunting opportunities. Ten recreation cabins would be inundated. The filling of the Watana impoundment would inundate the Vee Canyon rapids, which is a significant white-water resource. In addition, Vee Canyon is a recognized scenic resource (Sec. 4.1.9). Prime sport fishing areas where clearwater streams such as Deadman, Watana, and other creeks flow into the Susitna River would also be inundated (Exhibit E, Vol. 6A, Chap. 3, Sec. 2.3).

Downstream effects of Watana reservoir filling (1991-1993) would include the interruption of free flow of the Devil Canyon rapids, and the noteworthiness of this white-water resource would be diminished. Complete filling of the Devil Canyon impoundment in 2002 would inundate the rapids, and this notable (Class VI water) white-water resource would be eliminated. There are few comparable white-water runs in the world. Important fishing area and spawning habitat for Arctic grayling and other species at the confluences of Tsusena and Fog creeks with the Susitna River would also be inundated (Exhibit E, Vol. 6A, Chap. 3, Sec. 2.2). Controlled releases of water, first from the Watana dam and later the Devil Canyon dam, would affect recreation resources and activities downstream from the Devil Canyon site. For example, boating and other river recreation activities that are possible only during high river flows would be curtailed or foregone, particularly during periods of low precipitation and runoff. The quality, schedule, and temperature of water releases from the dams would create a potential for changes in sport fish populations and angling success rates in downstream stretches of the river and interconnected waterways (see Sec. 4.1.4).

The proposed operating scheme for the Watana and Devil Canyon facilities would result in substantial seasonal fluctuations in water levels within the reservoirs; this condition would limit the potential for development of recreation facilities at the land-water interface. Fluctuations in the Watana reservoir would range up to 11D ft (34 m) (Exhibit E, Vol. 5A, Chap. 2, Sec. 4.2.3), and exposed mud flats at low water levels would induce unsightly bank sloughing that could limit or restrict access along the shoreline. Drawdowns in the Devil Canyon reservoir would be less severe; water levels during August and September would be 5D ft (15 m) lower than for the remainder of the year.

The proposed access road for the Watana site would entail upgrading a 21-mi (34-km) segment of the Denali Highway extending east from Cantwell and the construction of a 42-mi (68-km) road south to the Watana site. Construction activities during upgrading of the Denali Highway would adversely affect highway travelers, including touring sightseers and recreationists. In addition to being subjected to disrupted traffic patterns and other short-term inconveniences, travelers would view the disrupted terrain, which would detract from the aesthetic qualities of the highway route. Completion of the upgrading of the Denali Highway would likely induce increased traffic that could result in overutilization of Brushkana Campground and other recreation resource areas along the highway.

Recreation use in the vicinity of the proposed 42-mi (68-km) access road between the Denali Highway and the Watana dam site currently consists of dispersed recreation activities, primarily hunting and fishing. Road construction and subsequent traffic would result in displacement and disturbance of game species (Sec. 4.1.5), which in turn could affect sport hunting. Assuming that the Denali Highway-Watana access road would be opened to the public following Watana construction (1994), recreation use patterns in the project area would be expected to change substantially. The access road would facilitate increased participation in a wide range of recreation opportunities. Concurrent with the increased recreation benefits, pressure on game and fish resources would increase. Participation in trail-related activities would likewise increase, thus risking overutilization of the more accessible areas, as well as degradation of sensitive remote areas.

The proposed Watana-to-Devil Canyon access road and the Watana-to-Devil Canyon transmission lines would be essentially parallel over most of the 37-mi (60-km) access route between the Watana and Devil Canyon sites. The rights-of-way of the access road and transmission lines would traverse remote terrain with the exception that the lines would pass within 2 mi (3.2 km) of the High Lake Lodge and the access road would pass a slightly closer distance (Exhibit E, Vol. 8, Chap. 7, Sec. 3.1.4). The lodge is currently accessible by aircraft; thus, the proposed access road could benefit the lodge owner by providing developed overland access to the lodge. On the other hand, the presence of the road, construction noise, and road traffic would detract from the relatively undisturbed landscapes surrounding the lodge. The transmission lines would also be visible to lodge residents, as well as recreationists in the Susitna River and Tsusina Creek areas.

Railway access to the Devil Canyon site would consist of a 14-mi (23-km) railroad spur off the Alaska Railroad at Gold Creek, extending easterly along the southern bank of the Susitna River. The Devil Canyon-to-Gold Creek transmission lines would generally parallel the railroad spur. Clearing for, and construction of, the two facilities would result in reduced success rates of sport hunting and fishing and would cause adverse visual effects for participants in trail-related activities. Operation of the railroad would continue to impact game animals throughout the project construction period, which in turn would adversely affect sport hunting opportunities.

The Gold Creek-to-Fairbanks transmission line would not encroach on any dedicated recreation areas, but owners of several isolated recreation cabins would be affected by short-term construction impacts. Construction of the line could also have minor effects on sport hunting and fishing opportunities. However, the principal and enduring impacts would be of a visual nature. The lines would variously parallel and/or intersect major tourist routes (George Parks and Denali highways, and the Alaska Railroad), major river recreation corridors (Nenana, Tanana, and Susitna rivers), and local roads and trails. Visual impacts would be incremental for the Gold Creek-to-Healy segment, since the route would parallel an existing line.

Visual impacts would also be significant for the proposed Gold Creek-to-Anchorage transmission lines. Major tourist routes paralleled and/or intersected would include the George Parks, Glenn, and Davis highways, and the Alaska Railroad. Major river recreation corridors would include the Talkeetna, Kashwitna, and Little Susitna rivers, and Willow Creek. The lines would parallel and/or intersect numerous recreation trails (including the Iditarod Trail), particularly in the vicinity and south of the Nancy Lakes area. Numerous lakeside recreation cabins would be within viewing distance of the lines. Since a number of these cabins are accessed via float plane, the lines would pose a degree of hazard for local cabin owners. Visual impacts for the

Gold Creek-to-Willow transmission line segment and in the Anchorage area would be incremental since the proposed lines would parallel existing facilities. Lastly, the proposed lines would traverse the Susitna Flats State Game Refuge for 5 mi (8 km), as well as a proposed expansion of the Willow Creek State Recreation Area.

The Applicant has proposed to implement a recreation development plan to compensate for public recreation opportunities foregone as a result of developing the proposed Susitna project and to accommodate recreation demand induced by the project. The recreation plan consists of phased development and entails monitoring and periodic analysis of recreation demand prior to successive phases of development (Sec. 2.1.11). A key element of the recreation plan is the monitoring program, which would entail collection of recreation use and demand data. Analysis of the data would provide guidance to establish the scope and pattern of future recreation developments.

It is pertinent to note that implementation of the recreation plan would in itself generate impacts on existing recreation resources and opportunities. For example, the development of a given hiking trail could result in diminished remoteness of an accessed area, a condition that some individuals might consider as a diminution in the primary recreational attractiveness of the affected area. Further, the developed access would tend to induce recreation demand for successive extensions of access to other remote areas. In this respect, a public survey reported by the University of Alaska is relevant (Exhibit E, Vol. 8, Chap. 7, Sec. 5.1.2). Selected residents of Anchorage, Fairbanks, and the general Railbelt area were requested to indicate preference for management of recreation resources in the project area, assuming development of the proposed project. The predominant response indicated preference for managed wilderness with limited access. This preference was factored into the design of the Applicant's proposed recreation plan (Exhibit E, Vol. 8, Chap. 7, Sec. 5.1.2). The foregoing illustrates the utility of the monitoring aspect of the proposed plan. Given development of the proposed Susitna project, public attitudes concerning local recreation opportunities would likely change appreciably in subsequent times; such changes in attitude would be detected by analysis of monitoring data.

4.1.8 Socioeconomic Impacts

The principal socioeconomic impacts related to the proposed Susitna project would be of the kinds commonly called "boomtown" phenomena--caused by sudden, rapid growth in population in a rural area, followed by a decline or "bust" period. For the Watana Dam and Devil Canyon dam developments combined, the ratio of peak construction work force to operation work force would be 21:1, indicating a large difference between peak and long-term, postproject demands for housing and other community resources. These potential impacts are discussed below.

Population: As described in Section 3.1.8, baseline population projections for the project area vary greatly, reflecting the conditions prevalent when the projections were made. It is a complex task to allocate the project workers and support workers, and the household members accompanying both groups, to population centers in the project area. Research has indicated that projected impacts of large-scale construction projects often have been underestimated because of unexpected delays in construction schedules caused by, for example, work stoppages or delays in receiving equipment or materials (Denver Research Institute et al., 1982). However, total population growth has generally been overestimated. The projections made here for the Susitna project should be considered in light of these findings.

A model was used by the Applicant to predict the size of project-induced population for both Watana and Devil Canyon phases and to allocate that inmigrating population to the region's population centers. In general, the Applicant's predictions of project-related population have been used by the FERC Staff as part of their analysis. However, in the FERC analysis, these project-related inmigration figures have been added to the 1983 baseline population projections made by the Institute of Social and Economic Research (ISER) at the University of Alaska. As discussed in Section 3.1.8, the ISER projections are considerably lower than the Applicant's baseline projections. The net result of adding the Applicant's project-related inmigration values to the ISER baseline projection is that the values for total population increases (project-related plus baseline) used in this document are lower than those cited by the Applicant in Exhibit E (Vol. 7). It should be kept in mind that project-related population growth and associated impacts could vary widely, depending on the transportation plans developed to permit workers to commute to the site and depending on shift and leave plans (Metz, 1983). Such plans have not yet been developed.

The Applicant has made several assumptions that lead to conservative projections of project-induced growth. It was assumed that all single workers would live in the construction camps or temporary villages at the dam sites, thus minimizing population impacts in surrounding communities. It also was assumed in the Applicant's model that onsite housing would be used to capacity. The model allocates inmigrating workers who are expected to reside (temporarily or permanently) offsite according to time of travel from distance of the community to the project site. Although transportation time is a crucial factor, it is not the only factor considered in a decision to establish a residence. Further, it is assumed by the Applicant that only 10% of project workers who would be hired from the Railbelt, Fairbanks, or Cook Inlet regions (about 350 workers) would move closer to the project area, e.g., to Talkeetna, Trapper Creek, or Cantwell. Since the Applicant projects that only 7% of the work force would come from the Matanuska-Susitna (Mat-Su) Borough, in which the Susitna dam sites are located, this is probably a low estimate of inmigration. Additionally, a characteristic of population influxes related to large-scale Alaskan construction projects is that a large number of unemployed workers come to the project area looking for work. This potential factor increases the probability of underestimating project-related inmigration.

The Applicant did not include Healy, Nenana, or Paxson when projecting the distribution of the inmigrating population. Therefore, the projected distribution was adjusted by the FERC Staff to include these additional communities, which are as accessible from the project site as are many of the communities in the Mat-Su Borough. The Applicant's original projections and the Staff's revised version are shown in Table 4-4. Projections used for Cantwell are those of the Applicant's high case, which was made based on the assumption that the Native Corporation AHTNA, Inc., would allow residential development of their land in the Cantwell area.

Mat-Su Borough planners have made population projections for the borough both with and without Susitna project effects. Both the Applicant's and borough's projections of project-induced population impacts are shown in Table 4-5. Borough planners assumed a more stabilized, but still growing, baseline population--particularly in the area north of Anchorage--and assumed greater project-induced growth impacts in communities near the site than did the Applicant. The borough projection has been used by the Staff to provide a high bound to the range of projected impacts.

In their projections, borough planners distributed population to Borough Planning Districts, which may include one or more communities and a large amount of relatively unpopulated land. The Applicant allocated project-related populations to specific communities. Thus, the geographical areas used for distribution are not identical. In Table 4-5, the "Other" category for Mat-Su Borough covers the interior of the borough--in which the Susitna project, but no population centers, are located. This category includes the population projected to live in project housing at the dam site. For the Applicant's projections, the "Other" category includes any part of the borough not specifically listed separately, and excludes the population housed at the dam sites. Comparison of the two population projections (and the other impacts based on them) thus should be based on relative estimates and distribution rather than absolute numbers. Precise or even narrowly-bounded estimates cannot be made with confidence.

The two sets of projections for overall with-project growth are shown in Table 4-6. They provide a wide range of growth projections for Mat-Su Borough. The lower set [Applicant (revised)] is that made by combining ISER baseline projections with the Applicant's project-induced (direct and support workers and their accompanying household members) population projections redistributed slightly to include Healy, Nenana, and Paxson. This set also includes projections for Anchorage, Fairbanks, and Cantwell. The projections made by the Mat-Su Borough planners are the higher set. These show higher total borough population growth due to the project, but it is concentrated in communities close to the project. Mat-Su Borough projections are used as the basis for any borough preparations in progress or anticipated.

Both sets of projections indicate substantial population growth by 1990 in Talkeetna (45%), Trapper Creek (20%), and Cantwell (900%). The population of the areas included in the "Other" category, primarily the central, sparsely populated area of Mat-Su Borough, would increase by between 25% (Applicant) and 2000% (borough) (Table 4-7).

The severity of "boom-bust" impacts that would occur in the project area after completion of construction would depend on the stability of the population, i.e., the percentage of the peak project-induced population that remains in the area. Many assumptions must be made about how much of the population inmigrating during the "boom" period would remain after construction and to what extent existing community services and facilities could be expanded or stretched to handle the peak, yet not be left with unused capacity during the bust period that followed. Mat-Su Borough planners project far more volatility in the population than does the Applicant. Thus, borough planners have expectations that the borough would experience these "boom-bust" planning problems.

The Devil Canyon construction period would create a second, more moderate boom-and-bust cycle. Smaller communities like Talkeetna, Trapper Creek, and Cantwell would experience the greatest increases again. Additionally, an influx of job-seekers beyond the number that could be hired might recur. Impacts on the area would be similar to, but not as severe as, those that would have occurred earlier during construction of the Watana Dam. The decreased severity would be because adjustments to rapid growth would have been made previously. Few, if any, additional population impacts would occur from operation of project facilities. This is because the small work forces would reside principally at the permanent village at the Watana dam site.

Table 4-4. Cumulative Distribution (Applicant's and Staff's revised) of Projected Project Population to Impact-Area Communities for Alternate Years, 1990 (peak year), and 2002 (end of construction)†[1]

Community/ Planning District	1985	1987	1989	1990	1991	1993	1995	1997	1999	2001	2002
Talkeetna											
Applicant	25	174	267	335	323	250	222	240	257	230	209
Revised	25	174	267	335	323	250	222	240	257	230	209
Trapper Creek											
Applicant	32	241	378	475	451	288	227	278	314	256	212
Revised	32	241	378	475	451	288	227	278	314	256	212
Houston											
Applicant	4	23	35	44	42	37	35	36	37	35	33
Revised	3	15	23	29	28	25	23	24	23	23	22
Wasilla											
Applicant	5	31	47	59	57	48	44	46	48	44	42
Revised	3	21	31	39	38	32	29	31	32	29	28
Palmer											
Applicant	5	26	39	49	48	39	35	37	39	36	33
Revised	3	17	26	33	32	26	23	25	26	24	22
Other											
Applicant	40	226	341	427	415	351	327	338	352	328	308
Revised	40	226	341	427	415	351	327	338	352	328	308
Mat-Su Borough Total											
Applicant	110	721	1,107	1,389	1,337	1,013	891	975	1,047	930	837
Revised†[4]	105	694	966	1,338	1,288	972	852	936	1,006	891	8D1
Cantwell											
Applicant	430	638	843	999	984	920	785	785	796	767	744
Revised	430	638	843	999	984	920	785	785	796	767	744
Healy											
Applicant	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Revised	2	11	16	20	20	16	16	16	16	16	14
Nenana											
Applicant	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Revised	2	11	16	20	20	16	16	16	16	16	14
Paxson											
Applicant	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Revised	1	5	9	11	9	9	7	7	9	7	8
Anchorage Census Division											
Applicant	435	325	537	663	556	-219	-523	-219	-36	-333	-532
Revised	435	325	537	663	556	-219	-523	-219	-36	-333	-532
Fairbanks Census Division											
Applicant	82	-89	-136	-173	-171	-280	-323	-295	-271	-309	-341
Revised	82	-89	-136	-173	-171	-280	-323	-295	-271	-309	-341

†[1] "Applicant" values are from Exhibit E, Vol. 7, Chap. 5, Table E.5.35. "Revised" values have been adjusted by the FERC Staff to include Healy, Nenana, and Paxson in the distribution. To accomplish this, one-third of the population allocated to each of Houston, Wasilla, and Palmer were subtracted and then reallocated: 40% each to Healy and Nenana, 20% to Paxson.

NA = Not available.

Table 4-5. Cumulative Distribution of Annual Project-Induced Population to Mat-Su Borough Communities as Projected by Applicant (unrevised) and Mat-Su Borough Planning Department

Community/ Planning District†[1]	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Talkeetna																		
Applicant	25	33	174	237	267	335	323	294	250	233	222	229	240	253	257	251	230	209
Borough	NA	NA	NA	882†[2]	854	826	796	551	302	265	295	385	405	244	90	60	65	NA
Trapper Creek																		
Applicant	32	43	241	337	378	475	451	387	288	250	227	247	278	306	314	302	256	212
Borough	NA	NA	NA	588†[2]	570	550	530	368	202	177	196	256	270	162	60	40	42	NA
Houston																		
Applicant	4	5	23	31	35	44	42	40	37	36	35	35	36	37	37	36	35	33
Borough	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wasilla																		
Applicant	5	7	31	42	47	59	57	54	48	46	44	45	46	48	48	47	44	42
Borough	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Palmer																		
Applicant	5	6	26	35	39	49	48	44	39	37	35	36	37	39	39	39	36	33
Borough	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Other																		
Applicant†[3]	40	52	226	303	341	427	415	390	351	336	327	331	338	349	352	346	328	308
Borough	393	1,542	4,296	5,013	5,059	5,107	5,157	3,519	2,600	2,649	2,652	2,920	2,884	1,840	1,107	1,025	1,066	NA
Mat-Su Borough Total																		
Applicant†[3]	110	146	721	985	1,107	1,389	1,337	1,210	1,013	937	891	924	975	1,032	1,047	1,021	930	837
Borough†[4]	393	1,542	4,296	6,483	6,483	6,483	6,483	4,438	3,104	3,091	3,143	3,561	3,559	2,246	1,257	1,125	1,173	NA

†[1] The Applicant allocated projected population specifically to the communities listed. The borough planning department allocated projected population to planning districts that include the community and some surrounding land. The units are similar, although not identical, geographical areas.

†[2] It is not clear from the source if all these persons would move in only during 1988 or over several of the previous years.

†[3] Excludes workers, household members, and staff housed in onsite housing. If these workers were added, peak years of 1990 and 1999 would increase in the "Other" category to 3,727 and 2,552, respectively, and to 4,689 and 2,847 in the Total Borough, respectively.

†[4] It is not explicitly stated that projections for this planning district include persons housed in onsite facilities, but the large numbers during peak Watana employment years imply that these persons are included.

NA = Not available. Borough projections not made for these areas/years.

Sources: Applicant's projections are from Application Exhibit E, Vol. 7, Chap. 5, Table E.5.35; Mat-Su Borough projections are from DOWL Engineers (1983), pp. IV-21 - IV-22.

Table 4-6. Cumulative Projections of Total Population Including Susitna Project-Induced Population, as Made by Applicant (revised)†[1] and Mat-Su Borough†[2] for Alternate Years, 1990 (peak year), and 2002 (end of construction)

Community/ Planning District	1985	1987	1989	1990	1991	1993	1995	1997	1999	2001	2002
Talkeetna											
Appl. Rev.	648	833	955	1,035	1,046	975	948	967	1,092	977	913
Borough	1,209	1,463	2,577	2,687	2,806	2,582	2,833	3,151	3,060	3,149	3,278
Trapper Creek											
Appl. Rev.	247	468	615	716	700	538	477	528	567	514	472
Borough	172	208	815	815	816	526	556	659	481	478	498
Willow											
Appl. Rev.†[3]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Borough	1,073	1,298	1,528	1,650	1,782	2,021	2,249	2,433	2,631	2,736	2,845
Houston											
Appl. Rev.	583	628	664	681	701	700	699	700	709	719	724
Borough†[4]	3,874	4,687	5,518	5,959	6,436	7,300	8,125	8,788	9,506	9,886	10,281
Wasilla											
Appl. Rev.	2,085	2,225	2,334	2,381	2,456	2,457	2,457	2,462	2,491	2,529	2,551
Borough	13,709	16,942	20,363	22,217	24,237	28,041	31,824	35,085	38,667	40,960	42,600
Palmer											
Appl. Rev.	2,472	2,630	2,756	2,809	2,898	2,901	2,901	2,907	2,941	2,988	3,013
Borough	6,722	7,779	8,742	9,216	9,710	10,461	11,029	11,265	11,467	11,551	11,626
Other											
Appl. Rev.	16,555 (15,538)†[5]	18,600 (16,629)	20,465 (17,483)	21,824 (17,857)	21,883 (18,411)	20,126 (18,402)	19,454 (18,399)	20,195 (18,430)	20,838 (18,655)	20,122 (18,937)	19,475 (19,089)
Borough	542	4,476	5,271	5,336	5,404	2,880	2,964	3,221	1,471	1,404	1,460
Mat-Su Borough Total											
Appl. Rev.	22,588 (21,571)	25,384 (23,413)	27,690 (24,708)	29,447 (25,480)	29,685 (26,213)	27,698 (25,974)	26,937 (25,882)	27,759 (25,994)	28,540 (26,357)	27,850 (26,665)	27,199 (26,813)
Borough	32,927	44,103	53,558	57,254	61,205	64,617	71,511	77,494	80,782	84,175	87,205
Cantwell											
Appl. Rev.	527	739	948	1,106	1,093	1,033	902	906	921	898	878
Borough	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Healy											
Appl. Rev.	427	454	477	490	499	515	535	556	578	600	610
Borough	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nenana											
Appl. Rev.	531	572	611	633	651	685	726	769	815	864	887
Borough	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Paxson											
Appl. Rev.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Borough	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Anchorage Census Division											
Appl. Rev.	198,264	208,271	215,139	218,786	224,114	230,079	233,860	238,793	243,142	249,203	252,380
Borough	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fairbanks Census Division											
Appl. Rev.	63,643	66,659	68,836	69,887	71,510	72,841	73,720	74,559	75,734	77,281	78,165
Borough	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

†[1] Projections were made using ISER baseline projections as shown in Table 3-4 and Revised Applicant's project-related population projection from Table 4-4.

†[2] DOWL Engineers (1983), pp. IV-18 - IV-19, except for Mat-Su Borough totals. Totals are updated, higher projections made in light of more recent census data. However, these new figures were not distributed to Planning Districts. Thus, total population in any year exceeds the sum of the Planning Districts above.

†[3] Applicant did not make projections specifically for Willow, but instead included the Willow area in the "Other" category.

†[4] Borough's projection for Houston Planning District includes Big Lake.

†[5] Number outside parentheses includes residents of onsite villages and construction camps; number inside parentheses excludes those residents.

NA = Not Available.

Table 4-7. Percentage over Baseline ISER Projections of Population Growth Projected with Susitna Project†[1]

Community/ Planning District	1985	1990	1995	1999	2001/2002
Talkeetna					
Appl. Rev.	4	48	31	35	28
Borough	0	44	11	3	2
Trapper Creek					
Appl. Rev.	15	197	91	124	82
Borough	0	208	54	14	9
Houston					
Appl. Rev.	<1	4	3	4	3
Borough	0	0	0	0	0
Wasilla					
Appl. Rev.	<1	2	1	1	1
Borough	0	0	0	0	0
Palmer					
Appl. Rev.	<1	1	1	1	1
Borough	0	0	0	0	0
Other†[2]					
Appl. Rev.	7 (<1)	25 (2)	8 (2)	14 (2)	4 (2)
Borough	263	2,230	850	304	271
Mat-Su Borough Total†[2]					
Appl. Rev.	5 (<1)	22 (6)	8 (3)	13 (4)	5 (3)
Borough	1	11	4	2	1
Cantwell					
Appl. Rev.	443	934	671	637	555
Healy					
Appl. Rev.	<1	4	3	3	2
Nenana					
Appl. Rev.	<1	3	2	2	2
Paxson					
Appl. Rev.	NA	NA	NA	NA	NA
Anchorage Census Division					
Appl. Rev.	<1	<1	<1	<1	<1
Fairbanks Census Division					
Appl. Rev.	<1	<1	<1	<1	<1

†[1] The bases for selection of the years included in the table are: 1985 is the beginning of Watana construction; 1990 is the peak employment year for Watana construction; 1995 is the year Watana is operational and the lowest employment year; 1999 is the peak employment year for Devil Canyon; 2001/2002 is the last year of Devil Canyon construction or the year in which projections were made (see Exhibit E, Vol. 7, Chap. 5, Table E.5.28). No projections were made by the Applicant after 2002; none were made by the borough after 2001.

†[2] Number outside parentheses includes residents of onsite villages and construction camps; number inside parentheses excludes those residents.

NA = Not Available.

Sources: Calculated from Tables 3-4, 4-4, and 4-5.

The rail extension proposed for construction from Gold Creek to the Devil Canyon camp for transport of materials and supplies might induce population inmigration to Gold Creek. Additionally, because of its location at the head of the proposed rail spur and at the head of an access road, Gold Creek (and the surrounding area) might be selected for permanent or long-term temporary residence by inmigrating Devil Canyon dam construction workers if they were allowed to commute to the site by rail. Even a small influx of population would mean a substantial increase in this very sparsely populated area.

Negligible socioeconomic impacts would occur at any of the alternative borrow sites, as they are far from population centers and residences.

Institutional Issues and Quality of Life Impacts: Faced with increasing demands to provide planning and services for project-induced population influxes, Mat-Su Borough would have to expand its administrative operations before property tax revenue was available to pay for the expansions. Based on a ratio of about six borough staff employees in the Palmer office per 1,000 borough residents, the office staff would have to nearly double by the end of the project. Additional administrative duties would be taken on by the Mat-Su Borough School Oistrict to administer the onsite school. Because of greatly increased population, desire for greater local control, and potential need for larger tax revenues, Talkeetna, Trapper Creek, and Cantwell might find it practical to incorporate.

Many residents of the project area fear that project-induced growth would interfere with their rural way of life. Even slight increases in population would greatly affect the nature of small communities such as Talkeetna, Trapper Creek, Cantwell, and Gold Creek for those who now live there. The quality of life for these people who value their isolation and the wilderness would change--be reduced, in the eyes of most (Acres American, undated; Braund and Lonner, 1982). These fears are supported by experience in other rapid-growth areas. Greater formalization of activities and larger numbers of residents have changed the nature of small-town cultures reliant on personal trust, community social control mechanisms, and face-to-face contact. Crime, alcoholism, and other social problems increase. Shortages of housing and services raise prices (Cortese and Jones, 1977; Finsterbusch, 1980; Freudenburg, 1981; Payne and Welch, 1982). On the other hand, many long-term residents who have already seen many changes in the area and many Native Alaskans are not so opposed to the project, because of the economic and employment opportunities that they believe would result (Braund and Lonner, 1982).

Increased growth and development could interfere with subsistence activities particularly in Native Alaskan communities. Subsistence activities are protected by law for "rural Alaska residents" (Alaska Board of Game, undated; see also App. N, Sec. N.1.1.3). Project activity, population growth, and improved access to hunting, fishing, and trapping areas could increase competition for subsistence harvests and drive fish and animals to new areas. Although subsistence activities are protected by law, the availability of resources in traditionally used areas is not. Subsistence activities are usually carried on by Natives. Because of lack of training and because they are not members of construction workers unions, Natives are not expected to be hired for the project in great numbers. Thus, they will remain dependent on subsistence activities to supplement their food and other resource supplies. In addition to filling resource needs, subsistence activities are a part of a cultural heritage for Native Alaskans and for others who select to live at least partially "off the land" in remote areas of Alaska. Disruption of those activities could reduce the preservation of that culture (Justus and Simonetta, 1983).

Economy and Employment: Labor demand for Watana construction activities would start in 1985 at 1,100 workers, build to a peak of 3,498 workers, and then drop to a low of 649 workers in 1995 (Table 2-1). The project would provide many job opportunities, although these would be seasonal and short-term, as different skill needs in construction pass quickly. Because hiring would be through union halls in Anchorage and Fairbanks, project area residents who are not union members or skilled workers would not be likely to obtain project work. Thus, direct project work opportunities may help to reduce the already fairly low unemployment rates in Anchorage and Fairbanks, but may do little to reduce the much larger unemployment in Mat-Su Borough. Opportunities in support jobs generated by the increased demand for services would more likely be available to people residing in the local area, particularly women. However, current Mat-Su residents would have to compete with household members of inmigrating workers for these positions. Counterbalancing the expansion of job opportunities would be the fact that large-scale construction projects in Alaska (particularly the Trans-Alaska Pipeline) have historically attracted a larger group of job-seekers than could be hired.

The project-related construction activities and improved access to the project area could provide an opportunity for subsidiaries of AHTNA, Inc., to expand their experience and businesses. Expansion could take the form of catering, housekeeping, and maintenance for construction facilities; developing more Native-owned and operated tourist-related businesses; and creating a demand for development of Native lands held by several village corporations. Other tourist-related businesses would also prosper. However, some current residents feel increased access would detract from the tourist, recreational, and residence value of the area as a remote, relatively undeveloped wilderness.

Local commercial operations and new businesses would benefit from increased sales to the larger population and from subcontracting for the project. Increased accessibility to remote wilderness areas for tourists and for recreational and commercial hunters, trappers, and fishermen would increase visitors' expenditures. However, some guiding businesses would also be displaced by the construction and operation of Watana and Devil Canyon facilities. Shortages of housing, services, and supplies would increase prices.

After the Watana construction peak in 1990, demand for goods and services would drop as construction efforts were completed and workers left the area. The Devil Canyon construction work force peak in 1999 would be only about half the size of the Watana work force (Table 2-1). Local businesses might be left with large inventories and too many workers. Some might have to close, unable to continue at the reduced level of demand, at least until Devil Canyon construction brought in more inmigrants. Additionally, rapid growth periods, such as would occur in communities near the site, are often accompanied by inflation and difficulty in getting financing and supplies (Gilmore and Stenejhem, 1980; Scrimgeour, undated), creating difficulties for buyers and sellers alike. Residents with lower or fixed incomes would have their buying capabilities reduced (Clemente, 1973, 1975; Cortese and Jones, 1977). However, businesses and workers alike could perhaps profit from use of the period between construction peaks to adjust and stabilize operations and to plan for the bust period after the year 2000.

Unemployment would also increase in the lull period between Watana and Devil Canyon construction peaks. Devil Canyon construction would employ only slightly more than half the number of workers of the peak employment year on the Watana phase. Thus, even if the same skills and workers could be used on both, over half would not be needed after 1995. Unless plans for new large-scale construction projects in Mat-Su Borough develop in the next decade, workers remaining in the area might cause increased unemployment, placing more financial and administrative burdens on the social service systems of local and state governments.

Financing a large proportion of the Susitna project would add to the state's problems of decreasing revenues, diminishing the proportion of its funds the state could provide for local governments, private industrial development, housing mortgages, and income for its citizens. Maintenance activities for Oenali Highway and the access road would also add to state expenses.

Additional impacts to the economy and employment from operation of all project facilities would be minimal once the area recovered from the decline in population between 1990 and 1995.

Housing: On the basis of the population projections shown in Table 4-6, the Staff has estimated the number of households that would be expected in the area of population impact. These estimates, shown in Table 4-8, provide an indication of the increased demands that would arise for housing. Demand for housing in Talkeetna, Trapper Creek, unincorporated areas of Mat-Su Borough, and Cantwell would rise dramatically between 1980 and 1995 as a result of project-related inmigration: 50%, 200%, and 900%, respectively (Table 4-7). Unincorporated and sparsely settled areas in the "Other" categories would also have large housing needs.

Vacant and seasonal housing would quickly be filled because the greatly increased housing need would begin suddenly and rise rapidly over about five years. Because vacancy rates are already low in the area, a substantial number of more short-term lodging units, trailer facilities, and multi-family units, as well as permanent residences, would be needed in the communities and unincorporated areas near the site, especially if the higher borough population projections proved correct. Approximately 50% of the housing demand could be for temporary units and would be highest in summer, when workers would be competing with tourists for the limited facilities. Considerable planning, development, financing, and construction of housing would have to occur before and during the early years of Watana construction to avoid a housing shortage, even under the more conservative revised Applicant's growth projections. Overcrowding and sanitation problems, rent gouging, displacement of current residents, and hasty construction of substandard housing, as occurred during construction of the Trans-Alaska Pipeline and in other boom situations, would also be likely to occur in the Susitna project area.

Demand for housing would decrease after the Watana construction peak, increase again until the Devil Canyon construction peak in 1999, and then decline. Some housing and community services constructed during the Watana period, if retained, would serve for the Devil Canyon construction period. However, initial overbuilding would be difficult to control, especially in light of the many uncertainties about housing and location preferences of workers.

Most, if not all, the small operations work force for Watana and Devil Canyon facilities would live in the permanent village constructed onsite, causing few additional impacts at surrounding communities.

Table 4-8. Cumulative Projected Number of Households in Impact Area Communities for Alternate Years, 1990 (peak year), and 2002 (end of construction)†[1]

Community/ Planning District	1980†[2]	1985	1987	1989	1990	1991	1993	1995	1997	1999	2001	2002
Talkeetna	209											
Appl. Rev.		212	272	312	338	342	319	310	316	357	319	298
Borough		395	478	842	878	917	844	926	1,030	1,000	1,029	1,071
Trapper Creek	74											
Appl. Rev.		81	153	201	234	229	176	156	173	185	168	154
Borough		56	68	226	266	266	172	182	215	157	156	163
Houston	197											
Appl. Rev.		191	205	217	223	229	229	229	229	232	235	237
Borough		1,266	1,532	1,803	1,947	2,103	2,386	2,655	2,874	3,107	3,231	3,360
Wasilla	708											
Appl. Rev.		681	727	763	778	803	803	803	805	814	826	834
Borough		4,480	5,537	6,655	7,260	7,921	9,164	10,400	11,466	12,636	13,386	13,922
Palmer	839											
Appl. Rev.		808	859	901	918	947	948	948	950	961	976	985
Borough		2,197	2,542	2,857	3,012	3,173	3,419	3,604	3,681	3,747	3,775	3,799
Other†[3]	5,436											
Appl. Rev.		5,410 (5,078)	6,078 (5,434)	6,688 (5,713)	7,132 (5,836)	7,151 (6,017)	6,577 (6,014)	6,358 (6,013)	6,600 (6,023)	6,810 (6,096)	6,576 (6,189)	6,364 (6,238)
Borough		528	1,897	2,222	2,283	2,348	1,602	1,704	1,848	1,351	1,353	1,407
Mat-Su Borough Total†[3]	7,283											
Appl. Rev.		7,382 (7,049)	8,295 (7,651)	9,049 (8,075)	9,623 (8,327)	9,701 (8,566)	9,052 (8,488)	8.803 (8,458)	9.072 (8,495)	9,327 (8,613)	9,101 (8,714)	8,889 (8,762)
Borough		10,760	14,413	17,503	18,710	20,002	21,117	23,389	25,325	26,399	27,508	28,498
Cantwell	20											
Appl. Rev.		166	232	298	348	344	325	284	285	290	282	276
Healy	105											
Appl. Rev.		134	143	150	154	157	162	168	175	182	189	192
Nenana	148											
Appl. Rev.		167	180	192	199	205	215	228	242	256	272	279
Paxson	NA											
Appl. Rev.		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Anchorage Census Division	61,791											
Appl. Rev.		70,809	74,383	76,835	78,138	80,041	82,171	83,521	85,283	86,836	89,001	90,136
Fairbanks Census Division	20,763											
Appl. Rev.		24,478	25,638	24,584	24,960	27,504	26,015	28,354	26,628	29,128	27,600	27,916

†[1] Based on the household sizes used in Table 3-7 (see footnote 2) and Table 4-6.

†[2] From Table 3-7. Values are for communities only, not for planning districts, so they are more comparable to the Revised Applicant's projections. Willow and Big Lake are included in "Other" category.

†[3] See footnotes 2 and 3 in Table 4-6.

If the proposed transmission line route went through existing residential areas or areas planned for development, controversies over reductions in property values near the right-of-way would be expected. Temporary losses in property values and permanent changes in development due to siting of transmission line rights-of-way have been documented in some cases.

Community Services and Fiscal Status: The large numbers of inmigrants would change the way some community services are provided and severely stress current capacities. Additional service needs for project-induced population alone have been estimated by the Staff and are shown in Table 4-9. The years when existing capacities would be equalled or exceeded by total population growth are shown in Table 4-10.

In situations of rapid growth, greater centralization and formalization of community services usually occurs. These effects occur because of greater needs for coordinated planning, higher and more consistent quality, greater efficiency in resource use, and more cost-effective construction or provision of services. Under Mat-Su Borough baseline population projections (Table 3-5), many services are already at or near capacity (Table 3-10). Individual provision of services (e.g., individual wells and septic tanks) may no longer suffice. Additionally, demand for services would decline after the two peaks in construction work force in 1990 and 1999. Services supplied for the Watana period could, if retained, be used for the Devil Canyon peak population. However, careful planning, particularly for Talkeetna, Trapper Creek, and Cantwell, would be needed to supply peak demand, yet not overbuild and be left with maintenance costs for unused capacities.

Because project-induced population increases projected for Fairbanks and Anchorage are slight, service and fiscal impacts are expected to be negligible. The Applicant has already projected a project-induced population or inmigration to Anchorage of about 650 people (Table 4-4). If a transportation plan provided for commuting between the project sites and those cities, it is assumed that Fairbanks would receive about 10% of the workers and their households (200 people for Fairbanks under Applicant's projections and 650 people to each city under Mat-Su Borough projections) (see App. N, Sec. N.2.1.1.7).

Communities like Talkeetna, Trapper Creek, and Cantwell would likely be faced with expectations of and demands for centralized water supplies and sewage treatment. Because these communities are currently unincorporated, Mat-Su Borough would be responsible for these services for Talkeetna and Trapper Creek and the state for Cantwell. The larger communities of Palmer and Wasilla are now facing shortages in water and sewer service, respectively, according to borough growth projections.

Anchorage's water and sewer system needs would be only slightly accelerated by the projected population increase of 200 to 650. Fairbanks is already in need of expanded water facilities, although sewer facilities are expected to suffice until after 2000. Using 10% of borough project-induced projections for the higher Watana peak (650 persons) the city would need expanded sewer facilities a year or two earlier and would have to expand capacities for its new water systems. Little accommodation would have to be made assuming the increase would be 200 persons, as indicated in the Applicant's projections (as revised).

Solid waste disposal is the responsibility of the borough in Mat-Su Borough. According to borough projections, existing landfills would suffice only until 1985. Plans are underway to develop new centralized landfills near Palmer and Houston that would have sufficient capacity to last 100 years. The remaining problem of transporting the wastes from Talkeetna and Trapper Creek would be further exacerbated by the Susitna project.

Based on the borough's growth projections, there would be impacts to the school system in Mat-Su Borough. Because of the Susitna project, schools serving people living outside established communities would require 18 additional classes for elementary students and 18 for secondary students--a total of 36 additional classes (equivalent to about two new schools). Under Borough projections, Talkeetna, Trapper Creek, Houston, and Wasilla schools would need to be expanded very soon or new schools added. Under Applicant's projections (as revised), Susitna-related population increases would add only about 10 to 12 children each to the school populations in the towns of Palmer, Houston, and Wasilla. Because the school for children of families living at the construction sites would be in Mat-Su Borough, the borough School District would prefer to have responsibility for its operation, adding to other project-induced service impacts.

Under the Applicant's population projections (as revised), if 10% of the peak Watana and Devil Canyon work forces living offsite commuted to Fairbanks and Anchorage to live, about 150 and 45 children, respectively--or the equivalent of approximately two extra classes and teachers--would be added to the elementary and secondary school populations of those cities by 1990. Under borough projections, about 150 children, or five classes, would be added to each of the city school systems.

Police forces would have to be expanded to maintain adequate officer-to-population ratios and possible increases in crime and to deal with the appearance of new kinds of crimes that often

Table 4-9. Additional Community Services Requirements over Baseline for Project-Induced Population in 1990 (peak Watana construction work force)†[1]

Community/ Planning District	Water	Sewers	Solid Waste Disposal	Schools†[2]		Fire	Police	Hospital Facilities
				Elementary	Secondary (Jr/Sr)			
Talkeetna								
Appl. Rev.	Individual sources may not be adequate	Individual septic tanks may not be adequate	Rely on borough landfills	1 class	1 class	Would need additional staff and full-time employees	1 officer	Would need full-time health care professionals
Borough				3 classes	3 classes		2 officers	
Trapper Creek								
Appl. Rev.	Individual sources may not be adequate	Individual septic tanks may not be adequate	Rely on borough landfills	2 classes	2 classes	Would need community based facilities	2 officers	Would need full-time health care professionals
Borough				2 classes	2 classes		2 officers	
Houston								
Appl. Rev.	Individual sources may not be adequate	Individual septic tanks may not be adequate	Rely on borough landfills	No additional needs	No additional needs	No additional needs	No additional needs	No additional needs
Borough								
Wasilla								
Appl. Rev.	No additional needs	Individual septic tanks may not be adequate	Rely on borough landfills	No additional needs	No additional needs	No additional needs	No additional needs	No additional needs
Borough								
Palmer								
Appl. Rev.	No additional needs	No additional needs	Rely on borough landfills	No additional needs	No additional needs	No additional needs	No additional needs	About 25% additional facilities and staff
Borough								

Table 4-9. (Continued)

Community/ Planning District	Water	Sewers	Solid Waste Disposal	Schools†[2] Elementary	Schools†[2] Secondary (Jr/Sr)	Fire	Police	Hospital Facilities
Other								
Appl. Rev.	Individual sources may not be adequate	Individual septic tanks may not be adequate	Rely on borough landfills	2 classes	2 classes	Would need additional staff and full-time employees	1 officer	Rely on Palmer
Borough				18 classes or 1 school	18 classes or 1 school		7 officers	
Mat-Su Borough Total†[3]								
Appl. Rev.	NA	NA	Landfill/area needed several years earlier than currently planned	5 classes	5 classes	Would need additional staff; and full-time employees	3 officers	see Palmer entry
Borough	NA	NA		5 classes + 1 school	5 classes + 1 school		11 officers	
Cantwell								
Appl. Rev.	Individual sources may not be adequate	Individual septic tanks may not be adequate	Private landfill may not be adequate	4 classes	4 classes	No additional need	2 officers	Would need full-time health care professionals
Healy								
Appl. Rev.	No additional need	No additional need	No additional need	No additional need	No additional need	No additional need	No additional need	No additional need
Nenana								
Appl. Rev.	No additional need	No additional need	No additional need	No additional need	No additional need	No additional need	No additional need	No additional need
Paxson								
Appl. Rev.	No additional need	No additional need	No additional need	No additional need	No additional need	No additional need	No additional need	No additional need

†[1] Calculated using Tables 3-8, 3-9, and 4-5 and standards from Stenehjem and Metzger (1980).

†[2] Each new class or school would require a teacher and other staff (principal, clerical, janitorial, librarian, etc.)

Table 4-10. Years When Existing or Planned Community Services Capacity of Project Area Communities Would Be Exceeded (Includes service requirements for project-related population)

Community/ Planning District	Water	Sewers	Solid Waste Disposal	Schools†[1] Elementary	Schools†[1] Secondary (Jr/Sr)	Fire	Police	Hospital Facilities
Talkeetna								
Appl. Rev.	Individual sources may not be adequate	Individual septic tanks may not be adequate	Rely on borough landfills	1990	2002+	2002+	Covered by borough	None exist
Borough				1985	1986	2002+		
Trapper Creek								
Appl. Rev.	Individual sources may not be adequate	Individual septic tanks may not be adequate	Rely on borough landfills	2002+	(80 students)†[2]	May need to acquire own facilities	Covered by borough	None exist
Borough				2002+	(90 students)†[2]			
Houston								
Appl. Rev.	Individual sources may not be adequate	Individual septic tanks may not be adequate	Rely on borough landfills	2002+	2002+	2002+	Covered by borough	None exist
Borough				1983	1983	1983		
Wasilla								
Appl. Rev.	2002+	Individual septic tanks may not be adequate	Rely on borough landfills	2002+	2002+/2002+	1985	Covered by borough	None exist
Borough	1983			1983	1983/1990	1983		
Palmer								
Appl. Rev.	2002+	2002+	Rely on borough landfills	2002+	2002+	1985	2002+	2002+
Borough	2002+	1983		1989	1990/2002+	1983	1983	1985
Other								
Appl. Rev.	Individual sources may not be adequate	Individual septic tanks may not be adequate	Rely on borough landfills	Correspondence courses or attend in communities		Covered by borough fires districts	Covered by borough	None exist
Borough								
Mat-Su Borough Total†[3]								
Appl. Rev.	NA	NA	2002+	2002+	2002+	NA	1985	Provided
Borough	NA	NA	1985	1985	1985	NA	1985	in Palmer

Table 4-10. (Continued)

Community/ Planning District	Water	Sewers	Solid Waste Disposal	Schools†[1] Elementary	Secondary (Jr/Sr)	Fire	Police	Hospital Facilities
Cantwell								
Appl. Rev.	Individual sources may not be adequate	Individual septic tanks may not be adequate	Private landfill services may not be adequate	1985	1985	2002+	Covered by state	None exist
Borough								
Healy								
Appl. Rev.	Individual sources may not be adequate	Individual septic tanks may not be adequate	Rely on private landfill	Unknown	Unknown	Unknown	Covered by state	None exist
Borough								
Nenana								
Appl. Rev.	Individual sources may not be adequate	Individual septic tanks may not be adequate	Rely on private landfill	Unknown	Unknown	Unknown	Covered by state	None exist
Borough								
Paxson								
Appl. Rev.	Individual sources may not be adequate	Individual septic tanks may not be adequate	Rely on private landfill	Unknown	Unknown	Unknown	Covered by state	None exist
Borough								

†[1] Projection for Mat-Su Borough is based on the borough's planning value of 22.8% of population in school-aged children; for Cantwell 18% school-aged children assumed (Frank Orth & Associates, 1983: p. 69).

†[2] Could attend in other communities.

†[3] All entries for Mat-Su Borough services are based on assumption that the borough would not provide services for onsite population. The borough would have to administer and may contribute to financing of some of these services, particularly the school located onsite.

NA = Not Applicable.

Sources: Tables 3-8 and 4-6, and standards from Stenehjem and Metzger (1980). Anchorage and Fairbanks do not appear on the table because the adequacy of their services cannot be estimated until worker transportation plans and work schedules are developed. However, see text discussion on estimates of service impacts in these cities under specified assumptions about transportation plans.

accompany boomtown conditions. There would also be a need to expand fire department staffs and to hire full-time paid fire professionals, rather than continuing to rely on volunteers. Estimates of personnel needs would depend on the number and distribution of fire stations and trucks. Expenses for the new staff would be incurred by the borough, adding to increased burdens from project-related growth.

Expansion of hospital facilities in Mat-Su Borough would be needed soon to meet baseline growth. The Susitna project would accelerate this need considerably. Besides hospitals, full-time health professionals, including social and mental health counselors, would be needed in clinics in many of the communities. The incremental increase in population in Anchorage and Fairbanks, assuming commuting plans to these cities, would probably not further stress existing health care facilities and services.

In rapid growth situations, community services must be planned and constructed in advance of population inmigration. Before a project is underway, many uncertainties exist as to its scale, schedules, timing of approval by licensing agencies, size, and nature of work force, and where inmigrants would settle. The borough may not have adequate staff to adjust and implement plans quickly. In boomtown situations, increased revenues are collected only after expenditures are required to provide increased services for the new population. Thus, large deficits, which may be difficult to repay, would be accrued before 1985 and during the first two years or so of project construction.

If the borough chose to increase services in anticipation of inmigration, it could be responsible for building and staffing a school and fire and police stations in the Talkeetna/Trapper Creek area, expanding landfills, establishing and extending sewer and water systems, and establishing a library, community recreation facilities, and health clinics. Financing of these items would severely strain already limited borough resources. The state, already facing declining revenues, would be responsible for planning and financing expansion of services in Yukon-Koyukuk Borough communities, and might have to compensate for shortfalls in Mat-Su Borough revenues in advance of the inmigrating population.

Transportation: All transportation modes and routes--roads, rails, and air fields--would be used more heavily during construction of all project structures. Highway use, particularly on the Denali and Parks highways, would experience the largest increase. Because the Parks Highway is currently used at only about 10% capacity, few difficulties would be anticipated along most of this highway. However, congestion could occur during peak tourist seasons, particularly at the intersection of the Parks and Denali highways, and at intersections with the site access road and railhead access roads. The Denali Highway would be paved and cleared in winter between Cantwell and the project access road, increasing use by recreation and tourist vehicles and increasing maintenance expenses for the State Department of Transportation. Traffic volume on this highway could increase to twice the projected baseline volume. Some disruption of normal rail activities may occur at the intersection of the main rail line and the spur at Gold Creek. Unless deliveries and transfers of materials are scheduled around routine rail traffic, some delays may occur. Increased populations in area communities would necessitate improvement and expansion of local road systems. The responsibility for planning and financing construction and maintenance of these roads would rest with private developers or with Mat-Su Borough and the state.

Human Use of Wildlife Resources: Human uses of wildlife resources of the upper and middle Susitna Basin would be affected by the increased accessibility that would result from the proposed project. Access by personal ground vehicles would become possible in an area that currently has limited access. Recreational demand in the northern half of Game Management Unit 13 would be expected to increase two- to fourfold as a result of the Susitna development. Both consumptive and nonconsumptive uses of wildlife would be involved.

Nonconsumptive uses in the basin (e.g., wildlife viewing, bird watching) would increase dramatically, and consumptive uses would be expected to increase up to twofold as a result of the project (Exhibit E, Vol. 8, Chap. 7, Table E-7-13). Wildlife populations in the basin interior would be subject to higher harvest pressure and increased take. In combination with increased mortality and decreased productivity due to other project impacts, increased harvesting would likely result in wildlife populations stabilizing at lower, perhaps much lower, sizes than currently exist.

The makeup of the basin's user population would probably change (Exhibit E, Vol. 8, Chap. 7, Table E-7-13). The average per-user-day dollar value would probably decline in the basin because of the presence of a less expensive access alternative and an increase in use types that carry lower dollar values. The proportion of high-dollar-value, out-of-state users would likely decline, whereas in-state user proportion would likely increase. The absolute number of out-of-state users might also decline in the basin because these users might not wish to pay high value for the hunting/wilderness experience in an area of higher user competition and more human development.

The development of the area would markedly alter the character of the hunting/wilderness experience for users in the basin. The consequences of altering that character would depend upon individual user tastes. Compared to conditions in the absence of the project, postproject users would probably encounter more human activity, suffer a lower take per effort or success rate, and perhaps view less game. For many users, these conditions would lower the quality of the hunting/ wilderness experience. Thus, users would be more likely to be those who prefer not to expend large sums of money to use areas with lower human development and possibly higher harvest success rate.

Subsistence users would be the group most severely impacted. Decreased wildlife productivity and increased competition for the harvest would result in decreased success rates. Decreased success rates would be detrimental to the extent that further effort could not be expended to maintain an absolute rate of take per season and to the extent the user is dependent upon subsistence for his or her own well-being. Unfortunately, this cannot be quantified at this time.

Human use and wildlife management policy and strategy for the upper and middle Susitna Basin would likely need to be reviewed and revised in order to meet goals for wildlife conservation, subsistence maintenance, and other uses.

4.1.9 Visual Resources

Construction of the Watana dam and associated facilities and filling of the reservoir would produce a significant change in the image and character of the upper and middle Susitna River Basin area, especially within and adjacent to the Susitna River Valley and the southern portion of the Wet Upland Tundra area north of the Susitna River. The currently remote and largely undisturbed Susitna River Valley would become an area of increased human activity and development, and visual resources would be altered accordingly. Temporary visual impacts during construction of the Watana dam would include the presence of construction personnel, heavy equipment, and materials, and the physical disturbance and alteration of the landscape. Landscape alterations that are not inundated by the reservoir would remain visible during the entire operational lifetime of the project, as discussed below.

The geometric lines and forms of the 885-ft (270-m) high, 4,100-ft (1,750-m) crest-length Watana dam and associated structures would be in dramatic visual contrast to the natural form, color, and texture of the river valley (see Fig. 4-16). The spillways would be positioned in deep rock cuts on the river valley slopes and would be highly visible to operation personnel and visitors as they crossed the access road bridge. This rock cut and grading would be inconsistent with the natural landforms and vegetation in the area. The visual scars created by construction of the access road to the powerhouse and tailrace tunnel areas would remain highly visible from the vicinity of the dam. The form, lines, and color of the electrical equipment within the Watana switchyard would predominate in an area where there is little vegetation screening. The electrical equipment and structures would be silhouetted against the skyline from various vantage points, such as along the access road. The dam facilities would be viewed by project personnel, support staff, recreationists in the area, and people flying over or near the project area.

When filled, the Watana impoundment would be about 54 mi (90 km) long, more than 5 mi (8 km) wide, and have a water surface area of 36,000 acres (14,600 ha). The landforms, waterforms, and vegetation within the valley of the Susitna River would be inundated. The impoundment also would inundate portions of major tributaries, including Deadman, Watana, Kosina, and Jay creeks. The Deadman and Watana creek waterfalls and much of the highly scenic Vee Canyon area would be inundated. Deadman Creek Falls is one of the largest and most scenic waterfalls in the project area. Vee Canyon includes a double hairpin bend, a deeply cut channel, and a stretch of whitewater rapids. Various rock formations, steep ridges, and varied coloration (rock interlaid with marble and green schist) make the area an important visual resource. The partial inundation of the canyon area would detract from its significance as a natural scenic feature.

It is anticipated that during operation, the maximum reservoir drawdown of 12D ft (35 m) would be in the spring (April and May) and would result in exposure of substantial areas of mudflats. These mudflats, expected to be more than 1 mi (1.6 km) wide, would be visually obtrusive to any recreationists near the reservoir (although snow cover may obscure the view of the mudflats in early spring). The mudflat areas would continue to be visually obtrusive to recreationists on or near the reservoir throughout the summer months until the reservoir was filled (completely covering exposed mudflat areas) in September. Extensive slumping, scaling, and landsliding would be expected to occur along steep slopes of the newly created reservoir. Such slumping could extend hundreds of feet up the sides of the slope and would result in unsightly scars visible to recreationists using the reservoir and adjacent areas.

Long-term visual impacts would occur at those borrow sites not inundated by the reservoir. Such areas would include islands in the river below the dam, the low north river terrace below the

Figure 4-16. Artist's Rendition of the Proposed Watana Dam and Reservoir. (Does not include permanent town, access roads, transmission lines, substation, or aircraft landing strip.) [Source: Application Exhibit E, Vol. 8, Appendix E8b]

dam (near the mouth of Tsusena Creek), and along the 640-acre (256-ha) borrow site located on the high north terrace adjacent to Deadman Creek. The borrow sites along the river below the dam would be in full view from the dam area. Borrow sites upstream of the dam might create rigid angular forms along the shoreline of the reservoir; these features would be visible to visitors in the area.

The proposed 300-acre (120-ha) temporary construction camp and village would cause long-term visual impacts that would extend into the operation phase of the Watana project. Visual impacts would include the presence of areas devoid of vegetation where the camp structures were removed. In these areas denuded of vegetation, mud and water ponding would result from soil compaction and would be visible to residents of the permanent town who traveled through the area and who lived adjacent to the construction village site. The 90-acre (36-ha) permanent town site would visually contrast with the natural landscape character of the area. The town would consist of a village center with approximately 20 buildings, a hospital, 125 dwelling units, and a water and sewage treatment plant. Extensive human activities in and around the permanent town would degrade the visual character of the existing wetland setting.

Temporary visual impacts during construction of the Devil Canyon dam project would be similar to those for the Watana project. The Devil Canyon project area would be viewed by project personnel, recreationists, and individuals flying over or near the area. The line, form, and color of the 645-ft (195-m) high, 1,300-ft (394-m) span concrete arch dam would visually contrast with the natural form, color, and texture of the Devil Canyon area (see Fig. 4-17). The electrical equipment and structures at the site would be silhouetted against the skyline from various vantage points, such as along the access road.

The operation of the Devil Canyon dam and the filling of the reservoir would produce an impoundment approximately 32 mi (53 km) long and a maximum of 1,800 ft (549 m) wide near the dam. The surface area of the reservoir would be about 7,800 acres (3,120 ha), and the water impoundment would reach upstream almost as far as the Watana dam. The reservoir would inundate Devil Canyon and the white-water rapids that extend through it. The unusual geology, hydrology, and aesthetic character of the canyon makes it a notable Alaskan natural feature. The canyon is a steep-sided, nearly enclosed gorge that constricts the Susitna River channel and results in over 10 mi (16 km) of turbulent (Class VI) white-water rapids. The impoundment would also inundate minor portions of Devil and Fog creeks.

The 1,000-ft (300-m) long Devil Canyon saddle dam that would be adjacent to the main arch dam would dominate the small-scale plateau-type landscape. The texture and color of the saddle dam would will be in sharp contrast to the surrounding vegetation and small pond area. Extensive clearing of vegetation and rock cutting for 2.5 mi (4 km) of road access during the construction of the powerhouse tunnel would leave large visual scars on the steep northern slopes. These would be visible from the access road and from the visitor center.

The development of the 200-acre (80-ha) temporary construction village and camp sites would cause long-term visual impacts that would extend into the operation phase of the Devil Canyon project. Large areas devoid of vegetation would be visible where the camp structures were removed. This lack of vegetation and the presence of ponds of mud and water created by soil compaction would be visible to persons who traveled through the area.

Temporary visual impacts during construction of the proposed Denali Highway-to-Watana dam access route site, the Watana dam-to-Devil Canyon dam access route, and the Devil Canyon rail spur would consist of the presence of workers, equipment, and materials along the routes. These impacts would be similar in nature to those previously discussed.

Visual impacts along the 42-mi (67-km) long Denali Highway-to-Watana access route would consist of views of large cut and fill areas, areas where vegetation had been removed, and areas of erosion. All these features would detract from the aesthetic character of the area. Large borrow pits would be located adjacent to the road and would result in long-term visual impacts from scarification caused by removal of vegetation, erosion, and the presence of partially water-filled depressions. On the positive side, the highway would also provide new access to scenic views for visitors, recreationists, and persons from the permanent Watana village. These would include panoramic views toward the Alaska Range, Clearwater Mountains, and the Talkeetna Range. However, recreationists in the area around the proposed route might consider the road a visual intrusion detracting from their enjoyment of the natural landscape.

As with the Denali Highway-to-Watana dam access road, the visual character of the 34-mi (56-km) long, Watana-to-Devil Canyon access road would be in contrast to the existing natural environment, but at the same time, the route would provide views of the surrounding area previously seen only by persons on foot. One of the more visually prominent features of the access road would be a 2,600-ft (785-m) steel bridge suspended 600 ft (180 m) above the Susitna River to the west of the Devil Canyon dam. Construction of this high-level suspension bridge would require extensive grading and disruption of land forms and vegetation for the bridge approaches. These alterations would continue to be visible after construction ceased. A clear view of the dam

Figure 4-17. Artist's Rendition of the Proposed Devil Canyon Dam and Reservoir. (Does not include construction camp and village, access roads, transmission lines, or substation.) [Source: Application Exhibit E, Vol. 8, Appendix E8B]

would not be possible from the bridge, and the proposed structural style and form of the bridge would do little to complement the form and line of the surrounding Devil Canyon landscape.

The presence of a 14-mi (23-km) long rail spur between Gold Creek and the Devil Canyon dam site would result in visual impacts along the Susitna River. The rail alignment would result in cut and fill operations that would contrast with the color and texture of the naturally forested and vegetated areas along the river valley. Recreationists using the Susitna River would be able to view the scarification on the slopes adjacent to the rail spur. At present, there is no intention of using the spur for public transportation; thus the line would not provide members of the public with new opportunities to view remote areas in the Susitna River Valley.

The temporary visual impacts that would occur during construction of the Susitna transmission line facilities would be similar for all segments of the proposed corridor. These impacts would consist of the presence of workers, equipment, and materials during construction of associated access roads, transmission line towers, substations, and the stringing of the conductors. These visual disturbances would be viewed by construction personnel, individuals flying over the transmission line route, recreationists, persons at various vantage points along project access roads and on highways and rail lines in the vicinities of the transmission line segments, and residents of communities along the various corridor segments. In addition to these temporary impacts, the development of the transmission facilities would create long-term visual impacts.

The transmission towers along 345-kV transmission line segments would consist principally of 100-ft (30-m) high, guyed, steel-pole, X-frame structures with some single steel-pole structures used for angles and areas with steep slopes. The width of the cleared right-of-way would vary from 300 to 510 ft (90-155 m). The distance between tower structures along a line typically would be 1,300-ft (39D-m); adjacent towers along parallel lines would be about 115-ft (35-m) apart.

Along the Dams-to-Gold Creek segment [45 mi (72 km) long] the transmission line towers and conductors would be silhouetted against the skyline from various viewpoints along the Watana-to-Devil Canyon access road (including the High Lake area) and rail spur and at the dam sites. Through wooded areas, the cleared right-of-way [300 to 510 ft (90 to 155 m) wide] would be highly visible from the air.

Between Gold Creek and the Healy and Willow substations, the transmission line would essentially parallel the Anchorage-to-Fairbanks Transmission Intertie. Therefore, visual impacts caused by the tower and line placement along this portion of the Gold Creek-to-Fairbanks and Gold Creek-to-Anchorage segments of the Susitna transmission line would be only incremental in nature. From the Healy substation to the terminus point at Ester near Fairbanks and from the Willow substation to the Anchorage terminus, completely new right-of-way would be required.

Areas of major visual resource impacts along the 185-mi (298-km) line extending between Gold Creek and Fairbanks would include the Broad Pass area, where the transmission line would extend across Denali Highway and be in full view of motorists. This area has been recommended by the state for designation as a scenic highway area. The transmission line would be from 200 ft (60 m) to about 2 mi (3 km) away from the George Parks Highway (Route 3) in this highly scenic region. The transmission line would also be visible at two Alaska Railroad crossings and from portions of the planned remote parcel land disposal areas between Gold Creek and Hurricane. Between Cantwell and the Yanert Fork, the transmission line would again extend close to the George Parks Highway. In the Alaska Range landscape, the transmission line would be highly visible along the Indian River. The transmission line corridor also would be visible from various vantage points along the eastern boundary of Denali National Park and the George Parks Highway. The Healy substation near the Alaska Railroad would be highly visible. From Healy to Fairbanks, the transmission line would extend through the forested Tanana Ridge and the Nenana Uplands landscapes, while paralleling the road near Healy.

Major visual resource impacts between Gold Creek and Anchorage (a line length of 145 mi, or 233 km) would include those in the Talkeetna Mountains area, where the transmission line would be in full view from Curry Ridge in Denali State Park and would be highly visible as it extended across the Talkeetna River, considered to be an important recreation resource. In the Chulitna River landscape area, the transmission line would be visible from the George Parks Highway. Between Willow and Anchorage, the transmission line corridor would be visible mainly from the air. Within the greater Anchorage area, from the Knik Arm to the terminus point, the corridor would essentially parallel an existing transmission line and would not significantly affect the visual resources of the area.

4.1.10 Cultural Resources

Eight archeological sites would be directly impacted, and six would be indirectly impacted by the construction of the proposed Watana dam and associated facilities (App. O, Sec. O.2.1).

The inundation of the impoundment area would directly impact 37 archeological and 3 historic sites and indirectly impact (due to increased slope instability and erosion) 18 archeological sites and 1 historic site. Most impacts to significant cultural resources would be mitigated by investigation, the results of which would almost certainly make a substantive contribution to knowledge of Alaskan prehistory. Currently, 19 of these sites have been tested for significance, and all but one have been assessed as significant. A number of additional sites are likely to be judged as significant.

During the operation phase, 53 archeological sites would be exposed to potential impact due to increased access to the area. Avoidance and protection (through a monitoring program), with investigation of significant sites when necessary, would mitigate most impacts. To date, three sites have been tested and assessed as significant.

No cultural resource sites occur in the immediate vicinity of the proposed Devil Canyon dam and associated facilities, but five archeological and two historic sites would be directly impacted by inundation of the impoundment area. One archeological site on the reservoir margin would be indirectly impacted. Investigation would mitigate most impacts to significant sites, and would be likely to contribute to knowledge of Alaskan prehistory. At present, three sites have been determined to be significant.

During the operation phase, two archeological and one historic site would be subject to potential impacts due to increased access to the area. Avoidance and protection (through a monitoring program), with investigation of significant sites when necessary, would mitigate most impacts. None of these sites has been assessed for significance.

During the construction of the proposed Denali Highway-to-Watana access road, four archeological sites would be directly impacted by excavation of proposed borrow pits, and four archeological sites would be indirectly impacted by greatly increased access to the area. Another eight archeological sites would be exposed to potential impact as a result of increased access. Most impacts to significant sites would be mitigated by avoidance and protection (through a monitoring program) or by investigation in cases of unavoidable direct or indirect impacts. No sites have been assessed for significance at present, and it does not appear likely that many will be termed significant. Any uninvestigated sites would continue to be subject to potential impacts during the operation phase.

A total of nine archeological sites would be directly impacted during the construction of the proposed Watana-to-Devil Canyon access road by borrow area excavation, while three more archeological sites would be subject to potential impacts due to increased access. Most impacts to significant sites would be mitigated by avoidance and protection (through a monitoring program) and by investigation in cases of unavoidable direct or indirect impacts. No sites have been assessed for significance at present, and it does not appear likely that many will be termed significant. Any uninvestigated sites would continue to be exposed to potential impacts during the operation phase.

Two historic sites are presently known along the proposed rail access to Devil Canyon. These sites would be exposed to potential impacts during both the construction and operation phase. Impacts would be mitigated by avoidance.

Nine cultural resource sites are presently known along the proposed transmission corridor, at least two of which are historic. All but one of these sites would be subject to potential impacts during the construction phase due to increased access. One archeological site (which is located in the direct impact zone of the proposed Watana camp and associated facilities) would be directly impacted by construction activity. Avoidance and protection (through a monitoring program during construction) would mitigate most impacts to significant sites, except in the case of the directly impacted site, which has been assessed as significant and would require mitigative investigation. Although the remaining known sites have not been evaluated for significance, it is likely that several of them will be termed significant.

4.2 SUSITNA DEVELOPMENT ALTERNATIVES

4.2.1 Land Resources

4.2.1.1 Geology and Soils

Impacts of the Watana I development would be similar to impacts for the proposed Watana dam (Sec. 4.1.1.1). The smaller Watana I dam would require less borrow material, thereby reducing impacts related to borrow sites, and less land would be inundated by the smaller Watana I reservoir. Because the shoreline elevation of the Watana I reservoir would be located mid-slope on many of the bordering hills, slope failure would be expected to be higher for the Watana I reservoir than for the proposed Watana development. Impacts of the Modified High Devil Canyon and Reregulating dams would be similar to impacts for the proposed Devil Canyon development. Reservoir slope failure would be expected to be less for the alternative Reregulating dam and for the Modified High Devil Canyon alternative than for the proposed project. Borrow material requirements would be somewhat less for the Reregulating dam alternative, and substantially less land would be flooded by the Reregulating dam alternative (see App. E, Sec. E.2.2.1).

Impacts related to the alternative access routes would be similar to impacts for the proposed access routes (Sec. 4.1.1.1). Extensive sidehill cutting would be required in the Portage Creek Valley for the northern access corridor and in the mountainous area between Devil Canyon and Watana for the southern access corridor. Erosion losses could be high in these areas even with the use of erosion-control measures (see App. E, Sec. E.2.2.2).

Impacts along alternative transmission routes would be similar to impacts for the proposed transmission routes (Sec. 4.1.1). In the Willow-to-Anchorage segment, impacts associated with access road development and right-of-way clearing would be minor for Corridor ABC' (Fig. 2-15) (although almost twice as long as the proposed corridor) because of the presence of existing transmission lines and highways along the route. In the Dams-to-Gold Creek segment (Fig. 2-14), Corridors ABCD, ABECD, AJCF, ABCF, AJCD, and ABECF are among the shortest routes and are located in a hilly area where moderate erosion would be expected. Corridors ABCJHI, ABECJHI, CBAHI, and CEBAHI are intermediate in length, and portions of these corridors extend through the most mountainous terrain of the area. Despite steep slopes, erosion losses in this area could be moderate because of the shallow bedrock and absence of soils. Corridors CBAG, CEBAG, and CJAG are the longest routes and cross gently sloping areas where erosion would be moderate because of the presence of extensive unconsolidated deposits and permafrost (see App. E, Sec. E.2.2.3). In the Healy-to-Fairbanks segment (Fig. 2-16), impacts of access road develoment, right-of-way clearing, and associated activities would be greater for the alternative corridors AEF, AEDC, and ABDC than for the proposed corridor, which follows an existing transmission corridor for much of its length.

4.2.1.2 Land Use and Ownership

For the alternative dam locations and designs, access routes, borrow areas, and power transmission routes, land use impacts of construction and operation would be of the same types discussed in Section 4.1.1.2. The Modified High Devil Canyon alternative would inundate 6,800 acres (2,750 ha) of land; the Watana I and Reregulating dams would inundate 28,300 acres (11,450 ha) and 4,000 acres (1,600 ha), respectively. Also, the northern and southern alternative access routes would impact additional lands between the community of Hurricane and the dam sites.

4.2.2 Climate, Air Quality, Noise

The impacts on climate, air quality, and noise from the alternative Susitna developments would be very similar to those described in Section 4.1.2 for the proposed project. The Modified High Devil Canyon alternative would involve dam construction at a nearby location. The Reregulating dam alternative would involve construction of a reregulation dam downstream of the Watana I dam. For all dam configurations and alternatives, fugitive dust emissions might extend beyond site boundaries as indicated from the calculations discussed in Section 4.1.2 for the proposed Watana dam.

4.2.3 Water Quantity and Quality

The major differences between the proposed Watana-Devil Canyon dams and the three Susitna development alternatives are in total storage volume of the reservoirs, surface area, and length of mainstem Susitna River that would be inundated (Table 4-11). All alternatives include Watana I, a modified design that would have a crest elevation 100 ft (30 m) lower than the proposed Watana dam. This reduction in dam height would result in a 30% reduction in both the storage volume and surface area of Watana reservoir. Combining Watana I with the Modified High Devil Canyon dam or the Reregulating dam would further reduce these parameters.

The Susitna development alternatives also would move the location of the downstream dam progressively upstream: Devil Canyon dam would be at RM 152, Modified High Devil Canyon would be at approximately RM 158, and the Reregulating dam would be at RM 168.2. With the Modified High Devil Canyon design, three tributaries would no longer be inundated, including Cheechako Creek. With the Reregulating dam design, nine tributaries or side sloughs would not be flooded, including both Cheechako and Devil creeks.

The flow regimes in the main channel below Devil Canyon would be similar to the postproject hydrographs described in Section 4.1.3. However, because live storage of the reservoirs would be reduced by each of the Susitna development alternatives, the magnitude of potential flow alteration would be corresponding less. Other impacts, such as reductions in habitat availabiity in side sloughs and stabilization of the channel, would also be similar to, but of lesser magnitude than, those discussed in Section 4.1.3.

The differences in water quality, relative to preproject conditions, between that resulting from construction, filling, and operation of the three Susitna development alternatives and that due to the Susitna project as proposed are predicted to be relatively minor. The largest difference

Table 4-11. Comparison of Storage Volume, Reservoir Area, and Miles of Stream Inundated for In-Basin Hydro Alternatives

Alternative	Total Volume (10^6 acre-feet)	Surface Area (10^3 acres)	Flooded River Channel (miles)
Watana	9.8	40.0	48
Watana I	6.7	28.0	47
Devil Canyon	1.1	7.8	32
Modified High Devil Canyon	0.96	6.8	26
Reregulating Dam	0.35	3.9	16
Watana-Devil Canyon	10.9	47.8	80
Watana I-Devil Canyon	7.8	35.8	79
Watana I-Modified High Devil Canyon	7.66	34.8	73
Watana I-Reregulating Dam	7.05	31.9	63

Conversion: To convert acre-feet to cubic meters, multiply by 1233; to convert acres to hectares, multiply by 0.405; to convert miles to kilometers, multiply by 1.61.

would be in suspended solids, with the construction of Watana I plus the Reregulating dam requiring less work in the river channel, thus resulting in less of an increase in suspended solids in the Susitna River during construction compared to that for Devil Canyon construction. The Reregulating dam, however, would have a lower trapping efficiency than the Devil Canyon dam. The result would be that suspended solids downstream of the Reregulating dam would be greater in both summer and winter than with Devil Canyon as proposed. None of the Susitna development alternatives would be expected to have a significantly greater adverse or positive impact on water quality than the Susitna project as proposed, with the possible exception of the adverse impact of the Watana I/Reregulating dams alternative on suspended solids in the Susitna River, particularly during winter.

Ice formation and break-up under the Susitna development alternatives would be qualitatively similar to the proposed project. Since discharge flows for these alternatives would be expected to more closely parallel baseline flows, changes in ice processes could be slightly reduced as compared to the proposed project.

The most important parameter influencing the thermal structure of an impoundment is the residence time of a water mass. For a short residence time, a water mass will quickly pass through the impoundment with minimal opportunity for surface heat exchange. Thus an impoundment with extremely short residence time will have a thermal structure that deviates only slightly from free-flowing conditions. Increasing the residence time will allow greater surface heat transfer, resulting in a more pronounced reservoir vertical temperature structure. The thermal structure of Susitna development alternative reservoirs as compared to the proposed reservoirs would be proportional to the relative change in water mass residence time. This factor, in turn, would be proportional to changes in the active storage volume of the reservoir.

The Watana I reservoir would likely have a lower active storage volume than Watana, resulting in a weaker summer thermal structure. Deep areas of this reservoir would be at 39°F (4°C) year-round, but summer surface water temperature would be cooler, perhaps by 2°F to 4°F (1°F to 2°C), than Watana. This would result in a reduced vertical temperature gradient. The weaker stratification would be a reduced barrier to vertical motion, so that the Watana I reservoir would exhibit greater mixing than the proposed Watana reservoir.

The active volume of the Modified High Devil Canyon reservoir would be comparable to the Devil Canyon reservoir and consequently their thermal structures would be quite similar as described in Section 4.1.3. The active volume of the Reregulating dam would be so small that the river reach between this dam and the Watana I dam would exhibit a free-flowing thermal regime.

In the mainstem Susitna, the relative changes in downstream water temperatures resulting from operation of the Susitna development alternatives would be related to changes in dam discharges and outlet temperatures as compared to the proposed project. For Watana I-Devil Canyon, differences in downstream temperatures would reflect differences between the Watana I reservoir and the Watana reservoir. Outlet water temperatures would depend strongly on the design and operation of the intake gate system. A well-designed system for Watana I could produce outlet water temperatures that would more closely parallel preoperational conditions than Watana. Due to the expected reduced active storage volume of the Watana I reservoir, discharge flows would be constrained to more closely parallel preoperational flows than Watana. These differences in outlet temperature and discharge are slight, and would slightly reduce the differences between baseline and operational water temperatures downstream of the Devil Canyon dam as compared with the proposed design. Downstream mainstem water temperatures resulting from the operation of the Watana I-Modified High Devil Canyon alternative would be essentially identical to the Watana I-Devil Canyon alternative.

For the Watana I-Reregulating dam alternative, the Reregulating dam would have an active storage volume sufficiently small that its presence would have negligible impact on downstream temperatures. Changes in downstream water temperatures, for this alternative, would be almost completely influenced by Watana I operation. The major difference between this alternative and the others is the addition of more than 20 river miles (32 km) at near free-flowing conditions. This distance would offer additional hours for river water to exchange heat with the atmosphere and approach baseline conditions. For this reason, the Watana I-Reregulating dam alternative would be expected to result in water temperatures downstream of the dams that were closer to baseline conditions than the proposed project or the other two Susitna development alternatives.

During periods when the berms at the upstream end of sloughs are overtopped, slough water temperature would be the same as the mainstem. It is likely that all the alternatives would offer greater summer discharge flows than the proposed project. Therefore, under the Susitna development alternatives, berms would be overtopped slightly more frequently. In addition, the increased stage associated with increased flows would produce mainstem infiltration closer to baseline conditions. These changes would be slight; however, they could result in slough water temperatures that were closer to baseline conditions than the proposed project.

Groundwater impacts would be slight for all the Susitna development alternatives and similar to impacts of the proposed project.

4.2.4 Aquatic Communities

Under the Watana I-Devil Canyon alternative, lowering the maximum elevation of Watana dam to 2,100 ft (640 m) above mean sea level, with other aspects of the project remaining the same, would not change downstream impacts significantly. The smaller storage volume would be expected to yield slight reductions in magnitude of temperature changes and flow regulation that are within the margins of error of our ability to predict ecological effects associated with the proposed project. There would be reduced flooding of reservoir tributary reaches, with proportional reduction in local impacts to these stream ecosystems.

Selection of the Watana I-Modified High Devil Canyon alternative would affect aquatic communities through (1) placement of the dam in Devil Canyon, (2) reduction in volume for water storage (that would alter water temperature and flow regimes and their effects on aquatic life), and (3) reduction of reservoir flooded area compared to the proposed project. Placement of the dam in Devil Canyon at a more upstream site would preserve several miles of freely flowing river habitat downstream. The reach is not especially valuable habitat, however, for it does not contain anadromous fish except in exceptionally low-flow years, and the high velocities and turbulence are not conducive to developing large populations of resident fish. Smaller changes in flow and temperature would be favorable for maintaining downstream aquatic life in a condition more like that before the project. Both upstream placement of the dam in Devil Canyon and a lower Watana dam would reduce flooding of reservoir tributary reaches, with a proportional reduction in local aquatic impacts. The Modified High Devil Canyon dam would avoid one major tributary completely, Cheechako Creek, which is habitat for resident species. At a maximum of 12,000 cfs (340 m^3/s) summer flow, more salmon might be able to penetrate Devil Canyon and utilize such tributaries for spawning on a more regular basis.

The combination of a lower Watana dam (Watana I) and a Reregulating dam for peaking power hydroelectric releases at Watana would reduce aquatic impacts when compared to the two-dam proposed project. Reduced flooding of tributaries by a Watana reservoir elevation of 2,100 ft (640 m) would reduce local stream impacts proportionally. Downstream effects of flow and temperature changes on aquatic life would be most comparable to having Watana alone (App. I, Sec. I.2.1.1), although the magnitudes would be reduced somewhat due to smaller storage volume. Differences would be within the margin of error of predictions for the Watana-only case.

4.2.5 Terrestrial Communities

4.2.5.1 Plant Communities

The types of impacts to plant communities from use of alternative designs for the proposed dam sites and for related facilities would be essentially similar to those impacts described in Section 4.1.5.1 for the proposed project. However, in some cases the magnitude of the impacts would be different.

Construction and operation of the Watana I alternative would result in impacts similar to those described for the proposed Watana dam site (see Sec. 4.1.5.1, and Sec. J.2.1.1 of App. J), although in most cases the extent of both direct and indirect impacts would be reduced somewhat due to the smaller impoundment size and because regulated flows would be more similar to pre-project flows. The Watana I impoundment would inundate about 28,300 acres (11,450 ha), of which about 24,000 acres (9,700 ha) are expected to be vegetated. Specific vegetation types that would be lost should be similar to those quantified in Table J-18 (App. J) except that the relative proportions of each type might change slightly.

Construction and operation of the Reregulating dam and Modified High Devil Canyon alternatives would result in similar, but probably less extensive, impacts (both direct and indirect) than those described for the proposed Devil Canyon dam site (see Sec. 4.1.5.1, and Sec. J.2.1.2 of App. J). The Reregulating dam alternative would inundate less area [about 4,000 acres (1,600 ha)] and less vegetation [about 3,000 acres (1,200 ha)] than Devil Canyon. Vegetation located in the 5 mi (8 km) between the Modified High Devil Canyon alternative dam site and the proposed Devil Canyon dam site (primarily mixed conifer-deciduous forest) would not be inundated by the Modified High Devil Canyon alternative. However, the higher reservoir elevation of this alternative would cause inundation of vegetation higher up the canyon slopes than would occur with the proposed Devil Canyon impoundment. The Modified High Devil Canyon alternative would inundate an estimated 6,800 acres (2,750 ha), of which approximately 5,100 acres (2,100 ha) would be vegetated. For both the Reregulating dam and Modified High Devil Canyon alternatives, specific vegetation types that would be lost should be similar to those quantified in Table J-22 (App. J), although the relative proportions of each type might change slightly.

Construction of the northern or southern access alternatives (see Sec. 2.2.2.4 and Fig. 2-13) would result in clearing and permanent loss of about 810 acres (330 ha) or 980 acres (400 ha) of vegetation, respectively (see Table J-36, App. J, for specific vegetation types). On the basis of worst-case estimates (see Sec. 4.1.5.1, and Table J-5 and Sec. J.1.2.1.5 of App. J), about 510 acres (210 ha) of potential wetland types might be cleared for the northern access alternative; whereas only 420 acres (170 ha) of potential wetland types would be cleared for the southern access alternative (see Table J-37, App. J, for specific wetland types). Potential indirect construction effects to vegetation as well as potential operational impacts to vegetation would be similar to those described in Section 4.1.5.1 (see also Sec. J.2.2.2, App. J).

The acreages of various vegetation types that would be crossed by alternative power transmission routes were estimated only for the technically and economically feasible alternatives, as identified in Exhibit E (Vol. 9, Chap. 10, Table E.10.24). In the northern study area (Fig. 2-15), the right-of-way for alternative power transmission route ABDC would cross about 3,100 acres (1,250 ha) of vegetation. In the central study area (Fig. 2-14), the rights-of-way for the six transmission route alternatives would cross varying acreages of vegetation, ranging from 1,300 acres (530 ha) for corridor AJCF to 3,000 acres (1,200 ha) for corridor CJAHI. In the southern study area (Fig. 2-16), 3,300 acres (1,300 ha) of vegetation would be crossed by the right-of-way for alternative ABC'; whereas 1,900 acres (770 ha) of vegetation would be crossed by alternative AEFC. These areas represent a worst-case estimate of vegetation to be impacted, since only the forest and tall shrub types (because of their overstory heights) would require major clearing (see Sec. 4.1.5.1). Worst-case estimates of potential wetland types (see Sec. 4.1.5.1, and Table J-5 and Sec. J.1.2.1.5 of App. J) that would be crossed by the alternative transmission line rights-of-way indicate that none of the alternatives except for alternative ABC' in the southern study area would cross significantly fewer potential wetland areas than the proposed corridors. Specific vegetation and wetland types that would be crossed by the technically and economically feasible alternative transmission routes have been quantified in Tables J-38 through J-41 of Appendix J. Additional possible alternative transmission line corridors in the northern and southern study areas (as identified in Wakefield, 1983) would cross similar types of vegetation as the technically and economically feasible alternatives identified in Exhibit E (Vol. 9, Chap. 10, Table E.10.24), although the specific proportions of various vegetation types contributing to the total acreage would be different. Other potential impacts to vegetation from construction and operation of the alternative power transmission routes would be similar to those already discussed in Section 4.1.5.1.

With the exception of borrow site J, which is contained within the Susitna River (Fig. 2-2), use of the alternative borrow sites would result in the temporary removal of vegetation from these sites. Vegetation and soils would be cleared prior to excavation, and the areas would be rehabilitated as outlined in Section 4.1.5.1. The acreages of vegetation cleared for borrow sites B and L (Fig. 2-2) would be relatively small; whereas, about 1,500 acres (610 ha) of vegetation would be cleared for borrow site C (Fig. 2-6).

4.2.5.2 Animal Communities

Reconfiguration of dam- or construction-facility features might alter the areal extent and distribution of habitat types to be affected by the proposed project. However, these alterations would not result in a substantive change in impacts to wildlife because these alternatives would not alter the major effects attributable to the impoundments, borrow areas, access routes, and transmission lines, which make up more than 95% of the habitat that would be affected (Table 4-3). Alternative operation scenarios would alter downstream flow dynamics to a different extent than would occur under the proposed flow regime. Wildlife impacts downstream from Devil Canyon would be reduced to the extent that alternative flow regimes more closely resembled natural fluctuations in river flow.

Alternative use of borrow areas would result in temporary loss of habitat in the areas actually used, except where the borrow areas would be inundated by the reservoir. No major reductions in impacts to wildlife would be achieved by selecting one area over another, except by using areas that would be inundated or affected by construction anyway, such as areas A, B, D, E, I, J, L, and G (Figs. 2-2 and 2-6). Excavation of borrow areas C and F would likely have additional impact on browse habitat for moose and other wildlife over and above reservoir filling, although the areas could be rehabilitated to regain at least a portion of the browse productivity. Borrow areas H and K are situated in more rugged, cliff habitat which would be suitable for raptor nesting.

Differences in impacts among alternative access routes (Fig. 2-13) are substantial. The access route from Hurricane on the Parks Highway to Devil Canyon would cross wetland habitat of high value to aquatic furbearers such as beaver and muskrat. Because of the nature of the terrain, development of this route could result in substantial erosion impacts (Sec. 4.2.1) to several wetland areas, as well as to the fisheries resources of Indian River and Portage Creek, which are used by bear. The area is also productive moose and bird habitat. This route would affect wildlife habitat of higher value than would a route from Gold Creek. Because the route would connect to the Parks Highway, the mainstem middle Susitna River would become readily accessible to Railbelt residents. Because the Parks Highway is more traveled by Railbelt residents, accessibility would be much higher than for a route from Gold Creek and, to a lesser extent, than for a route from the Denali Highway.

A southern access route from Devil Canyon to Watana would pass through extensive wetland habitat in the Stephan Lake/Fog Lakes area, which is used by large numbers of moose, furbearers, and waterfowl. Greater access to the Stephan Lake area could lead to increased human disturbance and hunting in the vicinity of Prairie Creek. This could severely degrade the suitability of the Prairie Creek area as a fishery for brown bear in the region (Miller, 1983). It could also affect the suitability of the area for use by bald eagle that nest in lowland forests along the Susitna River.

A decision to eliminate access from the Denali Highway to Watana would reduce impacts to beaver along Deadman Creek, as well as to brown bear denning in adjacent uplands. Under this alternative, caribou would continue to freely move across the area without the potential impediment of a road. Vehicular mortality would be reduced by reliance on rail transport of personnel rather than personal vehicles. Lack of linkage to a major highway would markedly reduce the accessibility of the area in comparison to either a Denali or a Parks Highway connection.

Selection of alternative transmission line routes would variably affect wildlife relative to the proposed routes, depending upon length of line, amount of clearing of forest habitat required, proximity to raptor or swan nesting locations, and amount of waterfowl habitat traversed. Qualitative impacts would be the same as discussed previously. The amount and distribution of impacts would vary among alternatives.

The alternative routes from the dam sites to the Railbelt are fundamentally similar except in length (Fig. 2-14). Several are twice or more the length of the proposed route and would be expected to have greater impact to wildlife habitats. Routes passing from Fog Lakes to Stephan Lake could have substantially higher potential for waterfowl collisions, albeit such mortality would still be a small fraction of overall mortality. Routes passing through the uplands north of the Susitna River could impact brown bear denning habitat. Selection of any route not associated with a selected access route would further enhance accessibility of the region. The proposed route would traverse the shortest length of habitat among the alternatives and would follow the proposed access route from Gold Creek.

Alternatives for the Healy-to-Fairbanks segment are basically similar except in length (Fig. 2-15). Only alternatives that swing south of the Tanana River and extend to the southern side of Fairbanks would avoid the prime peregrine falcon habitat located along the northern side of the river from Nenana to Chena Ridge. Impacts to the peregrine habitat can be avoided by proper scheduling of construction and maintenance activities. Therefore, the extra mileage required to avoid the area would not be warranted. From Willow to Anchorage, the principal difference among alternatives would be the length of the route (Fig. 2-16). Alternative routes around Knik Arm would be nearly twice the length of routes to Pt. MacKenzie. No particular advantages would be gained by selecting the longer alternatives.

The alternative dam configurations (Fig. 2-17) would result in an impact to wildlife at a level lower than would be expected under the proposed two-dam configuration. Reduction in the height of the Watana dam (Watana I configuration) would affect about 37,000 acres (15,DDO ha), about

85% of the projected area for the proposed project. A considerable amount of forest habitat would still be lost to the wildlife in the basin. Some black bear dens and some raptor nesting locations would be inundated under this alternative. The reservoir would still serve as an impediment to wildlife movement.

Impacts from the other two dam configurations would be less than those of the Watana I-Devil Canyon because of the lower area of inundation for the downstream dam. Habitat areas lost would be about 36,000 acres (14,000 ha) for a Watana I-Modified High Devil Canyon configuration, and 33,000 acres (13,000 ha) for a Watana I-Reregulating dam configuration. Anticipated impacts would be similar to those described earlier for the proposed project, but the magnitude of impact would be proportionately smaller.

4.2.6 Threatened and Endangered Species

No impacts to threatened or endangered species would be expected to occur as a result of construction and operation of any of the Susitna development alternatives.

4.2.7 Recreation Resources

The sites of the Susitna development alternatives are within the general area of the proposed project. Further, recreation use patterns are also similar. Thus, impacts associated with implementation of the alternatives would be similar to those discussed in Section 4.1.7, with the following exceptions. The reduction in the height of the proposed Watana dam (Watana I alternative) would result in a marked decrease in the land area preempted for energy production (App. J, Table J.45) and currently used primarily for dispersed recreation. Opting for the Watana 1-Reregulating dam would result in a further reduction in preempted land area. This alternative is of further significance with respect to river recreation, i.e., free flow of the Devil Canyon rapids would cease, but the rapids would not be inundated, as would be the case for other alternatives.

Recreation potentials associated with the three alternative access routes are essentially indistinguishable; current recreation use patterns along these routes are characterized by dispersed recreation activities. Based on public and agency meetings and discussions, the Applicant states that recreation potential was essentially eliminated as an evaluation criterion for access route selection (Exhibit E, Vol. 9, Chap. 10, Sec. 2.3.6).

The four principal alternatives selected for routing the Dams-to-Gold Creek transmission lines traverse remote terrain. Recreation use patterns are characterized by dispersed recreation activities, including trail-related activities and river touring. A few recreation trails might be temporarily obstructed or displaced; however, the principal effects of the transmission line development on recreationists would be of a visual nature. The alternative corridors for the Healy-to-Fairbanks transmission lines also traverse remote areas. Features common to the three alternative corridors include a few isolated cabins and several recreation trails. One of the corridors parallels a short segment of Healy Creek used for river touring, and all three corridors cross the Wood and Tanana rivers. The Tanana is a major river recreation corridor; however, adverse effects would essentially be limited to visual impacts. The alternative corridor for the Willow-Ft. MacKenzie transmission lines traverses Nancy Lake State Recreation Area for 9 mi (15 km) (Exhibit E, Vol. 9, Chap. 10, Fig. E.10.10). Transmission facilities would likely be aligned to avoid encroachment on developed recreation sites; however, visual impacts would prevail. A number of lakeside recreation cabins also are located along the corridor. Several of the lakes in the area are accessed by float plane; thus, the lines would create a degree of hazard for the local recreationists. The alternative Willow-Anchorage corridor traverses the Palmer-Wasilla area. Assuming that the relatively numerous public and private recreation areas could be avoided during final alignment, the transmission lines would constitute significant visual impacts.

No specific recreation resource areas or activities are identifiable with the alternative borrow areas. Thus, opting for use of one or more of the borrow sites would not meaningfully affect recreation resources.

4.2.8 Socioeconomic Factors

A number of assumptions have been made to assess impacts relative to Susitna development alternatives. To estimate population growth, one-half the construction work force was assumed to be unaccompanied by household members. Construction workers not in construction camps and the total population were assumed to have household sizes of 3.0 persons.

Because the facilities under each of the three alternative Susitna development hydropower plants would be located in the same socioeconomic environment as the proposed project, the impact area would be the same. The construction work forces for the alternatives would be slightly smaller and the construction period shorter. Thus, impacts of the alternatives would be only less than (particularly for the Watana I-Reregulating dam alternative), but substantially of the same type as, impacts of the proposed project (Sec. 4.1.8).

As with the proposed access route, both alternative routes would increase accessibility of the project area for tourists and for recreational and commercial hunting, fishing, and trapping. Native Alaskans could develop commercial operations on their land in the project area more easily than presently. Other residents would view increased accessibility as reducing the rural, isolated nature of the area which they value. Because of the easy commute to the dam sites, the northern alternative route would cause growth in Hurricane, the tiny unincorporated community where the access route would intersect the Parks Highway. Even a few new households in the community would change the nature of the setting and invite commercial and residential development. Service facilities, funded by the borough, would have to be built to accommodate new residents.

The southern alternative access route would make Gold Creek attractive to construction workers and to commercial and residential developers. Impacts to Gold Creek would thus be increased beyond the levels described for the proposed project in Section 4.1.8.

Impacts of alternative power transmission routes would be the same as those described for the proposed transmission routes (Sec. 4.1.8). All alternative borrow sites are located in unpopulated areas. Therefore, no socioeconomic impacts would occur as a result of the use of any of them.

4.2.9 Visual Resources

Use of the alternative dam locations and designs, access routes, borrow areas, and alternative power transmission routes would result in the same type of visual resource impacts discussed in Section 4.1.9. In addition, the Modified High Devil Canyon alternative would inundate Tsusena Falls. The northern alternative access route would parallel the scenic Portage Creek area. The southern access route would result in visual resource impacts because of a number of sidehill cuts that would be required in the mountainous terrain between the Devil Canyon and Watana dam sites. Two alternative borrow areas (near Tsusena and Fog Creeks) would require the construction of extended haul roads, further degrading views of the surrounding natural features. An alternative transmission line segment extending through the Fairbanks landscape area would be viewed by a substantial number of persons. Several of the alternative transmission route segments between Willow and Anchorage would be visible to a substantial number of people in the more populated areas around Wasilla and Palmer and the Glenn Highway area (Route 1) north of Anchorage.

4.2.10 Cultural Resources

The area of the Watana I reservoir would be subject to the same impacts on cultural resources as under the proposed Watana development (Sec. 4.1.10), except that 5 archeological sites would occupy indirect or potential rather than direct impact zones, and 17 archeological sites would occupy potential rather than indirect impact areas. In all cases, most impacts to significant sites would be mitigated by investigation in the case of direct or indirect impacts, or by avoidance and protection (through a monitoring program). Two of the sites shifted from direct to indirect or potential impact zones, and one site shifted from an indirect to a potential impact area have been evaluated as significant. Some of the remaining sites mentioned above also appear likely to be evaluated as significant. Impacts to cultural resources for the Modified High Devil Canyon development would be identical to those described for Devil Canyon (Sec. 4.1.10).

The Reregulating dam alternative also would have the same impacts on cultural resource sites as the proposed project Devil Canyon development (Sec. 4.1.10), except that there would be no impact (rather than a potential impact) on one historic and one archeological site located on Portage Creek and Devil Creek, respectively.

A number of cultural resource sites along the alternative access routes would likely be subject to direct, indirect, and potential impacts due to road construction, borrow site excavation, and increased access in Corridor 1 (North) and Corridor 3 (Denali-North). Most impacts to significant sites would be mitigated by avoidance and protection (through a monitoring program), with investigation where necessary. Few sites in these two corridors appear to be significant. No cultural resources are presently known in Corridor 2 (South), which appears to be an area of limited potential for significant sites.

Impacts to cultural resources presently known along the various proposed alternative transmission line routes would not differ significantly from impacts described for the proposed project transmission corridor (see Sec. 4.1.10). Archeological and historic sites would be subject to potential impacts due to increased access during the construction phase. Impacts would be mitigated by avoidance, coupled with construction-phase monitoring to determine whether investigation of any significant sites would be necessary. Although no sites along the alternative routes have been evaluated for significance, it appears likely that several will be termed significant.

Development of three of the alternative borrow sites (C, E, and F) would have impacts on cultural resources. Development of borrow site C would directly impact 15 archeological sites during excavation, and indirectly impact five archeological sites due to destabilization of slopes and increased erosion. The excavation of borrow site E (which would be within the proposed Devil Canyon impoundment area) would directly impact two archeological sites and one historic site. Use of borrow site F would have direct impacts on eight archeological sites and one historic site, and indirect impacts on two archeological sites due to destabilization of slopes and increased erosion. Most impacts to significant sites would be mitigated by investigation, the results of which would be likely to make a substantive contribution to knowledge of Alaskan prehistory. Two of the archeological sites (one each in borrow sites C and E) have been assessed as significant, and it appears likely that others will be termed significant as well.

4.3 NATURAL-GAS-FIRED GENERATION SCENARIO

4.3.1 Land Resources

4.3.1.1 Geology and Soils

A total of about 50 acres (20 ha) of land would be required for the natural-gas-fired generation scenario. Accelerated soil erosion and soil compaction would be the primary impacts of site construction activities. Erosion losses might be greater for the Chuitna and Anchorage locations, where the terrain is more sloping. No permafrost or mineral resources are known to exist in the vicinity of the proposed sites. Areas of agriculturally suitable soils are present near the Lower Beluga River and Kenai sites, but because of the small areal extent of the units, these features could be avoided with proper siting.

4.3.1.2 Land Use and Ownership

Land use impacts due to the construction and operation of natural-gas-fired plants would be minimal at the alternative site locations. Land requirements would be about 5 acres (2 ha) per plant for the ten combined-cycle and combustion-turbine units. It is estimated that over 9,000 acres (3,600 ha) of land would be required for transmission line facilities under this scenario. However, depending on final plant siting, significant land use impacts could occur if extended access or transmission stubs were required to reach the plant site or if a plant was constructed adjacent to an area supporting a land use that is not considered to be compatible with industrial development (e.g., dispersed recreation or residential area).

4.3.2 Climate, Air Quality, Noise

Climatic impacts of the eight 200-MW combined-cycle gas units and the two 70-MW combustion-turbine units would be negligible. Impacts would involve changes in surface albedos and heat capacities over small areas due to land clearing, paving, and erection of buildings. Also involved would be very slight temperature and humidity increases in the local area of the plants.

The visible plume from the wet/dry cooling towers would extend approximately 0-350 ft (0-100 m) downwind, depending upon atmospheric temperature and relative humidity.

Pollutant emissions from the gas units and combustion turbines would be very small except for NO_x emissions from the combined-cycle units. The NO_x release rate from a 200-MW unit varies from 138 grams per second (g/s) (no steam injection) to 34 g/s (steam injection). A standard 200-MW coal-fired plant emits 151 g/s of NO_x. Without steam injection to reduce NO_x emissions, the three units (600 MW) located on the Chuitna River would emit 414 g/s of NO_x. The Chuitna plant might be designed to have three identical 200-MW units, one stack per unit.

Calculations made with the EPA screening model PTPLU revealed that the maximum 24-hr ground-level concentration for NO_x would be 23 micrograms per cubic meter ($\mu g/m^3$), with this maximum concentration reached at a point 2.9 mi (4.7 km) downwind. The Alaska air quality standard is 100 $\mu g/m^3$ on an annual arithmetic mean basis. Since the predicted maximum 24-hr average concentration is less than the annual average limitation, it is clear that the annual limit for NO_x should be met. Other pollutants released from combined-cycle gas units are at very low levels. PSD limits on SO_2 and TSP should be satisfied due to the very low emission levels from such natural-gas units. Although the combined-cycle plant stacks would only be 65 ft (20 m) high, the very high temperature at plume exit (approximately 370°F, or 190°C) would lead to a very buoyant plume and high plume rise. As a result, low concentrations are predicted at ground level.

Because of the low pollutant emission levels and the large distances between any of these units and the Class I areas of Alaska, no significant impact on Class I areas would be expected. Carbon monoxide emissions from the 200-MW unit southeast of Anchorage should be sufficiently diluted during transport to Anchorage to have no significant impact on the Anchorage nonattainment area. Ground-level concentrations predicted by PTPLU at Anchorage were found to be significantly below the Alaska standard for impact on a carbon monoxide nonattainment area.

Climatic and air quality impacts of the 70-MW combustion turbines would be negligible because of the small heat, moisture, and pollutant releases. Noise impacts should be insignificant if the turbines are sited at least 0.5 to 1.5 mi (0.8 to 2.4 km) from the nearest noise-sensitive areas.

4.3.3 Water Quantity and Quality

The gas-fired, combined-cycle generators with wet/dry mechanical cooling towers would have very low consumptive water requirements (<2 cfs or 0.05 m^3/s). At the four sites considered, there would be no problems meeting these water demands from base flows in the Beluga and Chuitna rivers, from groundwater sources in alluvial aquifers, or from the small lakes in the vicinity of the Kenai site. Plant construction might require the localized destruction of wetland habitats, but this would not exceed 10 acres (4 ha) per site.

Sources of water pollution from natural-gas-fired power plants include cooling system blowdown, wastewater from regeneration of demineralizers, releases of cleaning solutions, accidental spills, and domestic water use. Releases to surface waters from these gas-fired units would be required to meet appropriate state (Alaska State Water Quality Statutes, Alaska Dept. of Environmental Conservation, 1979) and Federal (Clean Water Act-NPDES permits) water quality and effluent limitation guidelines. No significant adverse impacts from construction and operation of the natural-gas-fired power plants would be anticipated.

No thermal impacts, groundwater impacts, nor changes in ice processes would be expected with this alternative.

4.3.4 Aquatic Communities

Construction of the eight 200-MW combined-cycle units and the two 70-MW combustion-turbine units would impact aquatic communities in the immediate vicinity of the facilities and along access routes. Aquatic habitat (e.g., wetlands) would be lost wherever the facilities were sited. Increased siltation and turbidity would adversely affect aquatic communities in the vicinity of construction sites and where access routes and power transmission corridors crossed streams. The spatial extent of these impacts should be limited to the immediate vicinity [e.g., 300 ft (90 m)] of construction activities. Adverse effects should be less during operation of these units than during construction. The increased dissolved solids discharged from cooling systems into streams or other surface waters might cause some local changes in distribution of plant, invertebrate, and fish communities. Both construction and operation impacts are expected to be proportionally greater for the 200-MW combined-cycle units as compared to the 70-MW combustion-turbine units.

The greatest source of adverse impact on fish communities is likely to be the increased accessibility of streams, rivers, and lakes to sport and subsistence fishing pressure in the vicinity of the facilities and along access routes and transmission line corridors. Direct construction and operation impacts are likely to be limited to fish species in the streams and lakes directly affected by construction and operation. The indirect impacts due to increased accessibility, however, could also affect salmon populations migrating up nearby rivers, such as the Beluga and Chuitna. Increases in accessibility are more likely to be associated with the combined-cycle units than the combustion-turbine units, since the combustion turbines would tend to be located in or adjacent to already existing population centers, whereas the larger combined-cycle units would be located in more remote areas.

4.3.5 Terrestrial Communities

4.3.5.1 Plant Communities

Construction of facilities associated with each of the 200-MW combined-cycle units and the 70-MW combustion-turbine units in the natural-gas-fired generation scenario would result in the permanent removal of 5 acres (2 ha) of vegetation. Thus, a total of about 50 acres (20 ha) of vegetation would be permanently lost as a result of the implementation of this scenario. Placement of gas pipeline spurs to the plants would probably require temporary removal or disturbance and subsequent rehabilitation of relatively narrow and short corridors of vegetation. Relatively short [less than 10 mi (16 km)] transmission line stubs would probably be constructed to the plants, resulting in vegetation impacts similar to those described in Section 4.1.5.1. If, in addition to transmission line stubs to the plants, it is assumed that transmission of the power to the Railbelt would require at least (1) construction of two 345-kV lines from Willow to Anchorage and from Healy to Fairbanks and (2) upgrading of the existing Intertie between Healy and Willow to two 345-kV lines, then at least 9,000 acres (3,640 ha) of vegetation might be disturbed by construction and operation of power transmission facilities. No impacts to even sensitive plant species from SO_2 or NO_x emissions would be likely (Dvorak et al., 1978). Impacts to wetlands would probably be minimal if the facilities were sited so as to avoid critical or sensitive wetland areas.

4.3.5.2 Animal Communities

The two combined-cycle plants situated along the Beluga River would occupy about 10 acres (4 ha) of upland spruce-hardwood forest. Moose congregating in the area during winter might be disturbed by human activities during construction and operation and might tend to avoid the plant area. However, this would affect only a minute fraction of their winter range. Along the Chuitna River, the three combined-cycle plants would occupy about 15 acres (6 ha) of upland spruce-hardwood habitat. Plant construction and operation might disrupt black bear denning areas along the Chuitna River. However, the area affected would represent less than 1% of the available habitat. Some fishing areas used by brown bear during salmon spawning might also be impacted. No other areas of known wildlife sensitivity would be affected by these alternative thermal developments. The area is already accessible by road, and alternative developments would not increase accessibility.

Near Kenai, two combined-cycle plants would occupy about 10 acres (4 ha) of lowland spruce-hardwood habitat. Although a variety of wildlife range through the area, no known sensitive areas exist in the vicinity of these possible alternative developments. The affected habitat would be a small fraction (<<1%) of available range. The area is already developed with roads, and petroleum industry activities are extensive throughout the area. Thus, the alternative developments would not materially increase human presence.

The 15 acres (6 ha) needed for the three combined-cycle plants in the Anchorage area would be situated in more urbanized habitat and would not substantively affect wildlife resources.

4.3.6 Threatened and Endangered Species

No impacts to threatened or endangered species would be expected to occur as a result of construction and operation of facilities included in the natural-gas-fired generation scenario.

4.3.7 Recreation Resources

There are no dedicated or significant developed recreation resource areas in the Beluga and Chuitna river areas (Bechtel, 1983). Essentially all recreation use patterns result from dispersed recreation, primarily sport hunting and fishing, but also including trail-related and water-based recreation activities. Given judicious siting procedures, it is unlikely that developing five combined-cycle gas plants requiring a total of 30 acres (12 ha) would appreciably impact existing recreation patterns. Similarly, the development of two 200-MW combined-cycle units near Kenai would not appreciably impact recreation opportunities, provided that developed recreation sites of the Kenai National Wildlife Refuge and local state parks and recreation areas were avoided. Assuming that Chugach State Park and municipal recreation areas in Anchorage were avoided, the development of a 200-MW combined-cycle unit and two 70-MW combustion-turbine units requiring a total of about 20 acres (7 ha) would not meaningfully affect recreation resource areas or activities in the Anchorage-Turnagain Arm area.

4.3.8 Socioeconomic Factors

Tyonek is the community that would be nearest to the five combined-cycle units on the lower Beluga and Chuitna rivers. In general, construction of one of these units would require a work force of about 45 persons over a period of two to five years; operation would require about six persons per unit (Battelle Pacific Northwest Laboratories, 1982 p. 5-19). Assuming successive construction periods, a maximum total of 108 new workers would be in the area at once, for a total maximum inmigrating population of about 200, excluding inmigrating support workers--almost equal to the current population of 239. Few, if any, Tyonek residents would likely be hired on the projects. No vacant housing is available in Tyonek, with the exception of 24 rooms in the Shirleyville Lodge. Thus, housing would have to be built or lots for trailers developed. The school building would have enough capacity for many inmigrating children, but another teacher might be needed. The Kenai Peninsula Borough would bear the planning and funding responsibilities for expanded services.

Tyonek is a Native Alaskan community whose residents rely a great deal on subsistence activities for their livelihood. Development of commercial interests in response to the expanded population would be outweighed by conflicts between the cultures of the Natives and of construction workers, and by potential interference of the new population with traditional subsistence activities. A construction camp to house workers near the site would reduce these impacts considerably.

Roads would have to be built to the sites of the combined-cycle units. Better road connections with Anchorage would be beneficial but would increase access to the area. Permission to build some access roads might be difficult to obtain from the Tyonek Native Corporation.

Under this scenario, two combined-cycle units would be constructed in an area within commuting distance of the more substantial communities Kenai and Soldotna. If the two units were built in succession, a maximum of approximately 100 inmigrants might be expected at one time. This would be approximately a 2% increase over the 1982 population. Minor impacts would be mainly in the form of increased access to the area north of Kenai and slight disruption of the rural lifestyle of those who live nearby.

One combined-cycle unit and two 70-MW combustion-turbine units would be built near Anchorage. The work force needed for construction of a combustion-turbine unit would be approximately 30 persons. Since most workers could commute from Anchorage, impacts would be minor and limited to slight increases in road traffic and increased access to the site areas.

4.3.9 Visual Resources

Specific visual resource impacts for each of the 200-MW combined-cycle units and the 70-MW combustion-turbine units would depend on the actual location of the plant facilities within the proposed Beluga, Kenai, and Anchorage areas. Potential viewers impacted might include highway motorists, recreationists, or local residents. Impacts might occur from views of the plant structure, smokestack (about 75-ft, or 23-m high), any hazard warning lights (e.g., strobes) located on the stack, and, depending on cooling tower design and atmospheric conditions, water vapor plumes emanating from the cooling towers. If wet-dry cooling towers were used, no significant vapor plumes would be anticipated. In addition, visual resource impacts might occur along the gas pipeline and power transmission line right-of-ways that would be necessary to connect the power plant with existing utility facilities.

4.3.10 Cultural Resources

Potential for impacts to cultural resources in the designated locations for the natural-gas-fired generation scenario would appear to be limited. Most impacts to significant sites would probably be mitigable by avoidance and protection (through monitoring). Site-specific surveys and significance assessments would be necessary to determine the extent of needed mitigation.

4.4 COAL-FIRED GENERATION SCENARIO

4.4.1 Land Resources

4.4.1.1 Geology and Soils

Development of the five coal-fired units would disturb approximately 350 acres (140 ha) of land at Willow and 450 acres (180 ha) at Nenana, and would result in increased rates of erosion, sedimentation, and runoff; soil compaction; and increased levels of potentially hazardous materials in soil. Both areas are located in relatively level terrain where such erosion losses could be more easily controlled. Impacts from permafrost thaw would be expected at the Nenana sites only.

Approximately 110 million tons [97 million metric tons (MT)] of coal would be used consumptively over the 30-year life of the five 200-MW plants. Approximately 2,250 acres (910 ha) of land would be disturbed by mining associated with the operation of the five 200-MW plants. Surface mining impacts would include increased sedimentation and wind erosion of soils from spoil piles, modification of surface drainage and topography, slope failures due to excavation, and permafrost thaw resulting from vegetation stripping.

The ten 70-MW combustion-turbine plants that would be located around the Cook Inlet would appropriate a total of 50 acres (20 ha), and the construction-related impacts would be highly site-specific.

4.4.1.2 Land Use and Ownership

The construction and operation of coal-fired generation plants could produce significant land use impacts at all the plant sites. Land requirements for each of the two plants would be approximately 200 to 300 acres (80-120 ha) for plant and associated structures, coal unloading facilities, and coal storage piles, and an additional 1.5 acres (0.6 ha) of land per year for waste disposal. In addition, it is estimated that operation of a 200-MW coal-fired power plant would require 450 acres (180 ha) of land to be strip mined for coal over the 30-year life of the power plant. The five 200-MW coal-fired units located at Nenana and Willow and the ten 70-MW gas-combustion turbines under the coal-fired generation scenario would require a total of 600 acres (240 ha) of land for plant-site facilities, 225 acres (90 ha) of land for waste-disposal sites, and about 2,250 acres (910 ha) of land for surface mining of coal during the 30-year operating life of the facilities. Similar to the natural-gas generation scenario, it is estimated that over 9,000 acres (3,600 ha) of land would be required for transmission line right-of-way. As discussed in Section 4.3.1.2, significant land use impacts could also occur if extended access or transmission line stubs were needed to reach the plant site or if the site were located adjacent to an existing noncompatible land use.

4.4.2 Climate, Air Quality, Noise

The climatic and air quality impacts of siting various combinations of 200-MW coal-fired units at Nenana and Willow are described in this section. The cases of most significant interest (and impact) involve siting five units at Nenana or, alternatively, three units at Nenana and two at Willow. These plants would be too small to significantly affect the climate in the Nenana and Willow areas. The effect of land clearing, paving, and erection of buildings would involve a change in the surface albedos and heat capacities over small areas. A small vapor plume from 0 to 300 ft (0 to 100 m) long would be expected from the wet/dry cooling towers; only very small increases in temperature and humidity would be expected, and these changes would occur only in small areas near the tower structures. A visible vapor plume would extend from the plant stacks tens of feet in the summer and hundreds of feet in the winter.

The major air quality issues involving the coal-fired plant stack releases include: (a) maintaining Alaska ambient air quality standards, (b) meeting PSD increments not only in the Class II area in which Nenana and Willow are located, but also at the Class I Denali National Park approximately 60 mi (95 km) south of the Nenana site, (c) ensuring no significant impact on the nearby nonattainment area for carbon monoxide (CO) at Fairbanks, and (d) ensuring no visibility impairment at the Denali National Park.

To investigate these four issues, the Staff made numerical computations using EPA-approved models. First, the EPA screening model PTPLU was used to evaluate compliance with PSD Class II increments for the vicinity of Nenana and Willow. Calculations revealed that for sulfur dioxide (SO_2) and particulates, maximum 3-hr and 24-hr concentrations for SO_2 and maximum 24-hr concentrations for total suspended particulates (TSP) would be well within PSD Class II increments when flat terrain is impacted. Alaska ambient air quality standards would be met as well for SO_2, TSP, and NO_x. Willow and Nenana are not near major industrial sources and, as a result, ambient levels are very low. Increments contributed by the new coal-fired plants would be sufficiently small that when added to the background, the total would fall far below Alaska standards.

An example of the numerical values obtained is the prediction for three units at Nenana. The maximum 3-hr SO_2 concentration predicted was 90.3 $\mu g/m^3$ and the maximum 24-hr TSP concentration was 2.8 $\mu g/m^3$. PSD Class II increments for these pollutants are 512 $\mu g/m^3$ and 37 $\mu g/m^3$, respectively. All predicted maxima would occur 0.88 mi (1.4 km) downwind of the stacks.

Supplementary calculations were prepared to evaluate the impact of one to five units sited on the elevated terrain just to the northeast of Nenana. A simplified version of the VALLEY Model was used to evaluate concentrations at elevated terrain 5 mi (8 km) northeast of the plant stacks. Twenty-four-hour averaged SO_2 concentrations were predicted to be 68 $\mu g/m^3$ for two units, 102 $\mu g/m^3$ for three units, 136 $\mu g/m^3$ for four units, and 170 $\mu g/m^3$ for five units; the PSD Class II limit on 24-hr averaged concentrations is 91 $\mu g/m^3$. Although more detailed analyses than a screening analysis is required to confirm that regulatory violations would occur, the present predictions reveal a small exceedence for three units and significant exceedences for four and five units.

Next, the simplified version of the VALLEY Model was used to predict maximum incremental concentrations under a worst-case scenario at the Denali National Park. These calculations revealed acceptable SO_2 and TSP increments at this Class I area for two units at Nenana or Willow. However, maximum 24-hr concentrations of SO_2 at Denali were predicted to be 4.1 $\mu g/m^3$ for three units at Nenana, 5.4 $\mu g/m^3$ for four units, and 6.8 $\mu g/m^3$ for five units, compared with a PSD Class I increment of 5 $\mu g/m^3$. Here again, the siting of four or five units at Nenana would lead to a potential violation of PSD Class I increment requirements.

Calculations with the simplified VALLEY Model for carbon monoxide revealed an extremely small increment (1.1 $\mu g/m^3$, maximum 24-hr average) at Fairbanks, the nearest nonattainment area from a five-unit Nenana coal-fired plant. This predicted increment should not involve any violation of standards (5,000 $\mu g/m^3$ for maximum 8-hr average and 2,000 $\mu g/m^3$ for maximum 1-hr average) and is not within significant levels for CO for a nonattainment area.

Finally, a Level-1 screening analysis was performed to assess potential visibility impacts on Denali National Park caused by operation of one to five coal-fired units at Nenana and two units at Willow. Section 169A of the Clean Air Act requires visibility protection for mandatory Class I Federal areas where it has been determined that visibility is an important value. Furthermore, the State of Alaska assesses visibility impacts on a case by case basis (Alaska Dept. of Environmental Conservation, 1983). The purpose of this Level-1 screening analysis is to estimate the worst-case visual impacts that might occur at the National Park. The results of the analysis indicated significant visibility impairment due largely to the NO_x emissions from a plant at Nenana with three, four, or five units. Chemical conversions during transport of the Nenana plume would result in a visible plume over Denali. This plume is revealed through three contrast parameters, one of which contrasts the plume with the sky (rather than with terrain features). The value of this parameter, C_1, exceeded its limit of 0.1 in the Staff's calculation for three, four, and five Nenana units. The large background visual range at Denali [100 to 240 mi (170 to 390 km)] is a contributing factor in this visibility impairment. Level-2 and Level-3 analyses would likely lead to the same results due to the extreme meteorology in that area; i.e., large frequency of inversions and poor mixing of pollutants in the general region about Fairbanks. Application of the Level-1 screening analysis with one and two coal-fired units at Nenana or Willow revealed no visibility impairment, although some plume contrast with the sky would still be noticeable at Denali.

Control technology applied to NO_x might assist in the siting of three units at Nenana by mitigating the potential visibility problem. Another possibility is the placement of three units at Willow and two at Nenana. This latter alternative would not lead to either PSD or visibility impairment problems at either Nenana or Willow.

Construction and operational noise impacts from the coal-fired plants should be minimal if siting was at least 0.5 to 1.5 mi (0.8 to 2.4 km) from the nearest residences. The major noise sources in the operation of the plant should be the coal-handling equipment, the cooling tower, and the transformers. An in-depth treatment of noise impacts requires a precise location of the plant with respect to nearest noise-sensitive areas, ambient baseline noise data, and an identification of specific equipment to be used in plant construction and operation.

4.4.3 Water Quantity and Quality

The coal-fired power plants at Willow and Nenana would have negligible impacts on surface water resources. The consumptive water use estimated for a 200-MW facility with wet/dry mechanical draft cooling towers is only 4 cfs (0.11 m^3/s). Because of the performance of the cooling tower design, makeup water would be required only during the warmest months of the year (June, July, and August). This demand could be easily satisfied from available flows in the Susitna River at Willow, the Tanana or Nenana rivers at Nenana, or from local groundwater in alluvial aquifers.

Sources of water pollution from coal-fired power generation include cooling system blowdown, wastes from regenerating demineralizers, chemical cleaning solutions, ash pond overflow, coal pile drainage, and domestic water use (Battelle Pacific Northwest Laboratories, 1978). It is expected that all point-source discharges to surface waters from the coal-fired power plants would meet appropriate state and Federal water quality and effluent limitation guidelines and that no adverse impact on surface water quality would occur from discharges at these plants. Closed-cycle cooling (cooling towers) would be required, and thus no significant adverse changes in water temperature would result from operation of the coal-fired power plants.

No significant changes in ice processes should occur. Local ice-free areas could exist in the vicinity of thermal discharges.

Thermal impacts that could occur as a result of coal-fired power generation would be associated with the discharge of blowdown from the cooling water system producing a thermal plume in the receiving water body. For all the units considered in this scenario, thermal loading, if any, would be minor with adequate flow available for dilution. As a result, any thermal impacts would be minor and limited to a small thermal-plume mixing zone.

Groundwater contamination of shallow, unconfined aquifers could occur as a result infiltration of coal-pile runoff, accidental spills and leaks, and seepage from solid and liquid waste disposal areas. Such impacts could be eliminated or reduced to acceptable levels through proper facility design, operation, and maintenance.

4.4.4 Aquatic Communities

Construction of the five 200-MW coal units and the ten 70-MW combustion-turbine units would impact aquatic communities in the immediate vicinity of the facilities and along access routes. Aquatic habitat (e.g., wetlands) would be lost where the facilities were sited. Increased siltation and turbidity would adversely affect aquatic communities in the vicinity of construction sites and where access routes and power transmission corridors crossed streams. The spatial extent of these impacts should be limited to the immediate vicinity [e.g., 300 ft (90 m)] of construction activites. During operation of the combustion turbines, adverse affects would be expected to be less than during construction. During operation of the coal units, however, there would be additional impacts associated with coal piles and fly-ash disposal areas. Sites for these areas would likely include additional aquatic habitat (most likely wetland), and during operation there would likely be some change in the composition and distribution of aquatic plant, invertebrate, and fish communities in the immediate vicinity of runoff from these areas. The increased dissolved solids discharged from cooling systems into streams or other surface waters might cause some local changes in composition and distribution of plant, invertebrate, and fish communities. Both construction and operation impacts are expected to be proportionally greater for the 200-MW coal units than for the 70-MW combustion-turbine units.

The greatest source of adverse impact on fish communities would likely be the increased accessibility of streams, rivers, and lakes to sport and subsistence fishing pressure in the vicinity of the facilities and along access routes and transmission line corridors. Direct construction and operation impacts are likely to be limited to fish species in the streams and lakes directly affected by construction and operation. The indirect impacts due to increased accessibility, however, could also affect salmon populations migrating up nearby rivers such as the Susitna, Nenana, and Tanana. Increases in accessibility would be more likely to be associated with the coal units than with the combustion turbines, since the combustion turbines would be located in or adjacent to already existing population centers, whereas the larger coal units would be located in more remote areas.

4.4.5 Terrestrial Communities

4.4.5.1 Plant Communities

Construction of facilities associated with the five 200-MW coal units and the ten 70-MW combustion-turbine units of the coal-fired generation scenario could result in the permanent removal or disturbance of 600 acres (240 ha) of vegetation. Over the 30-year life of the coal units an additional total of about 225 acres (90 ha) of vegetation would be temporarily removed for solid waste disposal at the plant sites, and a total of about 2,250 acres (910 ha) of vegetation would be temporarily removed during surface mining of coal. It would be expected that the waste disposal and surface mine sites would eventually be rehabilitated. If soils could be adequately restored on these areas, rehabilitation should be no more difficult than the rehabilitation of borrow sites or other temporary facilities planned for the proposed Susitna project (see Sec. 4.1.5.1). Temporary removal or disturbance of vegetation would be associated with construction of transmission line stubs or gas pipelines (see Sec. 4.3.5.1). As with the natural-gas-fired generation scenario, transmission of power to the Railbelt would require construction and operation of power transmission facilities that could disturb about 9,000 acres (3,640 ha) of vegetation (Sec. 4.3.5.1).

Localized alteration or damage of plant communities might result from fugitive dusting near coal mine pits, along transportation routes, near coal storage piles, and near waste disposal sites. Trace elements in runoff or seepage from solid waste disposal areas might have some localized effects on vegetation surrounding the site, although the probability of this would likely be low (Dvorak et al., 1978). No impacts to vegetation from particulates or trace element combustion emissions would be expected. Under worst-case fumigation conditions (see Sec. 4.4.2; Sec. G.2.4, App. G; and Sec. J.2.3.2, App. J), SO_2-sensitive species would probably not suffer acute injury or damage, except perhaps at specific locations under certain conditions (see Sec. J.2.3.2, App. J). Although the potential for SO_2-induced chronic or long-term injury or alteration of plant communities near the coal units exists, it is impossible to predict whether or not such effects would actually occur because very little information on chronic or long-term injury threshold levels exists in the literature. It is unlikely that vegetation in the vicinity of the coal units would be directly affected by NO_x emissions, but NO_x together with other pollutant emissions might cause greater injury than any one of the pollutants would alone (Dvorak et al., 1978). Impacts to wetlands would probably be minimal if the facilities were sited to avoid critical or sensitive wetland areas.

4.4.5.2 Animal Communities

The 400 MW of coal-fired generating capacity sited near Willow would require approximately 350 acres (140 ha) of habitat for plant facilities and waste storage. Principally, lowland spruce-hardwood habitat would be impacted. The plant would be located in an area of high densities of moose and black bear. However, suitable habitat for these species occurs throughout this portion of the Susitna Basin. The area is lightly developed for recreational purposes, and access might be enhanced to some degree by development of the coal-fired units. This development could also result in increased disturbance to nesting trumpeter swans and bald eagles.

The three Nenana coal units would be located mainly in bottomland spruce-hardwood habitat and require about 450 acres (180 ha). Moose do concentrate in the area during winter, but the generating facilities would occupy only a small fraction of the habitat available. Some trumpeter swan nesting might be disturbed. Historical peregrine nesting locations would potentially be within 5 mi (8 km) of the plant. Because the area is located on the Parks Highway, no additional accessibility would result.

Coal mining near Healy would necessitate disturbing about 2,250 acres (910 ha) of upland spruce-hardwood and tundra habitat. Brown bear, caribou, and moose would be most impacted by this habitat loss. Reclamation of the mined land would recover some of the lost productivity. Mortality of big game along the Alaska Railroad could increase dramatically, particularly during winter when coal shipments could require two to three times the current rail traffic.

Use of approximately 50 acres (20 ha) for combustion-turbine plants would have effects similar to those described in Section 4.3.5.2, but the exact nature and magnitude of the impacts would depend upon precisely where the plants were located.

4.4.6 Threatened and Endangered Species

No impacts to threatened or endangered species would be expected to occur as a result of construction and operation of facilities in the coal-fired generation scenario.

4.4.7 Recreation Resources

Several dedicated recreation areas are located in the vicinity of Willow. The Willow State Recreation Area is proposed to be expanded by 3,450 acres (1,396 ha) (Park Planning Section, 1983). Additionally, the area has been the scene of a "recreation cabin boom" in recent years (U.S. Dept. of Agriculture, 1981). Patterns of dispersed recreation are also well established, especially with respect to fishing and boating activities associated with Willow Creek. Given that two 200-MW coal-fired units would be developed in a least sensitive area, outdoor recreationists would be subject to visual impacts involving stack emissions, coal transport activities, and other related effects. Aside from the George Parks Highway and the Alaska Railroad, which are major tourist routes, recreation patterns in the Nenana area consist of low-density dispersed recreation. Development of three coal-fired units in the Nenana area would result in considerably less impacts on recreation activities than would be the case in the Willow area. Development of the ten combustion-turbine units associated with the coal-fired scenario in the Tyonek-Beluga, northwest Kenai, and Anchorage areas would result in minor impacts on recreation resource areas and activities.

Based on the assumption that the Nenana coal field would be the fuel source for the Nenana and Willow coal-fired plants, recreation opportunities in the Healy area would be altered due to increased mining activity. Competition among inmigrating mine personnel, tourists, and local residents would likely generate the strongest recreation demand for accommodations and services of establishments in Healy (see Sec. 4.4.8), as well as those located along the Parks Highway. However, mining personnel would also compete for dispersed recreation opportunities, such as hunting and fishing. The demand for use of developed recreation facilities would be somewhat alleviated by the proximity of Denali National Park and, to a lesser extent, Denali State Park.

4.4.8 Socioeconomic Factors

It is assumed that all the coal for the coal-fired units that would be built under this scenario would come from the Nenana coal field near Healy. To supply the fuel for five 200-MW coal-burning power units and maintain current supplies to existing markets [about 700,000 tons (630,000 MT) per year], production would have to increase by over fivefold, to about 3.8 million tons (3.4 million MT) per year.

Current operation at the Usibelli Mine now employs about 90 persons in the summer and 70 in the winter. It is assumed here that a total of 300 workers (about 210 new) would be needed to meet the new production levels. Because mining operations would require a permanent work force, most of these workers would probably settle in the area. This would add a total of about 1,100 people to the existing population (see App. N, Sec. N.2.3.2.1).

An influx of 1,100 persons (300% increase) would create severe difficulties in Healy. Many services would be required--new and perhaps centralized water and sewer services; schools; fire, police, and health facilities; and new and upgraded roads. The state would be responsible for planning, financing, and administering the new services. Cultural difficulties between Native residents and non-Native inmigrants, interference with subsistence activities, and dramatic changes in lifestyle for current residents accustomed to the small-town setting would occur. Economic opportunities might expand, but these would be of more benefit to new developers and inmigrating support workers and their households than to current residents who could not adequately provide the services and skills.

Currently, all coal is shipped from the Usibelli Mine to Fairbanks by rail on 75-ton cars in about 3-1/2 unit trains per month in the summer and about 10 unit trains per month in winter, an average of about 1.8 trains per week. Approximately 2.3 million tons (2.1 million MT) per year would be shipped to the generating units in Nenana. This would bring the number of unit trains to about one (two trips) per day. Using 100-ton cars on 100-car unit trains (the more common size of unit trains in the lower 48 states), the number of unit trains needed would be reduced to about three trains every four days, more in the winter than in the summer, or about three times the current number.

Shipping coal to the Willow units would require about seven unit trains every two weeks if 75-ton cars were used, or about five trains of 100 cars every week, if 100-ton cars were used.

Currently, the Alaska Railroad is only used at 20% of freight capacity. A maximum average increment of about 14 trips per week between the mine and Nenana may not strain the line. Additional trips would be needed to transport equipment needed for mining and for operation of the power plants, and perhaps to transport goods to the greatly expanded populations in Healy and Nenana. More frequent maintenance of the line would be required, particularly in winter.

Each of the three generating units located in Nenana would require about 600 workers two to five years to construct and about 100 persons to operate. If built in succession, at peak construction of the third unit, the work force required would be at a maximum 800 persons. In the worst case, if all construction workers chose to live in Nenana rather than commute from Fairbanks [about 50 mi (80 km) away], population inmigration could reach a first peak of about 2,600 persons, drop off to as low as about 500, increase to a second peak of about 3,100, drop back to about 1,000 residents associated with operation of the two completed units, and increase once again to a final peak of about 3,600 persons, finally dropping to about 1,500 permanent residents related to all three operation work forces.

A population influx in the worst case of about 2,600 persons over only two or three years would cause severe impacts to the community. Population increases related only to the operation work force would still almost triple the size of the town; increases related to peak construction on the third plant (3,600 persons) would total seven times the current population of 470. In Nenana, shortfalls in housing and community and commercial services would occur, and the classic planning and financing "boom-bust" problems discussed in Section 4.1.8 would develop. The state would be responsible for the costs of planning and constructing new services. Native Alaskan culture and subsistence activities in Nenana would be overwhelmed by non-Native activities.

Construction of two units in the Willow area could have substantial impacts, although not as severe as those in Nenana. Peak inmigration of project and support workers and their households could be about 2,600 persons for the first unit, and 3,100 for the second, followed by a total permanent operations population of about 1,000. However, because of the existing support and service operations in the area, inmigration of support-worker-related population might be less, reducing these projections. Willow itself is a very small community, but larger communities--such as Houston, Wasilla, and Palmer--as well as unincorporated residential developments are located within reasonable commuting distance. If a large proportion of the inmigrants chose to reside in Willow, boom-and-bust impacts would be similar to those described in Section 4.1.8. To accommodate half of the influx, Willow would need a school, police and fire stations and staff, health care facilities, improved roads, and between 800 and 1,200 housing units to meet demands during peak construction periods. Mat-Su Borough would be responsible for these public services, and until extra tax revenue were collected, construction to prepare for the growth might present financial difficulties.

Palmer, Wasilla, and Houston would have to expand their service facilities, particularly the smaller Houston, to accommodate the proportions of construction and operation work forces that chose to settle within the boundaries of these communities. However, the scale of growth impacts would be less than those in Willow.

Because of the greater access to natural gas near Tyonek, a large proportion of the ten combustion turbines would be located in that area. Others would probably be located north of Kenai, and near Anchorage. A construction work force of 30 persons for nine months, possibly spread over two summers, would be needed for each unit. No operations work force would be necessary.

Accommodations of work forces for even two or three units built in succession would be minimal in the Anchorage and Kenai areas. For the short construction period, it is likely that a construction camp could be built to house workers for the Tyonek area plants. This would limit impacts to those resulting from use of Tyonek's limited commercial operations by project-related personnel.

4.4.9 Visual Resources

Coal-fired generation plants would produce many of the same visual resource impacts as discussed in Section 4.3.9. Furthermore, each plant would require additional plant structures, coal unloading facilities, reserve coal piles, and waste disposal areas. The stack at each plant would be between 400 and 500 ft (120-150 m) high and very visible from nearby areas. Depending on atmospheric conditions, the visible plume emanating from the stack would vary from being nonexistent to several hundred feet long during the summer and up to 1 mi (1.6 km) long during the winter. Visibility downwind from the plant would be adversely impacted by haze layers created from stack emissions. Additional visual impacts might occur as the result of strip mining of coal to fuel a plant.

In particular, the five 200-MW coal-fired units (three in Nenana and two in Willow) would probably be visually obtrusive in relation to their surrounding environment and because of their proximity to scenic highways, waterways, and recreation areas. Because of the proximity of Denali National Park and Preserve and other scenic resources, the visual resources of the Nenana area would be significantly impacted by the operation of three 200-MW coal-fired units. The residential and recreational areas surrounding the Willow area would also be adversely impacted by views of plant facilities and the associated haze layer created by the operation of two 200-MW coal-fired units.

4.4.10 Cultural Resources

Impacts to cultural resources in the designated locations for units that would be developed under this scenario would probably be limited. Most impacts to significant sites would probably be mitigable by avoidance and protection (through monitoring). Site-specific surveys and significance assessments would be necessary to determine the extent of needed mitigation.

4.5 COMBINED HYDRO-THERMAL GENERATION SCENARIO

4.5.1 Land Resources

4.5.1.1 Geology and Soils

Generally, impacts related to development of the non-Susitna hydropower projects would be similar in nature to those described for the Watana project in Section 4.1.1.1.

Due to the flat terrain in the site area, the Johnson reservoir would inundate 84,000 acres (34,000 ha) and result in the loss of areas of potentially good agricultural soils. The unconsolidated deposits and areas of permafrost on the low slopes surrounding the reservoir might be susceptible to flow and slump failures. Beach erosion would be expected to be extensive.

Slumping and slope failure would be expected in the glacial deposits forming the shoreline of the Keetna reservoir. Impacts of permafrost thaw would also be possible at this site. No agricultural soils or mineral resources would be lost by reservoir inundation.

The small areal extent (2,600 acres, or 1,050 ha) of the Snow reservoir and its location in a bedrock gorge would minimize both the length of shoreline subject to erosion and the potential for slope failures. Soils that would be flooded by the reservoir are agriculturally unsuitable. No known mineral resources would be inundated, although there are numerous mineral claims northeast of the area.

In the area of the Browne alternative, extensive slope failure and beach erosion might be expected to occur in the soft Tertiary sedimentary rock and unconsolidated deposits present throughout the reservoir area. Permafrost thaw impacts would also be probable in this area. Areas of agriculturally suitable lands and subbituminous coal reserves of the Nenana coal field would be inundated by the Browne reservoir, although the magnitude of these losses cannot be determined at this time.

No additional areas would be inundated through the use of the existing Lake Chakachamna. Changes in the rates of lake drawdown for this power generation plan might affect slope stabilities along the lake shoreline, however. Reactivation of the Mt. Spurr volcano could jeopardize the power facility, but failure of the lake would not be made more or less likely by the development of the lake-tap for the power plant.

Impacts that would be expected for the thermal units that would be constructed under this scenario have been outlined in Sections 4.3.1.1 and 4.4.1.1.

4.5.1.2 Land Use and Ownership

In general, land use impacts at the various alternative dam sites under the hydropower portion of the combined hydro-thermal scenario would be similar in nature to those discussed in Sec. 4.1.1.2. These dams would inundate about 102,000 acres (41,300 ha) of land; additional land would be required for access routes, power transmission rights-of-way, borrow areas, and support facilities. In particular, the Browne project would inundate 10,640 acres (4,310 ha), including portions of the existing George Parks Highway and Alaska Railroad. Development of the Johnson site would result in inundation of 84,000 acres (34,000 ha), including a portion of the Alaska Highway (Route 2) and an aboveground pipeline. Land use impacts would be minimal at the Chakachamna site since no dam and associated reservoir would be required. Land use impacts of the thermal (coal and gas) portion of the combined hydro-thermal scenario were discussed in Sections 4.3.1.2 and 4.4.1.2.

4.5.2 Climate, Air Quality, Noise

The thermal portion of this generation scenario has been discussed previously (Sec. 4.1.2, 4.2.2, 4.3.2, and 4.4.2). The impacts of the non-Susitna alternatives would parallel those of the Susitna development alternatives. Depending upon the extent of site boundaries for construction and operation of Johnson, Keetna, Snow, and Browne, fugitive emission and noise impacts might extend beyond those boundaries. No noise impacts would be expected if no noise-sensitive areas were within 0.5 to 1.5 mi (0.8 to 2.4 km) of the plant sites.

Fogging and icing effects at the 84,000-acre (34,000-ha) impoundment at the Johnson site might occasionally extend beyond the reservoir. However, such effects should be confined to within 150 ft (45 m) of the shoreline.

4.5.3 Water Quantity and Quality

Impacts on surface water resources from the natural-gas-fired and coal-fired thermal generating facilities are discussed in Sections 4.3.3 and 4.4.3. Impacts to surface water resources from the five non-Susitna hydropower projects would range from minor at the Snow site to major at Lake Chakachamna.

At the Snow site, natural streamflow would be diverted out of the original channel to a powerhouse on Kenai Lake. Approximately 8 mi (13 km) of the Snow River would be dewatered, the lower 4 mi (6.5 km) of which would parallel Highway 9 and the Alaska Railroad before entering the southern end of Kenai Lake.

The Johnson and Browne sites would involve construction of large mainstem reservoirs on the Tanana and Nenana rivers north of the Alaska Range. The maximum storage volume of Johnson reservoir would be 65,000 ac-ft (80 million m^3); the volume of Browne reservoir has not been determined. The Keetna hydro project would include construction of a dam and mainstem reservoir, with an estimated reservoir capacity of 1 million ac-ft (1 billion m^3) on the Talkeetna River.

The Chakachamna hydro project would involve the most severe hydrologic modifications of all the non-Susitna hydropower alternatives. It would affect two large river systems: (1) the Chakachatna River, which drains Lake Chakachamna, and (2) all the McArthur River, on which the powerhouse would be located. The natural flow regime of the lower 15 mi (24 km) of the Chakachatna River would be significantly reduced as the outflows from Lake Chakachamna were diverted into the McArthur River powerhouse. Daily outflows from Lake Chakachamna ranged from 10,500 cfs (300 m^3/s) in September 1982 to less than 600 cfs (17 m^3/s) in March and April 1983. Flows in the McArthur River for the same period ranged between 1,500 cfs (42 m^3/s) in September and 29 cfs (1 m^3/s) in March. A maximum of 7,200 cfs (204 m^3/s) would be diverted out of the Chakachatna River into the McArthur River. Fish passage facilities are planned to transport salmon up to Lake Chakachamna. The proposed minimum release through these facilities would be 343 cfs (10 m^3/s).

The potential impacts of these five hydropower alternatives on surface water quality are similar to those for the Susitna project described in Section 3.1.3. These include (1) changes in the suspended solid and turbidity regimes downstream of the projects, resulting from construction activities and from the retention and release of suspended solids retained within the reservoir, (2) changes in the thermal regime of receiving waters downstream of the project, and (3) supersaturation of water due to entrainment of air at discharges. Temporal changes in turbidity regimes, similar to those predicted for the Susitna project (Sec. 3.1.3.2), would occur at the hydropower sites, particularly those at which glacial flour dominates the suspended solid load (e.g., Browne, Johnson, Chakachmna). The Chakachmna project would result in temporal changes in the suspended solid load in the McArthur River from the diversion of water from Lake Chakachamna, with the concentration increasing during the fall-winter period and decreasing during the spring-summer period relative to preproject levels. Similar temporal changes in suspended solid concentrations would occur for the other hydropower alternatives. Although the magnitude of such changes cannot be estimated without information on the predicted reservoir hydrology and on water quality in the existing environment, adverse impacts on water quality from changes in the concentration of suspended solids would not be anticipated for any of the hydropower alternatives.

Nitrogen supersaturation at high-head dams can be prevented with appropriate design and mitigative measures. It is assumed that such measures would be implemented and that nitrogen supersaturation in excess of the Alaska water quality statute (110% of saturation) would not occur downstream of these alternative hydropower sites.

No major changes in ice processes would be expected at the Snow hydropower site. Changes in ice processes would be expected in the Chakachatna River and the McArthur River as a result of flow diversions associated with Chakachamna project operations. Changes in downstream flows resulting from the operation of the Johnson, Browne, and Keetna hydro facilities could produce changes in ice processes in the Tanana, Nenana, and Talkeetna rivers.

Relative to thermal conditions, the Snow project would not impound any water and, therefore, upstream of the diversion point the Snow River would maintain preproject conditions. The 8-mi (13-km) reach of the Snow River from the diversion point to Kenai Lake would be dewatered. Water diverted from the river could produce local and minor temperature changes to Kenai Lake, but would have no impact on the large-scale thermal structure of the lake.

The Chakachamna hydropower project would be expected to have no thermal impacts on Lake Chakachamna; however, the diversion of water from the Chakachatna River to the McArthur River could result in temperature changes to both rivers.

The Johnson, Brown, and Keetna hydro projects would result in the creation of reservoirs on the Tanana, Nenana, and Talkeetna rivers, respectively. In the impounded portion of these rivers, the thermal character would change from free-flowing isothermal to more static, with seasonal vertical thermal structure. Temperature changes would be expected downstream of these dams. The extent of these changes would depend on dam design and operation.

No significant groundwater impacts would be anticipated from any of the non-Susitna hydropower projects.

4.5.4. Aquatic Communities

Whereas the Snow, Browne, and Johnson sites would affect few fisheries resources, the Keetna site (Talkeetna River) and Chakachamna site (Chakachatna River) are important for anadromous salmonids (Sec. 3.5.4). Salmonid runs to the Talkeetna River have been incompletely characterized, but comparisons of data on upstream migrants in the Susitna mainstream at the Sunshine (below the confluence) and the Talkeetna (above) stations indicate numerous fish using either the Talkeetna or Chulitna rivers. Both Keetna and Chakachamna dams would block migrations to upstream spawning areas. These blockages could result in salmon losses greater than those due to the proposed Susitna project. The Chakachamna project has the additional potential to markedly impact anadromous fish downstream as a result of dewatering or decreasing flows in the upper Chakachatna River. There would be some impacts to aquatic life downstream of both projects due to alterations in water quality, changes in the food base, and access to lower river spawning sites under changed flow regimes. Diversion of the Chakachatna River flows to the McArthur River could affect the success of fish in that system through increased flows and altered water quality.

4.5.5 Terrestrial Communities

4.5.5.1 'Plant Communities

Construction of the various dams, impoundments, diversions, lake taps, and associated facilities at the Johnson, Keetna, Snow, Browne, and Chakachamna sites, and the various thermal facilities of the combined hydro-thermal generation scenario would result in the permanent or temporary removal of about 103,000 acres (41,700 ha) of vegetation either with or without Lake Chakachamna. Additional indirect vegetation losses plus damage and alteration of plant communities as a result of construction and operation of these hydropower sites and associated access roads and transmission lines would likely occur and would be similar in type to those impacts described in Section 4.1.5.1. As with the natural-gas- and coal-fired generation scenarios, transmission of power to the Railbelt would require construction and operation of power transmission facilities that could disturb about 9,000 acres (3,640 ha) of vegetation (see Sec. 4.3.5.1). In addition, construction and operation of transmission line stubs to each of the dam sites and thermal units (as described in Secs. 2.3.3 and 2.5.3) could potentially disturb another 4,800 acres (1,940 ha) of vegetation with Lake Chakachamna or another 3,500 acres (1,420 ha) without Lake Chakachamna. Thus, a total of about 12,500 to 13,800 acres (5,060 to 5,580 ha) of vegetation could be disturbed by transmission facilities for this scenario. Impacts to wetlands caused by development of the hydropower sites would be similar to those described in Section 4.1.5.1, but might vary depending on site-specific conditions. Non-transmission related impacts to vegetation from the thermal facilities of this scenario have been described in Sections 4.3.5.1 and 4.4.5.1.

4.5.5.2 Animal Communities

Implementation of either combined hydro-thermal alternative (with or without Chakachamna) would result in inundation of over 115,000 acres (46,500 ha) of habitat, ranging from tundra to forest. The Keetna development would eliminate the salmon runs to Prairie Creek. Loss of this fishery could have a severe impact to brown bear and bald eagle in the upper and middle Susitna Basin. The Chakachamna development could affect brown bear fisheries downstream. Winter range for caribou and moose would be affected by the Browne and Johnson developments. Mountain goat and Dall's sheep might be disturbed by construction activities at the Snow development. Increased accessibility would likely occur at the Keetna, Snow, and Chakachamna sites. Other impacts would be similar in nature to those described for the Susitna development. The magnitude of impacts would vary with size of the development, value of wildlife habitat affected, and numbers of wildlife affected.

4.5.6 Threatened and Endangered Species

No impacts to threatened or endangered species would be expected to occur as a result of construction and operation of facilities in the combined hydro-thermal generation scenario.

4.5.7 Recreation Resources

Development of the Johnson site would preempt an extensive area [84,000 acres (40,000 ha)] currently used for a variety of dispersed recreation activities. Both private and commercial river touring of the Tanana River would be curtailed (Alaska Northwest Publishing, 1983), and a segment of the Alaska Highway--a major tourist route--would be displaced. Impacts on recreation resources of the Keetna alternative would include curtailment of sport fishing for anadromous species in Prairie Creek and the Talkeetna River, inundation of a major trail used primarily for accessing prime hunting and fishing areas, and inundation of significant white-water resources (Alaska Dept. of Natural Resources, 1982). Construction of an impoundment at the Snow site would inundate some developed facilities maintained by the U.S. Forest Service, as well as an area used extensively for dispersed recreation activities. Development at the Browne site would curtail river touring on the Nenana River; inundate 10,640 acres (4,305 ha) used primarily for low-density dispersed recreation; and cause displacement of segments of the George Parks Highway and the Alaska Railroad, which are major tourist routes. Effects on recreation resources associated with the Chakachamna site would be similar to those discussed in Section 4.3.7 with respect to the Beluga and Chuitna river areas. Impacts related to development of a coal-fired plant at Nenana are discussed in Section 4.4.7, and effects of developing gas-fired units in the Chuitna area and near Anchorage are identified in Section 4.3.7.

4.5.8 Socioeconomic Factors

For this analysis, the Staff assumed that construction of the Snow, Browne, and Keetna hydropower plants would require construction periods of four years and work forces of 200 persons; 300 workers would be required for Johnson; and 400 for Chakachamna. The operations work force was assumed to be 10 persons for the smaller plants, 25 for Johnson, and 50 for Chakachamna.

The Johnson hydropower facility would be the first to be built under this scenario. In the most extreme case that no construction camp or onsite housing was provided, the sparsely populated area between Tok and Delta Junction would experience severe impacts during peak construction. A population influx of as many as 1,300 persons during the peak period would almost double the current population of the area (see App. N, Sec. N.2.3.3.1). As many as 400 new households would require temporary or permanent housing. Tok and Delta Junction would receive the majority of the inmigrants. Community services would have to be expanded considerably--at the cost of the state for Tok and of the community for Delta Junction. Boomtown impacts would occur in both communities (see Sec. 4.1.8). Existing commercial operations might be expanded and new ones be opened. However, these benefits might be offset by the decrease in the rural, undeveloped nature of the area and the change in the quality of the setting for current residents.

If construction camps or onsite housing were provided for the construction period, allowing workers to maintain permanent residences elsewhere [e.g., 140 mi (230 km) away in Fairbanks), impacts would be limited to greater demand on commercial operations from workers at the camps. The Native Alaskan communities of Tanacross and Dot Lake might experience cultural conflicts with the inmigrants. Subsistence activities might be interfered with as a result of increased competition for fish and game. Movement into the area by the operations work force of 25 persons and their families could result in 75 new permanent residents near the site. Impacts of this small population would be limited to increased business at existing commercial operations.

The impoundment created by the Johnson dam would inundate a portion of the Alaska Highway. It is assumed that construction of a new segment of the highway around the impoundment would occur concurrently with plant construction, further increasing population inmigration and boom-bust impacts. If the State of Alaska had to bear totally or partially the cost of this construction, this could be a substantial addition to expenditures.

Chakachamna would be the second hydroelectric plant to come on line in the scenario with Chakachamna and would be located in the sparsely populated, Native Alaskan, Tyonek area. The peak work force of 400 would mean a peak population increment of about 2,000 persons (including families and support personnel). The permanent operations work force of 50 persons could result in inmigration of up to about 250 persons (see App. N, Sec. N.2.3.3.2). Impacts to Tyonek would be of types similar to, but at substantially greater levels than, those described in Section 4.3.8.

Sewer and water systems, fire and police protection personnel, and local medical facilities would have to be added, and the school would have to be expanded by 50%, at least for the period of construction. Planning and construction of the services would be funded by the Kenai Peninsula Borough. Native Alaskan culture and subsistence activities would be interfered with if not dominated by the lifestyle of the inmigrants. Commercial operations would also expand and diversify. If project developers chose to establish workforce camps or a temporary community near the site and distant from Tyonek for construction and operation, impacts to Tyonek would be reduced to expansion of commercial operations and interference with culture and subsistence activities. Permits from the Tyonek Native Corporation to construct roads to the site might be difficult to acquire.

Construction and operation of the Snow hydropower plant would affect the Eastern Kenai Peninsula and the City of Seward. Inmigration at the construction peak would be about 900 persons, or a 25% increase over the 1982 population of the Eastern Peninsula. Some Seward residents might be hired to work on the project, possibly commuting from their residences in Seward, thus reducing the high unemployment there. Up to 300 new permanent or temporary housing units would have to be provided; sewer, water, and other community services expanded; and additional school staff hired at City of Seward expense. Traffic volume on transportation routes in the Eastern Peninsula would increase with project-related travel and deliveries.

If workers chose to live near the site, housing would be needed. Individual wells and septic tanks might suffice for water and sewer services, but schools, fire and police protection, and health facilities would have to be added at the expense of the Kenai Peninsula Borough. The small operations work force necessary would have negligible impacts on the area.

The Browne hydropower plant would cause impacts on Healy and Nenana similar to, although at a lesser scale and over a shorter time period than, those from the coal-fired alternative (Sec. 4.4.8). The Keetna plant would cause impacts in Talkeetna and Trapper Creek of a type similar to (but of a lesser magnitude and for a shorter period) than those projected for the proposed project (Sec. 4.1.8). In the scenario without Chakachamna, the effects would occur separately because construction periods would be ten years apart. However, with Chakachamna, the two plants would be constructed concurrently, and impacts might be increased and spread beyond these communities because of overlapping project-related demands.

4.5.9 Visual Resources

Visual resource impacts at the various non-Susitna hydropower and thermal generation scenario sites would be similar to those discussed in previous visual resource impact sections (Secs. 4.1.9 through 4.4.9). In particular, the Browne site would detract from the visual resources of the Nenana River valley. Two scenic areas, Sentinel Rock and Granite Gorge, would be inundated at the Keetna site. Although the Snow and Johnson sites would not impact any designated scenic areas, their development would result in the presence of man-made facilities in an area of high aesthetic quality and essentially natural, undisturbed areas. Long-term visual impacts at the Chakachamna site would be minimal since no dam structure would be constructed.

4.5.10 Cultural Resources

Development of the combined hydro-thermal generation scenario would probably have a number of impacts (direct, indirect, and potential) on significant cultural resource sites. The Browne dam location contains at least two known cultural resource sites that would be directly impacted and over a dozen other sites that would be indirectly or potentially impacted by the construction of a dam and reservoir. Further survey would almost certainly produce numerous additional sites. It seems likely that many of these sites would be termed significant. Although no sites are currently known at the remaining designated dam sites and reservoir areas, surveys would probably yield significant sites in direct and indirect impact areas of the Johnson site, and possibly others as well. Most impacts to significant sites would probably be mitigable by investigation and avoidance. Site-specific surveys and significance assessments would be necessary in all areas that would be affected under this scenario in order to determine the extent of needed mitigation.

4.6. NO-ACTION ALTERNATIVE

From the viewpoint of FERC, the no-action alternative amounts to denial of a license to construct and operate the Susitna Hydroelectric Project as proposed. The Applicant would need, then, to implement alternative methods for meeting load-growth requirements. These alternatives could include power generation scenarios as discussed in Sections 4.2 through 4.5, other conventional centralized sources of power generation, non-conventional centralized sources of power generation, dispersed sources of energy, efforts to limit power consumption and reduce demands, or no further effort to keep up with load growth.

Unless alternative Susitna developments were adopted, environmental impacts to the upper and middle Susitna Basin would be avoided by these alternatives to the proposed action. The environment of the basin would continue to maintain the baseline status outlined in Section 3.1. Factors other than power generation would continue to affect the environment of the basin, but the larger, stepwise effect of reservoir development would be avoided.

Adoption of alternative power sources would have potential for impacting the environment of the Railbelt and adjoining regions. Some of these impacts are discussed in Sections 4.3 through 4.5. The nature and magnitude of impacts would vary with location, type of facility, and extent of the facilities required for power generation. Coal-fired facilities would require large acreages for coal mining and waste disposal whereas natural-gas facilities would not. Tidal power development could affect oceanographic dynamics in Cook Inlet, altering fisheries resources. Reliance on dispersed use of diesel or wood fuels could have serious impacts on local air quality, particularly in the urban centers of Anchorage and Fairbanks. Even conservation efforts to limit energy use could have impacts to the socioeconomic development of Alaska. Specific discussion of impacts cannot be undertaken until specific no-action alternatives are proposed.

4.7 COMPARISON OF ALTERNATIVES

4.7.1 Land Resources

4.7.1.1 Geology and Soils

Each of the alternative Susitna dam configurations considered would inundate less land than the proposed Susitna project. From a geologic and soils perspective, however, the increased area that would be flooded by the proposed project is insignificant, as neither unique nor valuable mineral or soils resources would be inundated by either the proposed or alternative developments. The total areas that would be affected by reservoir slope instabilities could be similar for the proposed and alternative projects. Detailed geotechnical evaluations would be required to substantiate this conclusion, however.

Although the alternative access routes would not cross the potentially erodable and permafrost-rich area between the Denali Highway and the Watana dam site, the alternative access routes would cross areas of more rugged and erodable terrain between the dam sites and Hurricane and/or Gold Creek.

In the Willow-to-Anchorage segment, the proposed transmission route and Corridor AEFC (Fig. 2-16) would have similar impacts. Corridor ABC', although almost twice as long as the proposed route, would follow existing right-of-ways, and access route construction impacts might be less for Corridor ABC' than the proposed route. Between Gold Creek and the dam sites, the proposed route would cross less rugged topography than the alternative routes. The transmission line route also would parallel the access route, thereby reducing access route requirements and related impacts. In the Healy-to-Fairbanks segment, the proposed route (unlike the other alternative routes) would follow existing rights-of-way, thereby minimizing impacts.

The gas-fired and coal-fired generation scenarios would disturb insignificant amounts of land relative to the proposed project. With proper construction practices, the erosion losses related to power unit construction would be minimal for these scenarios and would be insignificant in comparison to the proposed alternative. Although no known mineral resources would be impacted by the proposed project, these alternative scenarios would require substantial consumptive use of regional natural gas or coal reserves. Siting of the gas- or coal-fired units might impact very small areas of agriculturally suitable land. No such impacts would be expected for the proposed project.

Under the combined hydro-thermal generation scenario, the development of the various reservoirs would have varying advantages and disadvantages over the proposed project. The Johnson project would inundate twice the area of the proposed project. Much smaller areas of land would be inundated by the Snow, Browne, and Keetna alternatives, and no land would be inundated by the Chakachamna alternative. Unlike the proposed project, varying amounts of potentially suitable agricultural land might be inundated or disturbed by the Johnson and Browne alternatives. Reservoir slope failures might be expected to be greater than the proposed project for the Johnson alternative, and significantly less for the Snow and the Chakachamna alternatives. Permafrost-thaw impacts would be expected for those alternatives outside the Cook Inlet lowland. Some subbituminous coal reserves of the Nenana coal field might be inundated by the Browne reservoir. No known mineral resources would be impacted by the other alternatives or the proposed project. The fewest geologically related construction impacts would be associated with the Chakachamna alternative, although this alternative would have the greatest geologic hazard risk due to the proximity of the active Mt. Spurr volcano. The seismic risk for all alternatives might be expected to be similar to the that of the proposed project.

4.7.1.2 Land Use and Ownership

In general, the construction and operation of the Susitna development alternatives and use of alternative access routes, transmission lines, and borrow areas would result in similar types of land use impacts as discussed for the proposed project in Section 4.1.1.2. In particular, the access route alternatives would promote greater land use activity and development between the dam sites and Hurricane (located along the George Parks Highway) and in the Gold Creek area. Several of the Healy-to-Fairbanks transmission line alternatives would impact the Healy Creek, Wood River, and open flat land areas south of Fairbanks. Alternative AEF (Fig. 2-16) would extend across the Blair Lake Air Force bombing range. Several transmission line alternative routes in the upper and middle Susitna River Basin would adversely impact natural and recreation lands within or near the Chulitna Mountains and the Denali Highway area used by recreationists for scenic road touring (see also Sec. 4.7.7). In the Willow-to-Anchorage transmission line corridor area, several of the alternative route segments would impact residential and recreational areas (e.g., Palmer, Nancy Lake State Recreation Area). All of the above-mentioned transmission line segments would result in greater impacts to land use than the proposed transmission line route.

Regarding the various alternative power generation scenarios, the natural-gas-fired generation scenario would require the least amount of land and would have fewer direct land use impacts than the proposed project, the coal-fired generation scenario, or the combined hydro-thermal generating scenario. The alternative coal-fired plants that would be located at Nenana and Willow could adversely impact the surrounding residential and recreational land use. The combined hydro-thermal generation scenario would require the greatest amount of acreage for project facilities. Additionally, the Browne and Johnson sites would significantly impact transportation and utility corridors by inundating portions of the George Parks and Alaska highways and a petroleum products pipeline.

4.7.2 Climate, Air Quality, Noise

The proposed Susitna project has only one air quality impact of significance: fugitive dust emissions during construction. Left uncontrolled, the TSP concentrations outside the site boundary might exceed Alaska ambient air quality standards. Mitigative measures such as sprinkling of water or the use of chemical stabilizing agents might be applied. All air quality impacts of the Susitna project would be limited to the vicinity of the dam and town sites.

Impacts of the coal-fired generation scenario would depend on the number and location of 200-MW generating units. All combinations of one and two 200-MW units sited at Willow or Nenana would satisfy Alaska ambient air quality standards and PSD regulations for Class I and Class II areas. The siting of three, four, or five 200-MW units at Nenana would almost certainly lead to periodic significant impairment of visibility at the nearest Class I area, Denali National Park. The implementation of NO_x control technology or the siting of only two units at Nenana (and three at Willow) are reasonable alternatives for consideration. In addition to visibility degradation, operation of three, four, or five units at Nenana also would lead to exceedences of the PSD Class II increments for SO_2 (24-hr averaged concentrations) at elevated terrain 5 mi (8 km) northeast of the plant. Also exceeded would be PSD Class I increments for SO_2 (24-hr averaged concentrations) for four and five units at Nenana. Additional SO_2 scrubbing beyond the mandatory 70% reduction could result in acceptability of these three, four, or five units at Nenana. Further analysis is required, however.

For the eight combined-cycle gas units proposed for the natural-gas-fired scenario, all applicable standards should be satisfied (Alaska ambient air quality and PSD regulations). NO_x is the only pollutant with significant emission rates. The stack heights would only be 65 ft (20 m) for these plants (two stacks per unit); however, plume rise would be very high due to elevated plume exit temperatures. As a result, plume impact with the ground would be delayed, leading to very low concentrations when ground impact did occur.

The 70-MW gas turbines proposed in all alternative generating scenarios would have very low pollutant release levels; their air quality impacts would be effectively nil.

Noise impacts for all alternatives would be negligible provided that the coal- and gas-fired plants were sited 0.5 to 1.5 mi (1 to 2 km) away from noise-sensitive areas.

In terms of air quality impacts, the Susitna proposed project, Susitna development alternatives, and out-of-basin hydro alternatives would provide the least climate, air quality, and noise impacts. The coal-generation scenario would provide the greatest impact. However, all alternatives would provide acceptable impacts (in terms of regulatory standards) except for the scenario with three, four, or five coal-fired plants at Nenana. These latter coal-fired scenarios in their present form are unlikely to be acceptable to the U.S. Environmental Protection Agency, the Alaska Department of Environmental Conservation, and the National Park Service. Climatic impacts would be negligible for all alternatives considered.

4.7.3 Water Quantity and Quality

Impacts to water quantity and quality resulting from the Susitna project hydro alternatives would be similar to those projected for the proposed action. Total impacts would likely be a function of the size of the action, with smaller projects anticipated to have smaller impacts. Access impacts would likely be similar for any in-basin alternative. Based on the size of the projects and the areas affected, the order of severity--from greatest to least--among the in-basin alternatives would be as follows: Proposed project, Watana I-Devil Canyon, Watana I-Modified High Devil Canyon, and Watana I-Reregulating dam.

The thermal alternatives would involve little or no water quality impacts, with only minor water consumption. Water quality changes due to coal mining and gas extraction are a function of controls employed, and are not presently a problem in Alaska.

The non-Susitna hydropower alternatives would involve modifications to rivers. The Snow project would result in relatively small changes, but the Chakachamna project would reroute a river, with large changes in flows and temperatures in both the Chakachatna and McArthur rivers. The Keetna project would strongly modify the Talkeetna River, while the Johnson dam would affect the Tanana River, and the Browne project would modify the Nenana River. The Chakachamna project would have greater impacts than the proposed project, whereas the Johnson, Browne, and Keetna projects would have impacts similar to but smaller than the proposed action. The water quantity and quality impacts of the Snow project would be significantly less than the proposed project or any Susitna basin development studied.

4.7.4 Aquatic Communities

Because it would increase the accessibility of the streams and lakes north of the Susitna River that are presently not readily accessible to large numbers of people, the proposed access plan would likely have the greatest aquatic resource impacts of all the access plans examined. The access alternative that would have the least impacts to aquatic resources would be rail and road access from Gold Creek to the Watana site. Under this alternative, fewer stream miles would be made readily available and access control would be more easily accomplished.

Susitna development alternatives would result in impacts similar to those of the proposed project, but on a smaller scale. The impacts for the development alternatives would be less because of reduced reservoir surface area, which would affect less tributary and mainstem habitat in the impounded reach, and because of reduced storage volume, which would result in decreased flow and temperature alterations from the present situation. Access impacts would be similar for any of the Susitna Basin developments, and would be a function of the controls placed on access by the Applicant and the regulatory agencies.

Based on the size of the projects and the areas affected, the order of severity--from greatest to least--among the Susitna alternatives would be as follows: Proposed project, Watana I-Devil Canyon, Watana I-Modified High Devil Canyon, and Watana I-Reregulating dam.

The nature and magnitude of aquatic impacts of the thermal alternatives would depend on the exact location of the project and the design and operation of the facilities. In the general locations selected for analysis, the likely aquatic impacts would be trivial. Consumptive use of water is assumed to be small for the combustion facilities, and no major thermal or chemical impacts should occur. Construction impacts could be successfully minimized, and access to presently unused areas would be a function of the actual locations chosen for the facilities and the transmission routes. The aquatic impacts of coal development and gas extraction are not presently severe in Alaska, and careful development could ensure that impacts remained small.

Because of the species affected, the non-Susitna hydropower alternatives would likely have smaller aquatic impacts than the Susitna Basin development alternatives, with two exceptions. The Keetna dam would intercept salmon migrations on the Talkeetna River, which could be a function of facility design. On the assumption that the impacts on the sockeye salmon run could not be averted, impacts at Chakachamna would exceed those of the Susitna alternatives, including the proposed project. Impacts at the Snow site would likely be small, due to the species present and the project envisioned at the site. Because of the fisheries affected, the impacts of the Johnson and Browne developments would likely be smaller than the Susitna alternatives. The design and operation of the alternative projects would have a major effect on the nature and magnitude of aquatic impacts.

4.7.5 Terrestrial Communities

4.7.5.1 Plant Communities

Comparison of the access alternatives (see Sec. 2.2.2.4 and Fig. 2-13) indicates that the proposed route would be the longest and would, therefore, disturb more vegetation. The proposed route would also disturb more potential wetland area than the two alternatives. The Applicant has indicated, however, that wetlands between Hurricane and Indian River in both the northern and southern alternative routes would have a relatively high potential for causing drainage alterations and might cause excessive settlement of the road in some areas (Exhibit E, Vol. 9, Chap. 10, Suppl. Information, June 30, 1983, pp. 10-15-1 and 10-15-2). The Applicant also indicated that the proposed Denali Highway-to-Watana route does not have any wetland areas with as high a potential for drainage alterations. However, the proposed route could provide increased access to greater land areas than either of the alternatives, thereby increasing the potential for increased human-use impacts to vegetation unless measures were taken to limit or prevent use of the access roads after construction of the project was completed.

A comparison of the alternative power transmission routes (see Figs. 2-14 to 2-16) indicates that the proposed routes would cross neither the most nor the least vegetation. However, in most cases, the proposed corridors would cross less forest and tall shrub communities (which would be subject to the greatest disturbance due to their overstory layer heights) and less potential wetlands than would the alternatives. The exceptions to this are alternatives ABDC in the northern study area (forest and tall shrubland), ABC' in the southern study area (wetlands), and AJCF in the central study area (both).

Relative to impacts to vegetation, alternative borrow areas (see Figs. 2-2 and 2-6) that would be inundated by the impoundments would have the least additional effects. Those borrow areas sited along the banks of otherwise undisturbed creeks might present more difficulties in rehabilitation. Depending upon the depth of the sites and provisions made for regrading steep slopes, quarry sites A, B, K, and L might be more difficult to rehabilitate than borrow sites C, D, E, F, G, H, I, and J.

A comparison of the impacts to vegetation for the various alternative power generation scenarios (including the Susitna project as proposed and the alternative Susitna developments) is presented in Table 4-12. This comparison indicates that the alternative Susitna developments would remove or disturb less vegetated area (about 82% to 88%) than would the proposed project. However, the natural-gas-fired and coal-fired generation scenarios would have the least effects on vegetation. Vegetation removed or disturbed by the natural-gas-fired and coal-fired scenarios would be about 16% and 22%, respectively, of the vegetated area that would be affected by the proposed project. Furthermore, each of these thermal scenarios would have fewer indirect effects on vegetation than would any of the alternative scenarios with hydropower sites. Due to the very large impoundment area estimated for the Johnson site [84,000 acres (34,000 ha)], the combined hydro-thermal scenario would probably disturb over twice as much vegetated area [more than 115,000 acres (46,500 ha)] as the proposed Susitna project.

4.7.5.2 Animal Communities

Differences among alternative borrow areas are only substantive for those that would not be inundated by reservoir filling--areas C, F, H, and K (Figs. 2-2 and 2-6). Alternative transmission line routes are all longer than the proposed routes, and a few cross more sensitive wildlife habitat (Figs. 2-14 to 2-16). The access alternative with least impacts to wildlife would be rail/road access from Gold Creek to Watana, south of the Susitna below Devil Canyon and north of the Susitna above Devil Canyon (Fig. 2-13). This route would avoid the sensitive Stephan Lake area, avoid the movement pathway of the Nenana-Upper Susitna caribou, and maintain more restricted access than is now proposed.

Alternative power generation configurations differ substantively in impacts. On the basis of amount of habitat lost, the combined hydro-thermal alternative is the least desirable for wildlife considerations; this alternative would affect twice the amount of habitat that would be affected by the proposed project. However, the value of the affected habitat might be lower for the combined configuration; although the Keetna development would eliminate the fisheries of the Prairie Creek area, which are used by brown bear.

The thermal alternatives would affect fewer wildlife resources than would any of the hydropower alternatives or the proposed project. Natural-gas configurations would affect about six to twelve times fewer acres of wildlife habitat, and coal-fired configurations would affect about five to ten times less acreage than hydropower developments (Table 4-13). For the most part, these alternatives would be developed in habitats of low sensitivity or affect only a small fraction of sensitive habitat. Additionally, thermal developments would generally occur in areas with some degree of existing human development.

The natural-gas configuration would be more compatible with wildlife management goals because far less land would be required than for other alternatives.

4.7.6 <u>Threatened and Endangered Species</u>

Since no impacts to threatened or endangered species would be expected to occur as a result of construction and operation of the proposed Susitna project or any alternatives, potential impacts to threatened and endangered species have no bearing on a comparison of alternatives.

4.7.7 <u>Recreation Resources</u>

Effects on recreation resources associated with the Watana I-Devil Canyon and Watana I-Modified High Devil Canyon alternatives would be essentially similar, but development of the Watana I-Reregulating dam alternative would result in significantly less area being withdrawn from dispersed recreation use. Also, this alternative would result in curtailment of free flow in the Devil Canyon rapids, but the rapids would not be inundated as would be the case for the two other alternatives. In comparison, the proposed impoundments would entail preemption of more land area than would be required for any of the aforementioned alternatives (Table 4-12), and the Devil Canyon white-water run would be inundated. No meaningful differences in impacts on public recreation resources would result from selecting between the proposed and alternative access routes or borrow areas. However, the proposed access route would pass within 1 mi (1.6 km) of the High Lake Lodge.

Selecting among the four alternatives considered in the final phase of route selection (including the proposed route) for the Dams-to-Gold Creek transmission lines would not differ with respect to impacts on recreation resources, with the following exceptions. Transmission

Table 4-12. Comparison of Estimated Quantifiable and Unquantifiable Disturbance to Vegetation Among the Power Generation Scenarios

Scenario	Permanent or Long-Term Vegetation Removal (acres)		Temporary Vegetation Removal (acres)†[1]	Vegetated Area Disturbed by Transmission Facilities (acres)†[2]	Total Quantifiable Vegetated Area Disturbed (acres)	Potential Unquantifiable Indirect Effects to Vegetation†[3]
	Dams, Impoundments, Construction of Permanent Facilities	Access	Temporary Facilities, Borrow Areas, Waste Disposal, Mining			
Proposed Susitna Project						
Watana-Devil Canyon	36,900	1,100	6,400	11,700	56,100	A,B,C,D,E,F,G,H
Alternative Susitna Developments						
Watana I-Devil Canyon	29,900	1,100	6,400	11,700	49,100	A,B,C,D,E,F,G,H
Watana I-Reregulating Dam	27,000	1,100	6,400	11,700	46,200	A,B,C,D,E,F,G,H
Watana I-Modified High Devil Canyon	29,100	1,100	6,400	11,700	48,300	A,B,C,D,E,F,G,H
Natural-Gas-Fired	50	N.D.†[4]	N.A.†[5]	9,000+	9,050+†[6]	A,B,C,F
Coal-Fired	600	N.D.	2,475	9,000+	12,075+	A,B,C,F,G,H
Combined Hydro-Thermal						
Johnson, Keetna, Snow, Browne, Chakachamna	102,040	N.D.	N.D.	13,600	115,640+	
Thermal Units	230	N.D.	495	200+	925+	
Total	102,270	N.D.	495+	13,800+	116,565+	A,B,C,D,E,F,G,H
Johnson, Keetna, Snow, Browne	102,040	N.D.	N.D.	12,300	114,340+	
Thermal Units	235	N.D.	495	200+	930+	
Total	102,275	N.D.	495+	12,500+	115,270+	A,B,C,D,E,F,G,H

†[1] The use of the word temporary implies that the area would eventually be rehabilitated.

†[2] For natural-gas-fired, coal-fired, and combined hydro-thermal scenarios, assumes (1) construction of two 345 kV lines from Willow to Anchorage and from Healy to Fairbanks and (2) upgrading of existing intertie between Healy and Willow to two 345 kV lines as well as construction of lines described in Sections 2.3.3 and 2.5.3 to the various dam sites and thermal units.

†[3] Caused by: A = erosion, slumpage, or permafrost thaw; B = alteration of drainage patterns; C = fugitive dusting; D = climatic changes; E = downstream flow changes; F = increased human use or access; G = potential for seepage from waste disposal areas, H = slight potential for air pollutant effects.

†[4] N.D. = Not determined.

†[5] N.A. = Not applicable.

†[6] "+" indicates an additional undeterminable acreage; these amounts would likely be higher for hydropower sites than for thermal sites due to greater constraints on siting.

Conversion: To convert acres to hectares, multiply by 0.405.

Table 4-13. Relative Potential for Impacts to Wildlife as a Result of Alternative Generation Scenarios

Scenario	Habitat Loss (acres)	Moose	Caribou	Brown Bear	Black Bear	Furbearers	Raptors	Waterbirds	Human Use
Susitna Hydroelectric Project	64,000	High	Moderate-High	Moderate	High	Low	Moderate	Low	High
Watana I-Devil Canyon	55,000	High	Moderate-High	Moderate	High	Low	Moderate	Low	High
Watana I-Mod. High Devil Cyn.	54,000	High	Moderate-High	Moderate	High	Low	Moderate	Low	High
Watana I-Reregulating Dam	52,000	High	Moderate-High	Moderate	High	Low	Moderate	Low	High
Natural-Gas Generation	9,000	Low	None	Low	Low	Low	Low	Low	Low
Coal Generation	12,000	Low-Moderate	Low	Low	Low	Low	Low-Moderate	Moderate	Low
Combined Hydro-Thermal w/o Chakachamna	115,000	Moderate	Low	High	Low	NO	NO	Low	Low-Moderate
Combined Hydro-Thermal w/ Chakachamna	116,000	Moderate	Low	High	Low	NO	NO	Low	Low-Moderate

Conversion: To convert acres to hectares, multiply by 0.405.

facilities constructed within the alternative corridor that traverses the Susitna River near the Watana dam site would be observable from private recreation developments in the Stephan and Fog Lakes areas, and the proposed corridor would pass within 2 mi (3.2 km) of High Lake Lodge. The proposed and alternative corridors for the Healy-Fairbanks transmission line traverse remote areas and recreation use patterns are characterized by low-density dispersed recreation. Overall, the shorter of the three alternatives would likely result in the least impacts on recreation resources. Of the two alternative corridors for the Willow-Anchorage lines, the Willow-Pt. MacKenzie corridor segment traverses some sensitive areas, including Nancy Lake State Recreation Area. However, the other alternative also traverses sensitive sites in the Palmer area and is almost twice the length of the Willow-Pt. MacKenzie segment. The proposed Willow-to-Pt. MacKenzie corridor segment bypasses Nancy Lake State Recreation Area and traverses fewer sensitive areas than the Willow-to-Pt. MacKenzie alternative.

In comparisons among alternative generation scenarios, the gas-fired alternatives would appear more compatible with existing recreation patterns. The relatively innocuous emissions and minor area requirements [about 5 acres (2 ha)] of individual gas-fired generation units would allow considerable flexibility in siting facilities to avoid sensitive areas with high intrinsic recreation potential. Although more extensive, the area requirements for the coal-fired scenario are also relatively modest. An estimated 600 acres (240 ha) would be required for developing all generating facilities related to the coal-fired scenario (Table 4-12). Mining and waste disposal activities would result in additional disturbed areas, but to some extent, the recreation potential of such areas would be restored by reclamation (Sec. 2.6.5.1). The coal-fired generation units located at Nenana would be within an area characterized by low-density, dispersed recreation, as opposed to the coal-fired facilities at Willow, where participation levels in recreation activities are relatively high. The intensity of impacts on recreation resources would vary depending on the actual siting of the coal-fired generation plants; however, the total area affected by the coal-fired scenario would be markedly less than that for the proposed project wherein more than 64,000 acres (26,200 ha) of land and water would be preempted for energy production (Exhibit A, Vol. 1, Secs. 1.1 and 7.1).

The combined hydro-thermal generation scenario would entail inundation of significantly more land area than for the proposed project. Development of the Johnson River site would preempt a large area [84,000 acres (34,000 ha)] that currently supports a wide variety of dispersed recreation use. The Snow and Keetna impoundments would inundate relatively small areas; however, recreation use levels are comparatively high. Additionally, the Talkeetna River (including the Keetna site) has been proposed for state recreation river status. Recreation use levels in the vicinity of the Browne site are relatively low, but development of the site would inundate an estimated 10,640 acres (4,300 ha), as well as segments of the George Parks Highway and the Alaska Railroad, which are major tourist routes. Development also would disrupt touring of the Nenana River.

4.7.8 Socioeconomic Factors

Construction and operation of Susitna development alternatives would have socioeconomic impacts generally similar in nature and magnitude to those of the proposed project. The small communities of Trapper Creek, Talkeetna, and Cantwell would be the locations affected most by these hydropower alternatives. The Susitna Basin alternatives also would have greater socioeconomic impacts than the non-Susitna Basin alternatives because the former would require larger construction work forces for longer periods than would the other alternatives. Thus, boom-and-bust phenomena would be greater for the communities near the sites of the Susitna Basin alternatives.

Each alternative access route would increase accessibility to a different section of the project area, thus increasing possibilities for recreational, tourist, and commercial uses of the area. Additionally, the northern access route alternative would cause growth in Hurricane, and the southern alternative would cause growth in Gold Creek. Both settlements are currently very small and would experience boomtown types of impacts. Thus, the alternative access routes are comparable in terms of socioeconomic impacts.

Each alternative power transmission route would have essentially comparable socioeconomic impacts. The alternative borrow sites would have negligible socioeconomic impacts.

The coal-fired and natural-gas-fired generation scenarios each would have socioeconomic impacts on the small Native community of Tyonek. Each of these alternative facilities would require inmigration of project workers to the area. Development of separate construction work force communities could reduce impacts, as would successive construction periods for the ten combustion-turbine units (requiring a total of about ten years) under the coal-fired generation alternative (see Sec. 4.4.8). About 1.5 times as many construction workers (45 workers) would be needed for about ten years for the natural-gas-fired generation alternative than for the coal-fired generation alternative. Construction camps and successive construction periods would reduce impacts. However, even if construction worker communities were developed, inmigration of project workers and their households could result in as much as a 100% increase in the present population of Tyonek (Sec. 4.3.8). With or without these camps, impacts to Tyonek and its citizens would be significantly greater under the natural-gas-fired generation scenario than the coal-fired scenario.

Except for impacts to Tyonek, the natural-gas-fired generation scenario would create fewer impacts to other communities than would the coal-fired generation scenario. Under the natural-gas scenario, other combined-cycle and combustion-turbine units would be located near Anchorage and the Kenai-Soldotna area. Both of these sites are within commuting distance of existing communities large enough to provide a source of the workers needed for construction and operation of the units.

Under the coal-fired generation scenario, however, other small communities besides Tyonek would experience significant population inmigration. Healy and Nenana, in particular, would grow considerably (by 300% and 700% at peak, respectively) due to inmigration of workers and their households for the coal mine operation and for construction and operation of the 200-MW units. This new population would significantly affect supplies of services and the lifestyle and subsistence activities of the largely Native populations of these communities. The area around Willow is better equipped to accommodate a workforce influx for construction of the two 200-MW coal units under this scenario. However, some boomtown effects would be experienced there also. Thus, with the exception of significant impacts to Tyonek, the natural-gas-fired generation scenario would have fewer overall socioeconomic impacts than would the Susitna Basin or coal-fired generation scenarios.

The hydro-thermal generation scenario with Chakachamna would have more severe impacts than the scenario without Chakachamna because of the significant socioeconomic impacts to Tyonek from construction and operation of the Chakachamna facility. As many as 2,000 persons could move to the area during peak construction--almost ten times the current population (Sec. 4.5.8). Additionally, under the scenario with Chakachamna, concurrent construction of the Keetna and Browne facilities might exacerbate independent effects of the two projects on nearby Nenana, Healy, Cantwell, Trapper Creek, and Talkeetna. Either with or without Chakachamna, thermal units would be constructed near Nenana and Tyonek, causing additional substantial growth impacts in these areas.

Other small communities would experience socioeconomic impacts from construction of the non-Susitna hydropower facilities. The sparsely settled area along the Alaska Highway between Tok and Delta Junction would be affected significantly by inmigration of as many as 1,300 people during peak construction. Dot Lake and Tanacross, two small Native Alaskan communities near the site, would be particularly stressed by even minor population increases (Sec. 4.5.8).

Development of the Snow facility could cause an increase in the population of the Seward area by as much as 25%. Development of the Browne hydropower facilities would affect Healy, Nenana, and Cantwell; the Keetna facility would affect the Trapper Creek and Talkeetna areas. The impacts that would be experienced in all cases would be shortages of services and changes in lifestyle and subsistence activities. However, the impacts would not be of the magnitude of those created under other scenarios.

Based on the assumption that construction camps would be built for projects in the Tyonek area, the natural-gas-fired generation scenario would appear to the Staff to have fewer overall socioeconomic impacts than any of the other scenario (including the proposed project). Substantial population growth from project-induced inmigration in presently small communities would occur to some degree under all scenarios. This growth would cause shortages in all community services, changes in lifestyles, and disruption of subsistence activities. The combined hydro-thermal scenario with Chakachamna and all the Susitna Basin developments (including the proposed project) would have the greatest socioeconomic impacts. The coal-fired generation scenario would have more substantial impacts than the natural-gas-fired scenario, but less than the other alternatives.

4.7.9 Visual Resources

The construction and operation of alternatives involving Watana I, the Reregulating dam, and Modified High Devil Canyon would essentially result in the same types of visual resource impacts as would the proposed Watana and Devil Canyon dams. The dam structures, associated facilities, and reservoirs would modify the visual character of the area from that of a remote and largely undisturbed river valley and canyon area to one of greater human activity, development, and disturbance. Construction activities along the northern and southern alternative access routes would result in similar visual disturbances as the proposed access route. All access routes would require cut and fill operations, vegetation removal, excavation of borrow areas, and construction of high-level suspension bridges that would degrade the natural character of the region and be visible during the long-term operation phase of the project. None of the alternative access routes or the proposed route are clearly preferable from a visual impacts standpoint.

In the northern study area (Fig. 2-15), alternative routes AEF and AEDC have more potential for disrupting backcountry views because of their length, extending through the Healy Creek and Wood River valleys, and extending across the extensive open, flat area south of Fairbanks. In general, the transmission line corridor segments within the central study area (Fig. 2-14) extending along Deadman Creek and the Denali Highway, Tsusena Creek and Jack River, and Devil Creek and

Jack River would produce greater significant visual impacts within the Chulitna Mountains and tundra uplands than the proposed and alternative corridor segments extending west from the dam sites to the Gold Creek area. Within the southern corridor area (Fig. 2-16), alternative route segments ABC' and AEFC would produce significantly greater visual impacts than the proposed route. Of the ten alternative borrow site areas (Figs. 2-2 and 2-6), four (B, I, J, and L) would be completely inundated and would not cause any long-term visual impacts. The six remaining alternative borrow site areas would be visible over the long term. Borrow sites C and H would require extensive haul roads, further degrading the views of the surrounding natural features and resulting in greater visual resource impacts to the Susitna River Valley area than the other eight sites.

Visual resource impacts for the various power generation scenarios are highly dependent on the actual siting location of the project alternatives with respect to the visual quality of the area, established viewpoints and viewshed areas, and the number of persons residing or traveling through such areas. In general, natural gas-fired generation plants would be visually less obtrusive and result in fewer visual resource impacts than the larger coal-fired plants or dam alternatives for the reasons discussed in previous sections. In particular, the urban Anchorage area would be best suited for additional natural-gas-fired powerplant development in relation to minimizing visual resource impacts. The five 200-MW coal-fired units (three in Nenana and two in Willow) would be visually obtrusive in relation to their surrounding environment and proximity to scenic highways, waterways, and recreational areas. Under the combined hydro-thermal alternative, Lake Chakachamna would not produce significant long-term visual impacts; however, the remaining hydro units and coal-fired plants in Nenana would produce significant visual resource impacts.

4.7.10 Cultural Resources

Of the Susitna development alternatives, the Watana I-Devil Canyon and Watana I-Modified High Devil Canyon alternatives would have the same reduced impacts to cultural resources (5 archeological sites in indirect or potential rather than direct impact areas, and 17 archeological sites in potential rather than indirect impact areas) compared with the proposed project. The Watana I-Reregulating dam alternative would have even less impact than the other alternatives, by excluding one archeological and one historic site from any impacts.

Among alternative access corridors (Fig. 2-13), Corridor 2 (South) would appear to have the least impact on cultural resources. No sites are presently known in this area, and it seems to have limited potential for significant localities. Corridors 1 (North) and 3 (Denali-North) would have similar impacts on archeological sites (directly or indirectly impacting eight and nine sites, respectively, along with potential impacts to several other sites each). However, most impacts would probably be mitigable by avoidance.

The alternative transmission routes would not appear to vary significantly with respect to impacts on cultural resources. Several segments would potentially impact fewer currently known sites, but additional survey would undoubtedly produce new sites, making comparisons difficult at this time. Most impacts would probably be mitigable by avoidance.

Only borrow sites C, E, and F (Figs. 2-2 and 2-6) would have impacts on significant sites. Borrow site C would have the heaviest impact (20 archeological sites directly or indirectly impacted), followed by F (10 archeological and 1 historic site directly or indirectly impacted), and E (2 archeological and 1 historic site directly impacted). Many of these sites seem likely to be significant, and mitigation would require investigation in these cases.

Among the three non-Susitna power generation scenarios, the combined hydro-thermal scenario seems likely to have the greatest impact to cultural resources. This is due to the inundation of the designated Browne reservoir, and possibly other alternative reservoir locations as well, which would probably directly and indirectly impact several significant archeological and historic sites. The gas-fired and coal-fired scenarios would be less likely to have unavoidable direct or indirect impacts on sites, due to limited land disturbance; few cultural resource sites are known in the designated siting locations. Site-specific surveys and significance assessment would be necessary for a reliable comparison of alternatives.

4.8. RELATIONSHIP TO RESOURCE PLANS AND UTILIZATION

The Alaska Board of Game establishes policy for the management of wildlife in the Susitna project area, and this policy is administered by the Alaska Department of Fish and Game. The game and furbearing wildlife of the region are managed such that populations are maintained at a viable level that can sustain a continued human harvest for subsistence and recreational use. Management goals and strategies of implementation within each game management unit are functions of harvest pressures in the unit, wildlife population productivity and growth potential, sustainable carrying capacity of the habitat, and conservation principles.

The proposed project would reduce habitat carrying capacity and alter the productivity of game animal populations, as well as change patterns of harvest pressure, principally in Game Management Unit 13, the Nelchina-Upper Susitna Basin. These effects would probably be sufficient to require changes in management strategies. In general, the strategy changes could result in a more restricted harvest sufficient to balance the negative impacts of the proposed project and maintain current population levels in habitat not lost to the project. Management goals might also be altered so as to allow population sizes to stabilize at lower levels than are currently present.

The Alaska Division of Parks is charged with numerous functions, including planning for future recreation needs. Current recommendations for acquisition, planning, development, and management are projected through 1992. Planned development pertinent to the proposed Susitna project includes the expansion of the Willow Creek State Recreation area. The proposed expansion [3,450 acres (1,395 ha)] would extend to the west of the existing Willow Creek State Recreation Area, paralleling either side of Willow Creek to the Susitna River.

4.9 UNAVOIDABLE ADVERSE IMPACTS

4.9.1 Proposed Project

Construction and operation of the proposed Susitna Hydroelectric Project would result in the following unavoidable and significant adverse impacts:

- Localized and temporary generation of noise and fugitive dust during construction of dams, access roads, and other project features.

- Large population increases in small communities near the project area during project construction, with subsequent growth-related impacts, including housing shortages, cultural conflicts, interference with subsistence lifestyles, and shortfalls in some community revenues and services.

- Dedication of about 56,000 acres (22,700 ha) of vegetated land to project features during the life of the project [approximately 6,000 acres (2,400 ha) of the total 56,000 acres (23,000 ha) could be rehabilitated].

- Large-scale impacts to wildlife habitat, with subsequent significant and permanent reductions in populations of some important big game species within certain parts of the Susitna River Basin.

- Essentially permanent impacts on recreational and subsistence hunting and fishing in some parts of the Susitna Basin.

- Permanent substantial impacts upon visual resources due to the presence of large and visually obtrusive project structures in what is presently a remote and largely undisturbed area.

4.9.2 Alternatives

Development of alternatives discussed in this document would have the following unavoidable impacts:

- Any of the alternative Susitna project designs and configurations would result in impacts generally similar in type to those identified in Section 4.9.1 above. The magnitude of impacts for the various alternatives would differ somewhat from the proposed project. These impacts for the various Susitna project alternatives are compared in Section 4.7.

- Of the thermal alternatives considered, only the coal-fired generation scenario would result in significant adverse impacts. While land disturbance for the coal scenario would total less than 25% that of the proposed project, it would nonetheless be considered a significant impact in an absolute sense. Additionally, Staff analyses suggest that siting of more than two 200-MW coal units at Nenana could result in signficant degradation of air quality in the vicinity of Nenana due to SO_2 emissions, and unacceptable visibility impacts at Denali National Park.

- The combined hydro-thermal scenario would result in dedication of over 115,000 acres (46,500 ha) of land to project features for the life of the various hydro components of the alternative (84,000 acres, or 34,000 ha, for the Johnson project alone).

- The Chakachamna hydro project would have severe adverse impacts on an existing salmon fishery. Lesser, but significant, fishery and wildlife impacts could also be associated with development of the Keetna and Johnson projects.

- Sociological, recreational, and visual quality impacts qualitatively similar to those identified in Section 4.9.1 would be associated with development of any of the alternatives. Severity of impacts would be project-specific.

4.10 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

4.10.1 Proposed Project

Land features in the project area would be permanently changed or lost due to construction of dams, access routes, and other project features. Land features, cultural resource sites, vegetation, fish and wildlife habitat, visual resources, and recreation patterns in the proposed inundation areas would be irretrievably lost or altered because it is unlikely that dams and accumulated sediment in reservoirs would be removed after project retirement. Areas within the proposed reservoir sites [a total of about 45,000 acres, (18,000 ha)] presently afford opportunities for dispersed recreation, such as fishing, hunting, sight-seeing, kayaking, and hiking. These opportunities would be lost following filling of the reservoirs. Additionally, previously undisturbed areas adjacent to project lands would likely be affected due to shifts in recreation patterns as a result of unavailability of project lands and increased access to adjacent lands via project access routes. These types of impacts would essentially be permanent.

Some socioeconomic impacts would also be considered irreversible; e.g., permanent changes in subsistence and rural life styles in areas near the project would result due to increased populations and differing attitudes among newcomers.

Fish and wildlife populations destroyed or displaced by dam construction and reservoir filling would be irretrievably lost in the affected areas, creating irreversible recreation-related impacts in the project area.

4.10.2 Alternatives

Development of any of the alternative Susitna project designs and configurations would result in qualitatively similar, but somewhat less severe, irreversible and irretrievable commitments of resources to those discussed in Section 4.10.1. However, one alternative project configuration, Watana I with a downstream reregulation dam, would not inundate Devil Canyon, which is considered to be a high-quality visual resource and unique white-water recreation area.

The combined hydro-thermal alternative would very likely permanently alter a land area of about 100,000 acres (40,000 ha). Secondary effects of this alternative would be similar in type to those of the proposed project. Both the coal and gas alternatives would result in large irretrievable commitments of fossil fuel resources.

4.11 SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

4.11.1 Proposed Project

The project environment and the waters of the Susitna River would be used to provide a source of electrical power that would in turn meet the majority of electric power demand for the Railbelt well into the next century. There would be no consumptive use of Susitna River waters. The Applicant would sell the generated power to utilities operating in the region, and thereby pay for project construction and operation.

Construction and operation of the project would include many short-term uses of the environment. For purposes of this discussion, "short-term" refers to the life of the project, estimated to be at least 50 years. Project structures and reservoirs would preempt lands previously devoted to fish and wildlife habitat, recreation, timber production, and subsistence hunting and fishing. Inundation of nearly 100 mi (160 km) of river channel would reduce significantly the amount of free-flowing aquatic and riparian habitat in the middle and upper Susitna River, and changes in stream hydraulic patterns below the dams would adversely affect fish and possibly wildlife populations in downstream reaches of the river. The increase in populations of nearby communities due to influx of construction workers would cause alterations of the human environment, as well as accelerated short-term uses. Increased access to areas adjacent to project lands would cause increased use of these areas.

Because it would be unlikely that dam structures of the magnitude proposed for this project would or could be removed after the useful life of the project, many of the major environmental uses outlined above would also be long-term, essentially permanent uses. It is conceivable that the large reservoirs would eventually fill with sediment and a new river channel would develop in what had been the reservoir area. This would restore the terrestrial habitat for use by animals, but it would not resemble either in physical appearance or use the preproject environment. Following abandonment, flows and channels downstream of the dams would stabilize and possibly return to preproject conditions, but one cannot predict if fish and wildlife use of the area affected by the project would return to preproject productivities. Secondary uses of the environment related to increased access and human populations would also persist over the long term. Environments used for some project features, e.g., transmission lines, could probably be returned over time to essentially preproject conditions.

4.11.2 Alternatives

Most and possibly all descriptions of short- and long-term uses of the environment outlined in the preceeding section would also apply to the various hydropower alternatives considered in this EIS. It is possible that with the smaller-scale hydro developments, some dams and reservoirs could be removed after project abandonment, with the environment possibly being returned to something resembling preproject uses. This would certainly be true for the Chakachamna project area, which would not be markedly affected by even long-term use of the project environment, with the possible exception of downstream fisheries which may not return to preproject conditions.

Environments used for thermal generating facilities could more easily be restored to preproject conditions following retirement and dismantling. This would be particularly true for the natural-gas-fired facilities, which disturb very limited areas and do not require the large fuel storage, mining, and disposal areas of coal-fired units.

REFERENCES FOR SECTION 4

Acres American, Inc. Undated. Susitna Hydroelectric Project, Feasibility Report. Vol. 7. Appendix D: Coordination and Public Participation. Final Draft. Prepared for Alaska Power Authority. Anchorage.

Acres American, Inc. 1982. Susitna Hydroelectric Project. Transmission Line Selected Route. Final Draft. Prepared for Alaska Power Authority. Anchorage.

Alaska Board of Game. Undated. Alaska Hunting Regulations. No. 24. Regulations effective July 1, 1983 - June 30, 1984. pp. 70-71.

Alaska Department of Environmental Conservation. 1979. Water Quality Standards. Juneau.

Alaska Department of Environmental Conservation. 1983. Air Quality Control Regulations 18 AA 50. October.

Alaska Department of Fish and Game. 1983a. Synopsis of the 1982 Aquatic Studies and Analysis of Fish and Habitat Relationships. Appendix E: Effects of Mainstem Susitna Discharge on Total Wetted Perimeter and Blackwater Surface Area at Selected Study Sites. Prepared for the Alaska Power Authority. Anchorage. 46 pp.

Alaska Department of Fish and Game. 1983b. Synopsis of the 1982 Aquatic Studies and Analysis of Fish and Habitat Relationships. Appendix B: Timing and Passage of Adult Salmon in the Mainstem Susitna River and Access into Selected Sloughs Upstream of the Chulitna River Confluence. Prepared for the Alaska Power Authority. Anchorage. 49 pp.

Alaska Department of Natural Resources. 1982. Land Use Issues and Preliminary Resource Inventory. Vol. 1. Planning Background Report. 199 pp.

Alaska Northwest Publishing Co. 1983. The Milepost 1983. Alaska, Western Canada. 35th ed. Anchorage. 496 pp.

Aldrich, J.W. and C.W. Slaughter. 1983. Soil erosion on subarctic forest slopes. Journal of Soil and Water Conservation 38:115-118.

Ballard, W.B., J.H. Westlund, C.L. Gardner and R. Tobey. 1982. Susitna Hydroelectric Project Phase I Final Report, Big Game Studies. Vol. V. Dall Sheep. Alaska Department of Fish and Game, submitted to the Alaska Power Authority. Anchorage.

Ballard, W.B., J.S. Whitman, N.G. Tankersley, L.D. Aumiller and P. Hessing. 1983a. Susitna Hydroelectric Project Phase II Progress Report, Big Game Studies. Vol. III. Moose - Upstream. Alaska Department of Fish and Game, submitted to the Alaska Power Authority. Anchorage.

Ballard, W.B., J.S. Whitman, L.D. Aumiller and P. Hessing. 1983b. Susitna Hydroelectric Project 1982 Annual Report, Big Game Studies. Vol. V. Wolf. Alaska Department of Fish and Game, submitted to the Alaska Power Authority. Anchorage.

Banks, R.C. 1979. Human Related Mortality of Birds in the United States. Specific Scientific Report - Wildlife No. 215. U.S. Fish and Wildlife Service. Washington, DC.

Battelle Pacific Northwest Laboratories. 1978. The Impact of Increased Coal Utilization in the Pacific Northwest. Prepared for U.S. Department of Energy.

Battelle Pacific Northwest Laboratories. 1982. Candidate Electric Energy Technologies for Future Application in the Railbelt Region of Alaska. Volume IV. Prepared for the Office of the Governor, State of Alaska.

Baxter, R.M. and P. Glaude. 1980. Environmental Effects of Dams and Impoundments in Canada: Experience and Prospects. Canadian Bulletin of Fisheries and Aquatic Science, Bulletin 205. pp. 1-34.

Bechtel Civil & Minerals, Inc. 1983. Chakachamna Hydroelectric Project Interim Feasibility Assessment Report. Vol. II. Appendix to Section 6.0. Prepared for the Alaska Power Authority. 239 pp.

Benson, P.C. 1982. Prevention of Golden Eagle Electrocution. Final Report. EA-2680; Research Project 1002. Brigham Young University for Electric Power Research Institute. Palo Alto, CA.

Berg, R.L. 1980. Road performance and associated investigations. pp. 53-100, In: J. Brown and R.L. Berg (eds.), Environmental Engineering and Ecological Baseline Investigations along the Yukon River-Prudhoe Bay Haul Road. CRREL Report 80-19. U.S. Army Corps of Engineers, Cold Regions Research and Engineering Laboratory, Hanover, NH.

Braund, S.R. and T.D. Lonner. 1982. Alaska Power Authority Susitna Hydroelectric Project Sociocultural Studies. Submitted to Acres American Inc.

Brune, G.M. 1953. Trap efficiency of reservoirs. Transactions of the American Geophysics Union 34:407-418.

Challinor, J.L. and P.L. Gersper. 1975. Vehicle perturbation effects upon a tundra soil-plant system. II: Effects on the chemical regime. Soil Science Society of America Proceedings 39:689-695.

Chapin, F.S. III and M.C. Chapin. 1980. Revegetation of an arctic disturbed site by native tundra species. Journal of Applied Ecology 17:449-456.

Clemente, F. 1973. Effects of industrial developments on heads of households: Comment. Growth and Change 14:20-21.

Clemente, F. 1975. What industry really means to a small town. Farm Economics. Pennsylvania State University and the U.S. Department of Agriculture. University Park, PA.

Cortese, C.F. and B. Jones. 1977. The sociological analysis of boomtowns. Western Sociological Review 8(1):76-90.

Cowardin, L.M., V. Carter, F.C. Golet and E.T. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. FWS/OBS-79/31. U.S. Department of the Interior, Fish and Wildlife Service, Biological Services Program. Washington, DC. 103 pp.

Denver Research Institute and Browne, Bortz & Coddington. 1982. Socioeconomic Impacts of Power Plants. EA-2228, Research Project 1226-4. Prepared for Electric Power Research Institute. Palo Alto, CA.

DOWL Engineers. 1983. Matanuska-Susitna Borough Comprehensive Development Plan. Draft. Prepared for Matanuska-Susitna Borough.

Drake, J.J. 1981. The effects of surface dust on snowmelt rates. Arctic and Alpine Research 13:219-223.

Dvorak, A.J., et al. 1978. Impacts of Coal-Fired Power Plants on Fish, Wildlife, and Their Habitats. FWS/OBS-78/29. U.S. Fish and Wildlife Service, prepared by Argonne National Laboratory. 261 pp.

Everett, K.R. 1980. Distribution and properties of road dust along the northern portion of the haul road. pp. 101-128, In: J. Brown and R.L. Berg (eds.), Environmental Engineering and Ecological Baseline Investigations along the Yukon River-Prudhoe Bay Haul Road. CRREL-Report 80-19. U.S. Army Corps of Engineers, Cold Regions Research and Engineering Laboratory, Hanover, NH.

Finsterbusch, K. 1980. Understanding Social Impacts. Assessing the Effects of Public Projects. Sage Publications. Beverly Hills, CA. 309 pp.

Frank Orth & Associates, Inc. 1983. Susitna Hydroelectric Project Subtask 4.5: Socioeconomic Studies. Draft Final. Projection Assumptions, Methodology and Output Formats. Prepared for Harza-Ebasco and the Alaska Power Authority. 94 pp.

Freudenburg, W.R. 1981. A social social impact analysis of a Rocky Mountain energy boomtown. pp. 287-290, In: J.E. Carlson, W.R. Lassey and M.L. Lassey (eds.), Rural Society and Environment in America. McGraw Hill. New York.

Geist, V. 1980. Behavior. pp. 297-304, In: J.L. Schmidt and D.L. Gilbert (eds.), Big Game of North America. Ecology and Management. Stackpole Books, Harrisburg, PA.

Gersper, P.L. and J.L. Challinor. 1975. Vehicle perturbation effects upon a tundra soil-plant system: I. Effects on morphological and physical environmental properties of the soils. Soil Science Society of America Proceedings 39:737-744.

Gilmore, J.S. and E.J. Stenehjem. 1980. Oil shale development: The need for and the problems of socio-economic impact management and assessment. Presented at a conference on Oil Shale--The Environmental Challenge, sponsored by the Oil Shale Task Force and the U.S. Department of Energy, Vail, CO, August 11-14.

Gipson, P.S., S.W. Buskirk and T.W. Hobgood. 1982. Susitna Hydroelectric Project Furbearer Studies, Phase I Report. Alaska Cooperative Wildlife Research Unit, submitted to Terrestrial Environmental Specialists, Inc.

Harvey, H.H. 1967. Supersaturation of lake water with a precaution to hatchery usage. Transactions of the American Fisheries Society 96:194-201.

Hemming, J.E. 1971. The Distribution and Movement Patterns of Caribou in Alaska. Game Technical Bulletin No. 1. Alaska Department of Fish and Game. Juneau.

Justus, R. and J. Simonetta. 1983. Social pollution: Impact mitigation and compensation schemes and the Indian interest. pp. 216-226, In: S. Yarie (ed.), Alaska Symposium on the Social, Economic, and Cultural Impacts of Natural Resource Development, Anchorage, August 25-27, 1982.

Kessel, B., S.O. MacDonald, D.D. Gibson, B.A. Cooper and B.A. Anderson. 1982. Alaska Power Authority Susitna Hydroelectric Project Environmental Studies, Phase I Final Report. Subtask 7.11. Birds and Non-Game Mammals. University of Alaska Museum. Fairbanks.

Leopold, L.B. and T. Maddock. 1953. The Hydraulic Geometry of Stream Channels and Some Physiographic Implications. U.S. Geological Survey Professional Paper 422-A.

Metz, W.C. 1983. Industry initiatives in impact mitigation. pp. 239-252, In: S. Yarie (ed.), Alaska Symposium on the Social, Economic, and Cultural Impacts of Natural Resource Development, Anchorage, August 25-27, 1982.

Miller, S.D. 1983. Susitna Hydroelectric Project Phase II First Annual Progress Report, Big Game Studies. Vol. VI. Black Bear and Brown Bear. Alaska Department of Fish and Game, submitted to the Alaska Power Authority. Anchorage.

Miller, S.D. and D.C. McAllister. 1982. Susitna Hydroelectric Project Final Phase I Report, Big Game Studies. Vol. VI. Black Bear and Brown Bear. Alaska Department of Fish and Game, submitted to the Alaska Power Authority. Anchorage.

Newbury, R.W., K.G. Beaty and G.K. McCullough. 1978. Initial shoreline erosion in a permafrost affected reservoir, Southern Indian Lake, Canada. pp. 834-839, In: Proceedings, Third International Conference on Permafrost. Vol. I. Edmonton, Alberta.

Parker, G. 1981. A prediction of the downstream response of Poplar Creek, California, to the Dutch Gulch Dam. pp. 128-162, In: D.B. Simons, R.M. Li, P. Lagassee and R.M. Milhouse (eds.), Proceedings of a Workshop on Downstream River Channel Changes Resulting from Diversions or Reservoir Construction. FWS/OBS-81/48. U.S. Department of the Interior, U.S. Fish and Wildlife Service. Washington, DC. 347 pp.

Park Planning Section. 1982. Alaska State Park System: South Central Region Plan. Alaska Division of Parks, Department of Natural Resources. 153 pp.

Park Planning Section. 1983. Master Plan for the Proposed Willow Creek State Recreation Area. Division of Parks. Alaska Department of Natural Resources. 85 pp.

Payne, B.A. and C. Welch. 1982. An Assessment of Energy-Related Development in the Western Oil Shale Region. Vol. II. An Assessment of the Socioeconomic Impacts of Energy Development in Northwestern Colorado. Unpublished report by Division of Environmental Impact Studies, Argonne National Laboratory.

Peratrovich, Nottingham, and Drage Consultants, and I.P.G. Hutchinson. 1982. Susitna River Sedimentation and Water Clarity Study. Prepared for Acres American, Inc. Buffalo, NY.

Peterson, L.A., and Associates and R&M Consultants, Inc. 1982. Water Quality Affects Resulting from Impoundment of the Susitna River. Prepared for Acres American, Inc. Buffalo, NY.

Pitcher, K.W. 1982. Susitna Hydroelectric Project Phase I Final Report, Big Game Studies. Vol. IV. Caribou. Alaska Department of Fish and Game, submitted to the Alaska Power Authority. Anchorage.

Pitcher, K.W. 1983. Susitna Hydroelectric Project Phase II 1982 Annual Report, Big Game Studies. Vol. IV. Caribou. Alaska Department of Fish and Game, submitted to the Alaska Power Authority. Anchorage.

R&M Consultants, Inc. 1982a. Susitna Hydroelectric Project, River Morphology. Prepared for Acres American, Inc. Buffalo, NY.

R&M Consultants, Inc. 1982b. Susitna Hydroelectric Project, Tributary Stability Analysis. Prepared for Acres American, Inc. Buffalo, NY.

R&M Consultants, Inc. 1982c. Susitna Hydroelectric Project, Hydraulic and Ice Studies. Prepared for Acres American, Inc. Buffalo, NY.

Rickard, W.E., Jr. and J. Brown. 1974. Effects of vehicles on arctic tundra. Environmental Conservation 1:55-62.

Scrimgeour, D.P. Undated. Mitigating the Social and Economic Impacts of Oil Shale Development. Prepared for Quality Development Associates, Inc. Denver, CO.

Stenehjem, E.J. and J.E. Metzger. 1980. A Framework for Projecting Employment and Population Changes Accompanying Energy Development. Vols. I and II. Report ANL/AA-14. Argonne National Laboratory. Argonne, IL.

Smith, V.H. 1977. User's Guide for the Estuary Hydrology and Water Quality Models. Department of the Army, Alaska District, Corps of Engineers. Anchorage.

Smith, V.H. 1982. The nitrogen and phosphorus dependence of algal biomass in lakes: An empirical and theoretical analysis. Limnology and Oceanography 27:1101-1111.

Sparrow, S.D., F.J. Wooding and E.H. Whiting. 1978. Effects of off-road vehicle traffic on soils and vegetation in the Denali Highway region of Alaska. Journal of Soil and Water Conservation 33:20-27.

Stout, I.J. and G.W. Cornwell. 1976. Nonhunting mortality of fledged North American waterfowl. Journal of Wildlife Management 40(4):681-693.

Tankersley, N.C. 1983. Susitna Hydroelectric Project Phase II Progress Report, Big Game Studies. Vol. VIII. Dall Sheep. Alaska Department of Fish and Game, submitted to Alaska Power Authority. Anchorage.

Todd, A.M.D. 1982. Natural regeneration: Policies, procedures and practices in the Prince George forest region. pp. 5-15, In: Forest Regeneration at High Latitudes: Experiences from Northern British Columbia. University of Alaska, Fairbanks and U.S. Forest Service, Pacific Northwest Forest and Range Experiment Station, Misc. Report No. 82-1.

Trihey, E.W. 1983. Preliminary Assessment of Access by Spawning Salmon into Portage Creek and Indian River. Prepared for the Alaska Power Authority. Anchorage.

U.S. Department of Agriculture. 1981. Willow Subbasin - Susitna River Basin Study - Alaska. Final Report. U.S. Department of Agriculture in cooperation with Alaska Department of Natural Resources, Alaska Department of Fish and Game, and U.S. Department of the Interior. 144 pp.

U.S. Geological Survey. 1982. Water Quality Annual Report for Alaska. U.S.G.S. Water Data Report.

Van Cleve, K. 1978. Recovery of disturbed tundra and taiga surfaces in Alaska. pp. 422-455, In: J. Cairns, Jr., K.L. Dickson and E.E. Herricks (eds.), Recovery and Restoration of Damaged Ecosystems. University Press of Virginia, Charlottesville.

Van Cleve, K. and L.A. Viereck. 1981. Forest succession in relation to nutrient cycling in the boreal forest of Alaska. pp. 185-211, In: D.C. West, H.H. Shugart and D.B. Botkin (eds.), Forest Succession: Concepts and Application. Springer-Verlag. New York.

Viereck, L.A. 1966. Plant succession and soil development on gravel outwash of the Muldrow Glacier, Alaska. Ecological Monographs 36:181-199.

Viereck, L.A. and L.A. Schandelmeier. 1980. Effects of Fire in Alaska and Adjacent Canada - A Literature Review. Alaska Technical Report 6. BLM/AK/TR-80/06. U.S. Department of Interior, Bureau of Land Management. Anchorage. 124 pp.

Wakefield, W.C. II. 1983. Memorandum from W.C. Wakefield II, FERC Susitna Project Manager, to Susitna Advisory Committee. Potential Refinements for the Susitna Hydroelectric Project. (Dated 18 October 1983).

Wangaard, D.B. and C.V. Burger. 1983. Effects of Various Water Temperature Regimes on the Egg and Alevin Incubation of Susitna River Chum and Sockeye Salmon. U.S. Department of the Interior, Fish and Wildlife Service, National Fishery Research Center, Alaska Field Station. Anchorage.

Wolff, J.O. 1978. Burning and browsing effects on willow growth in Interior Alaska. Journal of Wildlife Management 42:135-140.

Wolff, J.O. and J.C. Zasada. 1979. Moose habitat and forest succession on the Tanana River floodplain and Yukon-Tanana upland. Proceedings of the North American Moose Conference and Workshop 15:213-244.

5. STAFF CONCLUSIONS

5.1 SIGNIFICANT ENVIRONMENTAL IMPACTS

5.1.1 Proposed Project

5.1.1.1 Land Resources

5.1.1.1.1 Geology and Soils

- Accelerated slope erosion and slope failure along the shorelines of the Watana and, to a lesser extent, Devil Canyon reservoirs.
- Possible reservoir-induced seismic events.
- Possible substantial seepage losses in the Watana relict channel following reservoir development.
- Increased erosion and impacts related to permafrost with clearing of vegetation from reservoir areas and development of borrow areas, access routes, transmission lines, and construction facilities.
- Soil compaction, erosion, and disturbances along access routes, transmission lines and at construction camps, as well as in areas subject to off-road vehicle traffic.

5.1.1.1.2 Land Use and Ownership

- The remote, highly inaccessible, largely undisturbed Upper and Middle Susitna River Basin would become an area of increased human activity and development with the construction and operation of the project.
- The proposed Watana and Devil Canyon dams would inundate about 36,000 acres [14,600 hectares (ha)] and 7,900 acres (3,200 ha) of land, respectively, within the Susitna River Valley.
- The Watana and Devil Canyon construction camps and villages would require 435 acres (180 ha) of land, while the Watana permanent settlement and airstrip would require 130 acres (53 ha).
- Approximately 1,100 acres (450 ha) of land would be required for access routes, and 11,700 acres (4,730 ha) would be required for transmission line rights-of-way.
- The State of Alaska would be required to purchase or acquire right-of-way easement for substantial areas of Federal, Native, and private lands for the project. Lands required would include dam and reservoir areas, borrow areas, access routes, and transmission line corridors totaling more than 64,000 acres (25,900 ha).
- Land values within the upper and middle Susitna River Basin would increase over time, especially for lands adjacent to the access routes, permanent settlement, and along the reservoir. Residential and recreational lands adjacent to the transmission line corridor could decrease in value.
- Recreation use would be adversely impacted where the proposed transmission line would be viewed by recreationists within the Denali National Park and Preserve and the Denali State Park.

5.1.1.2 Climate, Air Quality, Noise

- During construction, fugitive emissions could exceed Alaska standards for total suspended particulates (TSP) within and just beyond the project boundaries at the Watana dam site. The largest sources would be road dust raised by truck traffic and wind-blown dust from storage piles.

5.1.1.3 Water Quantity and Quality

- The Susitna River would be altered from an uncontrolled glacial river to a controlled flow.
- Turbidity levels would be reduced in the summer and increased in the winter.

- Water temperatures in the mainstem would be reduced in the summer and increased in the winter.
- The river channel between the dams and Talkeetna would be narrowed and stabilized.
- Onset of ice cover would be delayed in the autumn and ice breakup would be slowed in the spring between the dams and Talkeetna.

5.1.1.4 Aquatic Communities

- Access to sloughs used for spawning by adult chum and sockeye salmon would be restricted by reduced summer flows. The impacts would vary according to the site-specific topography of the sloughs.
- Timing of salmon egg incubation would be altered by changes in river temperature, resulting in premature emergence of fry from early spawns.
- Survival rates of salmon spawned in the Devil Canyon-to-Talkeetna reach would be reduced due to lower accumulated growths by the smolts as a result of altered temperatures.
- Improved access to the Basin would result in increased fishing pressure on the fisheries resource of the entire area.
- Alteration of flows would cause a loss of suitable salmon spawning habitat.
- Loss of tributary and river habitat would occur in the reservoir zones.
- Relative abundance of salmon species would shift due to changes in habitat, flows, and temperatures.

5.1.1.5 Terrestrial Communities

5.1.1.5.1 Plant Communities

- Construction of the proposed Watana and Devil Canyon dams and impoundments, related facilities, and access roads would result in the direct removal of about 44,000 acres (17,800 ha) of vegetation, or about 1.3% of the vegetated area within the upper and middle Susitna Basin. More specifically, about 4% of all forested areas, about 10% of mixed conifer-deciduous forest types, about one-third of the paper birch forest stands, and less than 1% of the tundra and shrubland types within the upper and middle Susitna Basin would be removed.
- More than 80% [37,000 acres (15,000 ha)] of the vegetation that would be removed could also be considered potential wetland areas. This represents about 1.7% of the potential wetland areas within the upper and middle Susitna Basin.
- Following completion of the proposed Watana and Devil Canyon dams and impoundments, about 6,400 acres (2,600 ha), or about 15% of the total vegetated area removed during construction, would require rehabilitation to prevent future erosion, vegetation and wildlife habitat loss, and visual and recreational impacts.
- In addition to the areas described above, about 12,000 acres (4,900 ha) of vegetation (of which almost two-thirds might also be considered potential wetlands) would be crossed by the proposed power transmission corridors and would be subject to selective clearing. Forest and tall shrub types, which represent almost 60% of the vegetation crossed by the corridors, would be most impacted by clearing because of the height of overstory vegetation.
- The regulated flows and changes in ice processes associated with Watana and Devil Canyon operation would variously affect the development of riparian plant communities downstream of the dam sites, but specific effects are difficult or impossible to reliably predict or quantify.
- An additional unquantifiable acreage of vegetation would be indirectly lost, damaged, and/or altered due to factors such as erosion, permafrost thaw, slumpage, wind, fugitive dust, alteration of drainage patterns, mesoclimatic changes, and increased human activities and usage caused by construction and operation of the proposed project.

5.1.1.5.2 Wildlife

- Reduction of the Susitna Basin's moose population due to loss of about 60 square miles (mi^2) [150 square kilometers (km^2)] of important habitat, a twofold increase in hunting pressure, and increased mortality.
- Severe reduction in the basin's black bear population due to loss of about 60 mi^2 (150 km^2) already-limited habitat, loss of 50% of available denning sites, and a twofold increase in hunting pressure.
- Reduction in the basin's brown bear population due to loss of some spring habitat, reduced availability of prey (moose and some salmon), and a twofold increase in hunting pressure.

- Reduction in the basin's gray wolf population due to loss of about 10% of the home range of the central-most pack, reduced availability of prey (moose), and a twofold increase in hunting pressure.
- Possible reduction of the Watana Hills group of Dall's sheep due to reduction in the suitability of the Jay Creek mineral lick as a result of inundation and leaching of soluble minerals.
- Possible restriction of the movement of caribou in the basin.
- Loss or disturbance of 4 bald eagle and 16 to 18 golden eagle nesting locations.
- Loss of 50% of the cliff-nesting habitat along the middle Susitna River.
- Possible need to alter wildlife management plans and goals within the basin.

5.1.1.6 Recreation Resources

- Aside from construction sites and access and transmission line corridors, the development of the proposed project would disrupt current recreation use patterns on more than 45,000 acres (18,200 ha) of land and water that would be inundated (Exhibit A, Vol. 1, Sec. 2.8)*, thereby intensifying the demand for comparable wilderness recreation experiences in adjoining areas.
- The filling of the Watana impoundment (1991-1993) (Exhibit C, Vol. 1, Fig. C.1) would inundate the Vee Canyon rapids, which constitute a significant white-water resource and recognized scenic area.
- The filling of the Devil Canyon impoundment (2001-2002) would inundate the Devil Canyon rapids, recognized as one of the few Class VI white-water runs in the world (Exhibit E, Vol. 8, Chap. 7, Sec. 3.1.2).
- Off-duty construction personnel opting to reside in onsite housing would compete among themselves and with local residents for recreation opportunities; this could jeopardize recreation resources in and adjacent to the project area, particularly during peak construction periods; i.e., 1988-1992 for the Watana site, and 1997-2000 for the Devil Canyon site (Exhibit E, Vol. 7, Chap. 5, Table E.5.25).
- Project development would result in some diminution in the quality and success rates of sport hunting and fishing opportunities within and downstream of the project area.
- Project access would create opportunities for successive extensions of access, thus jeopardizing wilderness settings and wilderness recreation activities in otherwise remote areas.

5.1.1.7 Socioeconomic Factors

- Significant population increases would result from inmigration of project workers, support workers, and their families (particularly in Trapper Creek, Talkeetna, and Cantwell), followed by large decreases in population after construction at the Watana site was completed.
- The boom-and-bust pattern would be repeated with the construction and operation of the Devil Canyon facility.
- Population growth would be accompanied by housing shortages; cultural conflicts; interference with subsistence use in the project area; and shortages of community water, sewer, solid waste disposal, fire, police, and health services.
- Shortfalls would occur in Mat-Su Borough revenues due to the need to finance expansion of community services prior to population inmigration.
- Greater accessibility of the area would cause conflicts with subsistence users and subsistence activities.
- Human-use patterns in the Susitna River Basin would be altered due to a fourfold increase in number of users, possibly leading to lowered game-harvest success rates, reduction in the quality of the hunting experience, and a change in the makeup of users of the basin.
- With rapid population growth, communities in the project area would lose their rural, small-town, isolated character, thus changing the quality of life for residents.

*Throughout this document, references to specific "Exhibits" are to the exhibits submitted to FERC as part of Alaska Power Authority's Susitna Hydroelectric Project License Application. References to specific "Appendices" (App.) are to the appendices provided in Volumes 2 through 7 of this Draft Environmental Impact Statement.

5.1.1.8 Visual Resources

- The geometric lines and forms of the Watana and Devil Canyon dams and associated structures would be in significant visual contrast to the natural setting of the Susitna River Valley and Devil Canyon landscapes.
- The Watana reservoir would inundate the scenic Deadman and Watana Creek waterfalls and much of the highly aesthetic Vee Canyon area, detracting from its significance as a natural scenic feature.
- The Devil Canyon reservoir would inundate the highly scenic and remote Devil Canyon and the Class VI white-water rapids that extend through it.
- It is anticipated that during maximum Watana reservoir drawdown (April and May), substantial areas of mudflats more than 1 mi (1.6 km) wide would be exposed along the shore of the impoundment and would continue to be visually obtrusive to recreationists on and near the reservoir throughout the summer months until the reservoir was filled in September.
- Extensive slumping, scaling, and landsliding would be expected to occur along the steep slopes of the Watana reservoir, resulting in significant visual impacts for recreationists boating on, or using land adjacent to, the reservoir.
- Extensive human development and activities around the Watana and Devil Canyon construction camp and village and the Watana permanent settlement would degrade the visual character of the existing natural settings.
- The project access routes would visually detract from the natural character of the area because of road surfacing, cut and fill operations, vegetation removal, erosion, and development of borrow areas.
- Along the transmission line corridors, cleared right-of-way and the 100-foot (ft) [30-meter (m)] high, guyed, steel-pole, x-frame towers would be visible from various vantage points within the upper and middle Susitna River Basin. These rights-of-way and towers also would be visible from points along the George Parks Highway, Alaska Railroad, and Denali Highway at various locations in Railbelt communities, Denali National Park and Preserve, and Denali State Park; and from aircraft flying overhead.

5.1.2 Alternatives

5.1.2.1 Land Resources

5.1.2.1.1 Geology and Soils

- Coal- and natural-gas-fired generation scenarios would result in significant consumptive use of regional coal and gas resources.
- Coal mining activities would result in topographic disturbances and possible increased erosion and sedimentation.
- Areas of soils potentially suitable for agriculture would be disturbed by construction of coal-fired units at Willow and Nenana.
- All but the Chakachamna hydropower alternatives would inundate extensive areas, and reservoir slope failures could be substantial for all but the Chakachamna and Snow alternatives.
- The Johnson and Browne hydropower alternatives would inundate potentially suitable agricultural land, and the Browne alternative would inundate unknown amounts of coal reserves.

5.1.2.1.2 Land Use and Ownership

- Significant land use impacts resulting from development of alternative Susitna Basin dam locations and designs, access routes, borrow areas, and alternative power transmission routes would be similar in scope to those discussed in Section 5.1.1.1.2. Because of the smaller reservoir areas, less acreage would be required for the alternative dams than for the proposed project.
- The combined hydro-thermal generation scenario would inundate more than 102,000 acres (41,300 ha) of land and result in similar land use impacts as described for the proposed project. In particular, the Browne hydro site alternative would significantly impact land use within the Alaska Railbelt by inundating 10,640 acres (4,310 ha) of land, including portions of the George Parks Highway and Alaska Railroad. The Johnson hydro site alternative would inundate a land area of 84,000 acres (34,000 ha), including a portion of the Alaska Highway and an above-ground pipeline.
- The coal-fired generation scenario would require more than 3,000 acres (1,200 ha) of land, including 600 acres (240 ha) for site facilities, 225 acres (91 ha) for waste disposal sites, and 2,250 acres (910 ha) (over 30 years) for surface mining of coal. An additional 9,000 acres (3,600 ha) would be required for transmission line rights-of-way. In addition, operation of coal-fired generation plants (such as those that would be located at Nenana

and Willow) is often incompatible with use of surrounding natural, recreational, residential, or commercial lands.

5.1.2.2 Climate, Air Quality, Noise

- Under the coal-fired generation scenario in which three to five coal units were assumed to be sited at Nenana, three significant impacts could result:

  - Impaired visibility could occur at the Class I area at Denali National Park because of the operation of three or more coal units at Nenana. Mitigation might involve application of NO_x controls for these Nenana plants. No Class I visibility impairment would occur if three units were placed at Willow and two at Nenana.

  - The PSD Class II increment for SO_2 (24-hour average) at elevated terrain northeast of Nenana would be violated with the operation of three, four, or five units at Nenana.

  - The PSD Class I increment for SO_2 (24-hour average) at Denali National Park would be violated with four or five units at Nenana.

5.1.2.3 Water Quantity and Quality

- Adoption of any of the alternative Susitna Basin dam designs or configurations would result in modification of the basin in a manner similar to, but to a lesser degree than, the proposed project.
- Development of non-Susitna hydropower alternatives would result in modification of the rivers upon which dams would be constructed. The Chakachamna project would divert the Chakachatna River into the McArthur River drainage.
- Development of coal-fired generating units could result in increased turbidity in streams near coal mining operations.

5.1.2.4 Aquatic Communities

- Improved access would result in increased fishing pressure in presently remote areas of the Tanana, Talkeetna, Nenana, and Susitna river basins.
- Adoption of the Chakachamna project would result in the loss of a major sockeye salmon fishery at Lake Chakachamna.
- Adoption of the Keetna project would result in a major impact on a salmon run on the Talkeetna River.

5.1.2.5 Terrestrial Communities

5.1.2.5.1 Plant Communities

- Impacts to vegetation from alternative Susitna dam locations and designs, access routes, power transmission routes, and borrow sites would be similar in type and magnitude to impacts of the proposed project.
- The combined hydro-thermal generation scenario would result in the direct removal or disturbance of more than 115,000 acres (46,500 ha) of vegetation (or more than twice the vegetated area that would be affected by the proposed project), as well as other types of impacts similar to those identified for the proposed project.

5.1.2.5.2 Wildlife

- Several alternative transmission routes would double the amount of wildlife habitat crossed in comparison to the proposed routes.
- A Parks Highway access connection would increase accessibility of the basin even more than would the proposed plan.
- An access route to Watana south of the river could reduce the suitability of Prairie Creek as a fishery for brown bear.
- Adoption of the combined hydro-thermal generation configuration would result in twice the habitat loss as the proposed project, as well as loss of the Prairie Creek fishery.

5.1.2.6 Recreation Resources

- The Watana I-Devil Canyon and Watana I-Modified High Devil Canyon alternatives would involve inundation of the Devil Canyon white-water run, as does the proposed project. In contrast, development of the Watana I plus Reregulating dam alternative would result in controlled flows through Devil Canyon, but the rapids would not be inundated.

- The alternative Willow-to-Pt. MacKenzie transmission line segment would traverse Nancy Lake State Recreation Area for about 9 mi (15 km) (Exhibit E, Vol. 9, Chap. 10, Fig. E.10.10).
- Installation of two 200-MW coal-fired units would significantly degrade environmental settings in the vicinity of Willow, where recreation resources include public, private, and commercial developments, and where participation levels in dispersed recreation activities are relatively high (App. L, Sec. L.1.4.2.2).
- The Johnson site alternative would entail inundation of 84,000 acres (34,000 ha) and elimination of dispersed recreation opportunities on that acreage. A segment of the Alaska Highway, which is a major tourist route, would be inundated. Commercial and private recreation touring of the Tanana River would also be disrupted (App. L, Sec. L.1.4.3.2).
- Development of the Browne alternative would disrupt a major river touring route and inundate 10,640 acres (4,300 ha), including segments of the George Parks Highway and the Alaska Railroad, which are major tourist routes (App. L, Secs. L.1.4.2.2, L.1.4.3.5).
- Development of the Keetna impoundment would inundate prime moose harvest areas, notable white-water resource areas, a segment of a major off-road vehicle access route, and established hiking trails. The Talkeetna has been proposed for State Recreation River status (App. L, Sec. L.1.4.3.3).

5.1.2.7 Socioeconomic Factors

- Under the Susitna Basin hydropower alternatives, population would increase significantly, causing shortages in housing and services similar to those described for the proposed project. These initial population increases would be followed by large decreases in population and service demands upon completion of construction.
- For the gas-fired generation scenario, significant population increases would occur in Tyonek as a result of inmigration of construction and operation workers and their households. Population increases would be accompanied by shortages of housing and all community services and conflicts with Native Alaskan culture and subsistence activities.
- Under the coal-fired generation alternative, the population in and around Healy, Nenana, Willow, and Tyonek would increase significantly due to the influx of workers, their families, and support workers needed for the expansion of the Usibelli Coal Mine and construction and operation of the 200-MW coal-fired units and the 70-MW combustion turbines. Shortages of housing and all community services, and possible conflicts with the large Native Alaskan component of current residents, their culture, and their subsistence activities would occur.
- Under the combined hydro-thermal scenario, the population would increase significantly in the Tok-to-Delta Junction area along the Alaska Highway, and in and around Talkeetna, Seward, and the southeastern Kenai Peninsula, Healy, Nenana, and Tyonek due to inmigrating project workers, support workers, and their households. Population increases would be accompanied by shortages of housing and all community services. After the peak construction period passed, the population would decrease, potentially leaving these communities with excesses of housing and services. Possible conflicts with Native Alaskan culture and subsistence activities might also occur in Healy, Nenana, Tyonek, and in small Native Alaskan communities between Tok and Delta Junction.

5.1.2.8 Visual Resources

- Development of alternative Susitna Basin dam locations and designs, access routes, borrow areas, and power transmission routes could result in significant visual resource impacts similar in nature to those discussed in Section 5.1.1.8 for the proposed project. Of particular note, the Modified High Devil Canyon alternative would inundate Tsusena Falls.
- Construction of the Keetna hydropower alternative would result in the inundation of two scenic areas, Sentinel Rock and Granite Gorge.
- Development of the Browne alternative hydropower site would detract from the visual resources of the Nenana River Valley.
- Development of the Snow and Johnson alternative hydropower sites would detract from the natrual and high aesthetic quality of these areas.
- Significant visual resource impacts could result from the siting of coal-fired generation plants near Nenana and Willow due to the need for a 400- to 500-ft (120- to 150-m) smokestack at each plant and the degradation of visual resources in the downwind area because of the presence of vapor plumes and haze from stack emissions.

5.1.3. <u>No-Action Alternative</u>

Under the no-action alternative, the nature and magnitude of impacts would depend on which specific actions the Applicant would take should the license for the proposed action be denied (see Sec. 4.6).

5.2 RECOMMENDATIONS

5.2.1 Power Generation

The approach taken by the Staff in evaluating alternative means of meeting projected power generation requirements for the Railbelt region was to assess the economic, engineering, and environmental costs, feasibility and effects of a range of representative generation scenarios, each primarily based on an abundant available source of energy that could be developed to meet projected power needs. It was not possible to specifically analyze the large number of combinations of sites and generation technologies that could result from integration or mixing of the four power generation scenarios considered. Clearly, a tremendous number of mixed hydro or hydro-thermal scenarios could be conceived that would, before detailed study, appear likely or realistic candidates for meeting future energy needs in terms of cost, engineering feasibility, and environmental impacts. However, because the Staff assessment of representative, alternative power generation scenarios examined a variety of resonable sites for each technology, and because a range of technologies was included, it can be readily inferred from Staff's discussion that certain economic, engineering, and environmental characteristics of individual sites and technologies make them obviously preferable to others. It is on this basis that the following general recommendations are offered.

Based on considerations of engineering feasibility, economic characteristics, and environmental effects, the FERC Staff finds that a mixed thermal-based generation scenario, supplemented with selected non-Susitna basin hydropower facilities would be the most effective approach to meeting the projected generation requirements of the Railbelt area. Such an approach would provide flexibility in systems planning and efficient fuel use to cope with the uncertainties in population growth and generation requirements delineated in Section 1.

The thermal-based generation scenario with selected hydropower facilities would consist of a mixture of coal- and gas-fired plants sited throughout the Railbelt area, combined with hydropower projects developed after independent evaluation and determination of merit from an economic and environmental viewpoint. The benefits of this approach include economic and environmental factors. As demonstrated in Section 1 of this document, thermal generation with selected hydropower is less costly than the proposed Susitna development as a means of meeting the projected load growth of the Railbelt. Thermal generation costs for the median load forecast are approximately 75% of the cost of the proposed Susitna development on a levelized, total annual cost basis. Further, levelized capital outlays associated with the development of several plants, versus the single large capital commitment for the Susitna project, would reduce the impact of energy costs to the consumer. From an environmental perspective, the adverse impacts projected for the alternative hydro and thermal scenarios are generally less than those projected for the proposed Susitna project. Specifically, properly sited and sized coal- and gas-fired power units would result in minimal impacts to land, water, and air resources, while the selection of the most environmentally acceptable non-Susitna hydropower projects would also lessen impacts compared with those expected with full development of hydropower resources in the Susitna Basin. Additionally, the regional dispersion of impacts related to several coal, gas, and hydropower developments would dilute and decentralize adverse effects and would provide more opportunities and greater flexibility for optimization of mitigative features.

Although the Staff finds that the thermal-based scenario, with selected non-Susitna hydropower development, would be the most reasonable alternative, should any hydroelectric development be authorized in the Susitna Basin, it should be licensed and constructed in stages, responding to generation requirements. The first stage of this development in the Susitna Basin would be the Watana I alternative described in Section 2.

Staging the licensing and construction of any Susitna Basin development, rather than the proposed action of complete development of the basin, would require each increment of development to meet the economic, environmental, and load requirements existing at the time of licensing. Incremental development in the Susitna Basin would attempt to take advantage of some of the concepts expressed above in that costs and environmental impacts would be staged, matching the near-term load growth in a stepwise fashion. The first stage under this concept would be Watana I [normal pool elevation 2,100 ft (640 m)]. The second stage would be one of the following: Modified High Devil Canyon, Devil Canyon, or the reregulating dam included in the Applicant's tunnel No. 3 alternative scheme. The selection of the second stage would depend on load growth.

Staging the Susitna Basin development would result in incremental capital outlays that would have the advantage of levelizing the increases in energy costs to the consumer. Environmentally, this staged approach, due to the reliance on the lower Watana I, would significantly reduce the area of inundation, when compared to the proposed Susitna project, thus decreasing the level of terrestrial and aquatic impacts as discussed in Section 4. Further, staged development would ensure that unavoidable environmental impact would occur only when absolutely essential. Watana I with a downstream reregulation dam would be the most environmentally and economically sound Susitna Basin development. Ultimately, should development in the Susitna Basin go forward, rather than the previously recommended thermal and selected non-Susitna hydropower scenario, the Susitna Basin development should be staged to conserve both economic and environmental resources.

5.2.2 Flow Regulation

The Applicant considered a range of flow release scenarios. The minimum flow during salmon spawning (August 1 to September 15) is proposed to be 12,000 cubic feet per second (cfs) [340 cubic meters per second (m^3/s)], which will subject an estimated 50% of side slough habitat to acute access limitations. To reduce these access restrictions, the Staff has recommended that spiking flows of 20,000 cfs (566 m^3/s) be implemented during the salmon spawning season. These spike releases should occur for at least three continuous days, and should occur during at least three different periods between August 1 and September 15.

Minimum flows during salmon emergence, outmigration, and rearing (May, June, and July) should also be reevaluated in light of presently ongoing studies. All phases of the life cycles of salmon should be provided for in the minimum flow regimes for the project.

5.2.3 Access Plan

The Applicant considered three basic alternative access routes: from Denali Highway, from Gold Creek, and from Parks Highway (Exhibit E, Vol. 9, Chap. 10, Sec. 2.3). The Applicant adopted an access plan consisting of a road link from Denali Highway to Watana and Devil Canyon dams and a rail link from Gold Creek to Devil Canyon (Fig. 2-11). Access from Denali Highway would require construction of a new railhead at Cantwell, upgrading of about 20 mi (30 km) of the Denali Highway, and construction of about 40 mi (60 km) of new road to the Watana dam site (Sec. 2.1.7). Access from the Denali Highway would have severe impacts upon wildlife resources in the upper and middle Susitna River Basin (Sec. 4.1.5.2). The road would bisect a major path of movement for the Nenana-Upper Susitna subherd of caribou, impact beaver habitat along Deadman Creek, and provide ready access for personal vehicles into the central basin. This access would likely result in a major shift in patterns of human use within the upper and middle Susitna Basin and increased wildlife mortality due to hunting and trapping (Secs. 4.1.5 and 4.1.8). These changes would necessitate a review, and possibly alteration, of current wildlife management goals and practices.

Access from Gold Creek alone would markedly reduce the potential for impacts to the Nenana-Upper Susitna caribou subherd and allow greater control of access into the project region. Access from Gold Creek alone also would markedly reduce overfishing of grayling habitat north of the project area. Greater control of access would lead to a reduction in the potential for impacts due to increased fishing, hunting, and trapping pressure on fish and wildlife resources. In addition, patterns of human use of the basin's fish and wildlife resources would not be altered as much as under the proposed access plan. Thus, impacts to wildlife management goals would be substantially less than under the proposed conditions.

Based on these considerations, the Staff recommends that the Applicant adopt an alternative to the Denali Highway access plan that incorporates access from Gold Creek only.

5.3 MITIGATIVE MEASURES

5.3.1 Land Resources

5.3.1.1 Geology and Soils

The mitigative measures proposed by the Applicant to address geologic- and soil-related impacts are discussed in Section 2.1.12.1. Based on currently available site information, these measures would for the most part be effective in minimizing impacts. Because more site-specific information would become available during the Applicant's proposed geotechnical studies, the Staff suggests the involvement of the state and Federal soil conservation agencies and geological resource agencies in reviewing construction and mitigation plans so as to ensure the suitability of the proposed mitigative measures. Approval of the Applicant's erosion-control mitigative measures should be obtained from these state and Federal agencies (including FERC) prior to project development and upon completion of relevant geotechnical investigations.

Many of the significant impacts related to the proposed project, e.g., the loss of land due to reservoir inundation, reservoir slope instability, and seismically induced slope failures or liquefactions, would be essentially unmitigatable; however, the Staff suggests that the Applicant continue to evaluate the magnitude of such impacts as relevant geotechnical information arises from ongoing studies. Mitigative measures appropriate for the alternatives are discussed in Section 2.7.1.

5.3.1.2 Land Use and Ownership

At present, no single comprehensive land management plan exists for the entire upper and middle Susitna River Basin. In order to control unwanted development, conflictive land uses, and unlimited off-road access into the region, the Applicant must continue to coordinate with the various Federal, state, Native, and local governing agencies and with private landholders. The applicant should assist in the development and implementation of appropriate land management practices through land use and comprehensive plans, special purpose functional plans, zoning ordinances, and other pertinent land use controls. Agency coordination that has begun in the planning and design stage of the Susitna project should continue through the construction and operation phases. The Applicant also should continue to monitor the land status and ownership changes within the proposed project area and keep the new landowners and managers informed of project status and of any changes in design, construction methods, access requirements, and operational procedures.

To minimize conflictive land use along the power transmission line corridor, the Applicant should avoid, to the extent feasible, recreation lands, residential areas, and areas of exisiting or planned agricultural use. If a transmission line tower is located on agricultural land, the use of guyed, x-frame towers should be avoided if feasible. The amount of land removed from crop production can be minimized by using self-supporting H-frame or single-pole towers. Wherever possible, any tower structures in an agricultural area should be located along the edge of an agricultural field to lessen the probability of operational damage to farm equipment and/or to the transmission line tower and to minimize the amount of cropland (existing or potential) removed from production. Where feasible, the transmission line should be placed adjacent to existing transmission line corridors to minimize the amount of new right-of-way required.

Measures to mitigate impacts to recreational land use are discussed in Sections 2.1.12.6 and 5.3.6, while mitigative measures to minimize aesthetic impacts to landowners and others adjacent to project facilities are described in Sections 2.1.12.8 and 5.3.8.

5.3.2 Climate, Air Quality, Noise

The potential problem of offsite exceedences of Alaska ambient air quality regulations due to fugitive dust emissions may be solved through implementation of mitigative measures. For example, stabilizing agents can be used on storage piles to maintain a crust that would hold down fugitive emissions. Roads can be watered during dry periods. Restrictions can be placed on vehicle speeds, and unauthorized vehicles can be kept off unpaved roads in order to minimize dust impacts. The Applicant lists methods such as these in the Application; however, there is no commitment by the Applicant to carry out any specific mitigative measure.

The Applicant should prepare a detailed plan for the mitigation of fugitive dust emissions. Such a plan should be based on an evaluation of which areas of the project are more likely to lead to exceedences of Alaska ambient air quality standards outside the site boundary. Mitigative measures should be chosen and criteria defined to determine when and how often the mitigation should be applied. A combination of the methods listed in this section may be satisfactory.

5.3.3 Water Quantity and Quality

The selection of appropriate constraints on reservoir releases would be a critical element in the mitigation policy for the proposed project. These constraints include not only a minimum flow regime to protect downstream fisheries, but also limits on maximum releases, limits on the maximum rate of change of releases, allocation of excess reservoir volume when it is available, and the need for short-term spike releases to compensate for the loss of preproject floods. A policy for spiked releases is necessary because both the fluvial dynamics and the biology of the Susitna River are controlled by the magnitude and frequency of occurrence of high-flow events. Although a significant amount of information is now available on these subjects, the definition of release constraints should be negotiated after current field studies have been completed. A schedule for these negotiations is an integral part of the mitigation policy.

Accessibility to preproject salmon spawning habitat in the side sloughs would be severely limited under the proposed minimum flow regime. At the 12,000 cfs (340 m^3/s) minimum flow during salmon spawning (August 1 to September 15), an estimated 50% of side slough habitat would be unavailable (i.e., subject to acute access limitations). Mainstem flows of approximately 13,000 cfs (368 m^3/s) provide unrestricted access to half of the side slough habitat utilized by salmon in 1981 and 1982. Acute access limitations to the second half of preproject spawning habitat persist until mainstem flows reach 18,000 cfs (510 m^3/s). Unrestricted access to the second half of the spawning habitat does not begin until flows exceed 20,000 cfs (566 m^3/s). This second half of the spawning habitat includes highly utilized sloughs such as Slough 9 (RM 129.2) and Slough 21 (RM 142).

Therefore, the Staff recommends that spike flows in excess of 20,000 cfs (566 m^3/s) be implemented, along with the minimum release, during the salmon spawning period. These increased releases should occur during at least three different periods between August 1 and September 15, with each peak being held for at least three days. Some overtopping of sites such as Slough 9 would begin to occur if these peak flows reached 23,000 cfs (680 m^3/s). Nine days of spiked releases of 24,000 cfs (680 m^3/s) represent an additional 107,000 ac-ft (1.32 x 10^8 m^3) over the minimum flow regime, or 3% of the live storage of Watana reservoir. A strategy for allocating reservoir volume of this magnitude, especially in wet years, should be developed as part of project mitigation.

The minimum flows for May, June, and July should also be reconsidered. No evidence has yet been presented by the Applicant to support the assumption that the 6,000 cfs (170 m^3/s) minimum flows during this period adequately protect salmon emergence, outmigration, and rearing. The results of current studies should be evaluated to ensure that all phases of the life cycles are provided for in the minimum flow regime. For example, access becomes a moot point if the spawning areas are subsequently dewatered or no suitable rearing habitat is provided. The negotiations for release constraint policy will resolve these outstanding issues.

Minimum release policies should be required at all hydropower alternatives. Information available for the proposed project would be sufficient to evaluate instream flow needs for the in-basin alternatives. However, site-specific studies would have to be conducted at the out-of-basin alternatives, especially Johnson and Browne, where baseline information is limitied.

The implementation of a water-resource modeling program within the Susitna River Basin should be included in mitigation planning. The objectives of such a program should be to achieve state-of-the-art forecasting of streamflows within the basin and to improve reservoir operation by allocating streamflows in excess of power demands to optimize fisheries production below the dams. Recent studies have concluded that forecasting and reservoir optimization modeling can achieve significant improvements in the operating efficiency of water-resource developments (Office of Technology Assessment, 1982). The State of Alaska has not yet implemented these methodologies (Office of Technology Assessment, 1982). For a major project such as the Susitna project, such a program could help ensure that adverse impacts were minimized. Habitat response information and species requirements obtained from past field studies and future monitoring should be designed to improve the allocation of reservoir releases. This can be achieved through existing simulation or optimatic modeling (e.g., Sale et al., 1982).

5.3.4. Aquatic Communities

The conceptual mitigation plan for fisheries provided by the Applicant (Sec. 2.1.12.3) is generally appropriate. Based on additional data presently being collected, specific recommendations to mitigate problems will be developed.

The Applicant's objective of providing habitat sufficient to maintain naturally productive salmon populations downstream from the project is superior to reliance on hatchery production. Hatchery experience over several decades has not been totally successful in other locations (e.g., the Columbia River). The mitigative steps of avoiding, minimizing, rectifying, and compensating impacts, with monitoring over time to allow identification of unanticipated impacts, are appropriate and conceptually sound. The species selected for evaluation (e.g., chum, chinook, coho and pink salmon, and Arctic grayling) are generally those for which interest is most intense and which can be expected to be most susceptible to impacts. Alternative species might be considered that could provide management opportunities, especially in the reservoirs (e.g., Dolly Varden, Kokanee strains of sockeye salmon, or lake trout).

The Applicant's major premise that improved conditions in the Susitna River mainstem resulting from project operation would provide replacement habitat to mitigate for potential loss of sloughs is inadequately substantiated. Important impacts identified in Section 4.1.4 need to be integrated. For example, gravel cleaning in side channels and sloughs to provide substrate for spawning would be of little benefit when mainstem temperatures in winter are too low to allow incubation to progress at a normal rate (App. I, Fig. I-15). Piping of mainstem water into sloughs would similarly be of little advantage when analyses show overtopping of slough berms to cause detrimentally low temperatures.

Priority attention should be given to providing adequate quality of spawning gravel in slough areas that currently have abundant upwelling (as determined by observations of open water in winter) but deep, muddy sediments. Temperatures typical of groundwater would thus be available for incubation through the winter.

Impacts of filling Watana reservoir would require mitigation in addition to those measures proposed by the Applicant. There would be major alterations of river flow and temperature during the three-year filling of Watana reservoir, but less significant changes when Devil Canyon Reservoir was filled (Sec. 4.1.3). These alterations would be expected to have important effects on access to slough spawning areas by adult chum and sockeye salmon in all three years, and on growth rates of juveniles of all salmon species, especially in the second and third years (Sec. 4.1.4). Although the applicant has selected a flow regime that is planned to minimize flow-related impacts, there are no specific plans to mitigate losses in fish growth due to low temperatures in summer or to rectify or compensate lost spawning area in the filling years. Mitigation measures for impacts during operation are planned to be initiated during the filling period, and some may be effective during the filling years if begun earlier.

Management of the potential fishery resources in Watana and Devil Canyon reservoirs is likely to provide a mitigation opportunity beyond that planned by the Applicant. Experiences in Scandinavia suggest that good fisheries can be developed in impounded glacial rivers when species like lake trout and Arctic char (Dolly Varden) are used. In the United States, Kokanee salmon have provided new runs to upstream tributaries blocked by dams. Emphasis on management of these species would seem more appropriate than developing a hatchery for Arctic grayling.

Cone valves planned for both dams and water management in the reservoirs to reduce the likelihood of gas supersaturation in discharges seem appropriate. As plans develop further, their deployment on the dams can be more carefully addressed to avoid ancillary impacts.

The long-term effectiveness of mitigation measures remains unclear, principally because the uncertainty of predicting fundamental effects such as river temperatures and groundwater flow remains high (Sec. 4.1.3). As these effects are clarified and translated quantitatively into biological impacts (Sec. 4.1.4 and Appendix I), then the overall effectiveness (or necessity) of mitigative measures will be more evident.

5.3.5 Terrestrial Communities

As noted in Section 2.1.12, the Applicant has been developing an extensive mitigation plan that would be implemented during construction and operation of the proposed project. This plan has been developed in cooperation with the major Federal and state resource agencies in Alaska. Resource agencies' formal comments on proposed mitigation plans have tended to be general critiques of the mitigation plan in its current state. General recommendations include: (1) continued close interaction with the resource agencies; (2) continued monitoring of the status of botanical and wildlife resources, and associated mitigative actions in the basin; and (3) establishment of the feasibility of planned mitigative actions.

The Staff concurs that continued, close interaction with the resource agencies is a necessity for developing and implementing mitigative measures. The Applicant also acknowledges the necessity of such interaction. Continued interaction would ensure development of a plan that is more definitive than the current one. The current lack of definitiveness is due, in large part, to a lack of sufficient information as to the feasibility of mitigation proposals.

Continued monitoring of plant and wildlife populations and their responses to the project and to mitigative measures would be necessary (1) to devise future mitigation or alter the approach to mitigation if needed, and (2) to quantify the extent to which mitigation is compensating for losses. The Staff agrees that such studies should be an integral part of the mitigation plan.

There is some concern on the part of the agencies with regard to feasibility of the proposed compensation measures. The State of Alaska, Office of Management and Budget, has expressed concern that habitat enhancement efforts could be risky and, therefore, favors compensation with replacement lands. Conversely, the U.S. Fish and Wildlife Service has indicated support for the Applicant's chosen option of compensation through habitat enhancement, but noted that selection and development of lands for habitat enhancement must also include consideration of other habitat characteristics affecting wildlife habitat values, including (1) location with respect to wildlife-use patterns and (2) interspersion with vegetation types providing cover and protection.

There is also concern on the part of the agencies and the Staff about the feasibility and specifics of habitat-enhancement measures. Although it is fairly well documented that disturbances such as fire generally effect an increase in browse production, there are uncertainties as to selection of methods and the specific effects of factors such as soil and environmental conditions, the species composition of vegetative communities to be modified, and the composition of surrounding communities. Thus, at present it would be difficult in many locations to predict with confidence the precise results of enhancement manipulations on changes in vegetative community structure and productivity. Furthermore, it would be even more difficult to predict the responses of wildlife populations to various enhancement manipulations. Therefore, several agencies have indicated that additional studies are required to determine more precisely (1) what important habitat areas would be lost due to construction and operation of the proposed project, (2) whether it is possible or feasible to replace these areas, and (3) how and where to best attempt replacement manipulations. It is for these reasons that resource agencies have recommended vegetation and wetland studies and mapping that are oriented towards quantification and understanding of plant communities from a wildlife habitat perspective. The Applicant has acknowledged these concerns and has stated that efforts are being made to pursue such studies with the help and consultation of appropriate resource agencies during the mitigation plan refinement process. Because the Applicant has not documented the likelihood of success for its rehabilitation and enhancement proposals, nor documented the amount of compensation that could be attributed to the enhancement efforts, the Staff has assumed in its analysis that impacts to wildlife would not be compensated for by enhancement techniques. The Staff concurs that the Applicant should further study the efficacy of proposed rehabilitation and enhancement techniques with the goal of implementing feasible mitigative actions that have a likelihood of success.

The U.S. Fish and Wildlife Service has stated that several of the wildlife species which it has identified as evaluation species fall within its criteria for requiring "in-kind" compensation. This requires compensation for loss to a given species by replacement or enhancement of the affected species. This approach contrasts with "out-of-kind" mitigation of one species to compensate losses to another species.

Concerning the Applicant's approach to rectification of vegetation impacts, the agencies and the Staff concur with the general rehabilitation procedures proposed by the Applicant, recognizing that more specific details of procedures, locations, schedules, and costs are planned for the detailed design phase of the proposed project development and should also be covered in greater detail in the Applicant's planned Revegetation/Rehabilitation Manual. However, the Staff recommends that the Applicant, where feasible, consider the use of engineering practices to stabilize erosive areas either in addition to or in lieu of seeding with native grasses. For example, terracing would not only reduce erosion but would help collect moisture that might be critical to rapidly achieving successful revegetation. As another example, properly placed water-control diversions would minimize erosion while allowing surface drainage of excess water. Since seeding with grasses (even native species) might inhibit later invasion by other native species, the judicious use, where feasible, of such erosion-control measures in lieu of or to minimize seeding with grasses might allow development of a more typical native community than would otherwise occur.

The State of Alaska has noted that the Applicant cannot rely upon the Alaska Board of Game to mitigate the project-induced changes in patterns of human use and effects from these changes. The state argues that the Applicant should take every step possible to mitigate impacts prior to any need for the Board of Game to review and revise management strategies. The Staff agrees with this view and considers that any Board review and revisions necessitated by the project would be impacts resulting from the project and not a part of mitigative activities.

Several agencies suggested alterations in proposed project plans in order to reduce or avoid impacts. The Staff has considered these suggestions in its discussion of alternatives to proposed project features.

5.3.6 Recreation Resources

The Staff considers that the appropriate implementation of the Applicant's recreation plan (Sec. 2.1.11) would constitute reasonable mitigation for losses of recreation resources and opportunities related to the development of the proposed project, as well as for accommodating recreation demand that would accrue from construction and operation of project facilities. Accordingly, no additional mitigation appears warranted at this time.

Although not specifically identified as mitigation, several recommendations have been proposed by concerned resource agencies with respect to project-related, public recreation needs (Exhibit E, Vol. 10B, Chap. 11, App. 11J). For the most part, the recommendations entail additional development at sites other than those identified in the Applicant's recreation plan. However, the future need for the recommended developments is subject to varying degrees of uncertainty. One such example is the recommendation that consideration should be given to providing public access from the project transportation corridor to Portage Creek for fishing and/or kayaking. As presently planned, the construction of the appropriate segment of the project transportation corridor would be completed in 1994, but would not be available for public use before completion of construction at the Devil Canyon dam site in the year 2002. Accordingly, the need for the recommended public access to Portage Creek in 2002 is not foreseeable with meaningful certainty at the present time. Additional discussion of other recommendations concerning project-related recreation developments is presented in Appendix L, Section L.3.

5.3.7 Socioeconomic Factors

The Staff and Alaska state agencies concur on the need for development of the following additional mitigation strategies:

- Development of definitive transportation plans, including provision of low-cost transportion options from the site area to the Fairbanks and Anchorage areas, to discourage inmigration to local communities and to preclude or limit mobility by private vehicles.
- Development of definitive shift and leave schedules that encourage workers to establish or maintain permanent residences outside the project area, e.g., extended periods of work followed by extended leaves.
- Training and hiring of local subcontractors, the local labor force, and unemployed residents and inmigrants seeking employment so as to reduce local unemployment and welfare needs.
- Development of incentives (e.g., low rents, low-interest mortgages) to encourage workers (and their households) to live in onsite housing and thus reduce inmigration to small communities in the project area.
- Development, in cooperation with the affected agencies, of clear definitions of responsibilities by the Applicant, state, borough, or local authorities for administration and

funding of project-area facilities and services (e.g., power and telephones, roads, the onsite school) so as to reduce uncertainties in planning.

- Definition of legal responsibilities for access to the site during construction and operation to clarify funding and workforce needs and sources.
- Active, project-funded participation by state, Federal, and local agency representatives in developing mitigation strategies and monitoring of impacts. These representatives should have legal authority to approve mitigation plans and to recommend changes in implementation of plans in light of monitoring studies and information on effectiveness of the plans so as to ensure mutually satisfactory efforts and reduce future conflicts.
- Reimbursement of guides displaced by project structures and activities for losses of investments, losses from transfers to another area, and costs of reestablishing their businesses.
- Establishment of controls to limit fishing, hunting, and trapping by onsite personnel, particularly in areas used for subsistence activities, based on studies of effects of restricted and open access and of permitting.
- Coordination with state, Federal, and local agencies on specific plans for and administration of the construction camp/village, and for access options.
- Financing the development of community and borough land use plans to adapt to project-induced growth in an orderly fashion, in line with community goals.
- Provision of funds by the Applicant to the state, the borough, and local communities to finance construction of community services (e.g., water and sewer systems, counseling services, local roads) in advance of population inmigration. The amount and nature of funding (e.g., grants, loans, payments-in-lieu-of-taxes) should be determined in consultation with the government agencies, and adjusted as ongoing impact monitoring revealed effectiveness and shortfalls.
- Quarterly or on-demand, communication to local, borough, and state agencies of project schedules, delays and changes in schedule, workforce sizes and projected needs, and of shift and leave schedules to aid planning by these agencies.
- Financing of residential construction through loans and other incentives to local developers, recruiting developers when local ones are not available, and buying land for temporary or permanent housing so that (1) construction could begin prior to inmigration of workers and (2) difficulties of acquiring backing would be reduced. Such financing could be provided as investments by the Applicant.
- Provision of salaries and of equipment for community and service-area fire and police personnel.
- Cooperation with local, borough, and state transportation planners to plan and construct new traffic-control facilities at intersections (e.g., intersection of the Parks and Denali highways) and other areas of traffic congestion in the transportation network.
- Provision of incentives (e.g., salary increases, transportation costs) for workers laid off over the winter to return the following summer and for those employed on Watana to work on Devil Canyon in order to reduce the total number of inmigrants and the rate of population turnover.
- Provision of information about the local area, especially about Native Alaskan communities, culture, and subsistence activities, to inmigrating workers so as to reduce cultural and other conflicts with long-time residents.
- Analysis to determine what areas would be flooded should one of the dams fail, followed by development of land use restrictions in those areas.
- Development of a recruitment program to obtain physician and health care professionals for project-area communities.

5.3.8 Visual Resources

The Applicant's mitigation plan for visual resources is described in Section 2.1.12.9 and in Appendix M, Section M.4. The Staff agrees with all the measures stated. In addition, where road and stream crossings occur along the proposed transmission line route, shrubs and trees should be planted and/or retained to the extent possible to prevent a view into the corridor from along such crossing points. To minimize the viewing time and length of the line seen from roadways, crossings should be made at right angles to roadways wherever possible. H-frame and/or single-pole towers should be used to reduce tower dominance in sensitive viewing areas. Low-profile tower structures should be used (if feasible) in highly visible areas where towers of standard height could be viewed above the treetops. Tower structures should be set as far back from roadways and stream banks as feasible. All transmission line structures should be colored to blend in with the natural background vegetation.

Visual impacts in forested areas can be minimized by selective clearing, leaving as much low growth in the right-of-way as possible, and through additional planting. Tapered clearing of the right-of-way (through tree topping, etc.) would soften the edges of the right-of-way, thus reducing the visual impact. A right-of-way clearing pattern should be developed where feasible to reduce the straight-line corridor effect. The proposed line should be routed so that it follows and conforms to natural topographic lines as much as possible. In addition, lines should be sited to one edge of a valley or draw and parallel a landform change. Skylining of the line and towers should be minimized. If a hill must be crossed, it should be crossed at an angle (e.g., side or shoulder of the hill rather than the top). If the line traverses a prominent viewing area, the line should be located between the viewing area and a vegetative or topographical screen if feasible.

At the proposed substation locations, any existing trees, and vegetation should be left standing to the extent possible to screen the terminal facilities. The building and associated facilities should be painted a color that would best blend in with the background vegetation. The height of the transmission line terminating structures should be kept to the minimum safe and practical height.

5.3.9 Cultural Resources

Archeological and historic sites that possess significance (as defined in 36 CFR 60.4) and are eligible for inclusion in the National Register of Historic Places require appropriate mitigative measures. The two chief forms of recommended mitigation are investigation, in the case of directly or indirectly impacted sites, and avoidance, in the case of potentially impacted sites. The full extent of the mitigation necessary cannot be determined until the inventory of cultural resources and assessment of their significance is completed.

The proposed Watana and Devil Canyon developments would directly or indirectly impact 75 archeological and 6 historic sites. Twenty-two of these sites have been assessed as significant, and it appears likely that a high proportion of the remaining sites will be termed significant as well. The recommended mitigation for these cultural resources is investigation through excavation. Most of these sites occur in relatively shallow sedimentary contexts and appear to be of restricted areal extent, thus limiting the scope of investigation. Nevertheless, their excavation and analysis will almost certainly make a substantive contribution to knowledge of Alaskan prehistory. The remaining 55 archeological sites and 1 historic site (3 of which have been judged significant) in this proposed project area would be subject to potential impacts. The recommended mitigation for these sites is preservation through avoidance and protection (a monitoring program involving periodic site inspections by the appropriate land-managing agency). Site-specific lists of recommended mitigation measures are presented in Tables O-1 and O-2 of Appendix O.

The proposed access routes would directly or indirectly impact 17 archeological and 2 historic sites, and potentially impact 11 archeological sites (none of which has been assessed for significance). Avoidance and protection (through monitoring) of significant sites are recommended. It appears unlikely that many of these sites will be termed significant. A site-specific list of recommended mitigation measures is presented in Table O-3 of Appendix O.

The proposed transmission lines would potentially impact 11 archeological and historic sites. Although none of these sites has been evaluated for significance, it appears likely that several will be termed significant. For these sites, avoidance and protection (through construction-phase monitoring) are recommended. A site-specific mitigation list is presented in Table O-4 of Appendix O.

5.4 RECOMMENDED AND ONGOING STUDIES

5.4.1 Land Resources

5.4.1.1 Geology and Soils

The Applicant proposes to continue geotechnical studies to determine the site-specific foundation conditions for transmission tower, construction camp, and access road foundations. Such studies would be designed so as to match construction techniques and foundation designs to the existing conditions. Such studies would ensure the stability of the various facilities and, as a consequence, should also allow the Applicant to adapt construction techniques to the specific environment, thus minimizing soil erosion and impacts related to permafrost thaw. Seepage channel investigations would be continued to ensure the safe functioning of the reservoir system.

5.4.1.2 Land Use and Ownership

It is recommended that the Applicant continue to monitor ongoing land ownership changes, management plan revisions, and land value information for the proposed project area.

5.4.2 Aquatic Communities

The extensive field studies in fisheries and aquatic resources being conducted for the Applicant by several groups, including the Alaska Department of Fish and Game, are appropriate and extremely valuable. The Staff recommends that these studies be continued. Increased attention to the interactions between intragravel water (supply, temperature, and quality) and incubation rates and success in sloughs is warranted. Since growth dynamics of young salmon appear to be important impacts, and since both negative influences (low temperature, slough dewatering) and positive ones (water clarification, increased benthic productivity) have been identified, additional study of growth dynamics may be important for issue resolution.

Staff recommends additional attention to defining aquatic (especially fisheries) resources in two areas of the Susitna drainage that are not well characterized: (1) the Talkeetna-to-Cook Inlet reach and (2) the Chulitna and Talkeetna rivers. The lower reach of the Susitna River may be influenced by the Susitna project to a larger extent than initially anticipated, especially as habitat for rearing and overwintering of juvenile salmon. The numbers of spawning salmon that use the Chulitna and Talkeetna rivers are not characterized except by subtraction of the Talkeetna Station numbers from those of Sunshine Station. Relative suitability of habitats in these two rivers is germane to estimating impacts of project-caused alterations in the Susitna River.

5.4.3 Terrestrial Communities

The Staff recommends that ongoing studies oriented towards quantification and understanding of plant communities from a wildlife habitat perspective as well as those designed to evaluate the responses of plant communities and wildlife populations to various habitat manipulation options be completed. These studies should include direct mapping of wetlands for all areas that would be affected by construction and operation of the proposed project (including the Healy-to-Willow transmission line segment) using classification categories sufficiently specific to assess losses of high-value wetland types.

The Staff also recommends that studies be conducted to determine the effects of long-term (five to ten years) soil storage on rehabilitation success. Although there is evidence that replacement of mineral and/or organic-layer soils can significantly improve revegetation of disturbed sites, long-term storage of soil (mineral or organic-layer) could affect seed or vegetative propagule viability and/or the chemical, physical, and microbial properties of the soil. These effects could reduce rehabilitation success compared to areas where replaced soils were stored for less than a year or two. Even more importantly, it should be determined whether specific storage methods or practices (e.g., controlling moisture content or compaction levels, depth of stockpiles, or mixture of organic and mineral soils) can enhance the potential for rehabilitation success when replacement soils must be stored for long periods.

5.4.4 Recreation Resources

The Applicant proposes to prepare a recreation master plan for Phase One development of public recreation facilities (Sec. 2.1.11), to be completed in September 1985. Information included in the master plan relative to final site selection and site-specific information would be used as a basis for Phase Two engineering design specifications to be finalized in 1986. Development of public recreation facilities would be initiated during the 1986 construction season (Schedule B, Supplemental Items Vol. 2, Sec. 7, Response to Comment 11).

5.4.5 Socioeconomic Factors

The Applicant states that studies are being conducted to:

- Update baseline and project-induced population projections;
- Develop and update a mitigation plan;
- Plan the location of the proposed townsite and provision of services and facilities; and
- Revise all socioeconomic impact analyses.

Studies recommended in addition to those ongoing are:

- Analysis of the impacts of the location, type, and administration of the onsite camp and village on fish and wildlife resources;
- Analysis of the impacts of the proposed project on commercial fishing, including changes in the number of jobs, in dollar values of catch, in lifestyle of fishing families, and in subsistence catches;
- Evaluation and monitoring of subsistence, recreational, and commercial hunting, fishing, and trapping in the project area;

- Monitoring of the availability of labor and skills in the local area, both among the current resident population and among the inmigrant population attracted by the prospect of employment on the project, in order to reduce local unemployment and welfare programs;
- Surveying of workers to communicate to government agencies and local interests information on where the workers have their permanent residences; on the fishing, hunting, and trapping activities of the workers; and on use by the workers of local community facilities so that mitigation and planning can be updated; and
- Surveying (in cooperation with Native Corporations and Councils) of subsistence activities in Cantwell and in the vicinity of the project site so as to provide a basis for adjusting project activities to avoid any potential interference with such subsistence activities.

5.4.6 Visual Resources

The Applicant has stated that an interdisciplinary design team would be assembled during the Phase II detailed design process to resolve identified visual resource impact problems through (1) additional studies, (2) proper development practices, (3) alterations in engineering design, and (4) modification to structures and landscape using the visual concepts of form, line, color, and texture.

REFERENCES FOR SECTION 5

Office of Technology Assessment. 1982. Use of Models for Water Resource Management, Planning, and Policy. OTA-0-159. Congress of the United States, Office of Technology Assessment. Washington, DC. 242 pp.

Sale, M.J., E. Downey Brill, Jr. and E.E. Herricks. 1982. An approach to optimizing reservoir operation for downstream aquatic resources. Water Resources Research 18(4):705-712.

6. LIST OF PREPARERS

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7. LIST OF RECIPIENTS

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

Federal

Advisory Council on Historic Preservation
Department of Agriculture, Forest Service
Department of Army, Corps of Engineers
Department of Commerce
Department of Energy, Alaska Power Administration
Department of Health and Human Services
Department of the Interior
Department of Transportation
Environmental Protection Agency
Rural Electrification Administration

Local

Mayor, City of Anchorage
Mayor, City of Fairbanks
Matanuska-Susitna Borough
Community of Cantwell, Inc.
Alaska Resources Library
Anchorage Municipal Library
Elmer E. Rasmauson Library--University of Alaska at Fairbanks
Fairbanks North Star Borough Public Library and Regional Center
Palmer Public Library
Susitna Valley High School Library
Talkeetna Public Library
University of Alaska at Anchorage Library

Applicant

Alaska Power Authority

State

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

Others

Senator Ted Stevens
Senator Frank H. Murkowski
Representative Donald E. Young
Cook Inlet Region, Inc.
Tyonek Native Corporation
AHTNA, Inc.
Cook Inlet Aquaculture Association
Cook Inlet Native Association
Sierra Club
Northern Alaska Environmental Center
Trustees for Alaska
Alaska Center for the Environment
National Wildlife Federation
Alaskan Survival

8. ATTACHMENTS

ATTACHMENT I

FEDERAL POWER COMMISSION-ORDER 415-C
(Issued December 18, 1972)
STATEMENT OF GENERAL POLICY TO IMPLEMENT PROCEDURES FOR COMPLIANCE WITH THE NATIONAL ENVIRONMENTAL POLICY ACT OF 1969

§ 2.80 Detailed Environmental Statement.

(a) It shall be the general policy of the Federal Power Commission to adopt and to adhere to the objectives and aims of the National Environmental Policy Act of 1969 (Act) in its regulation under the Federal Power Act and the Natural Gas Act. The National Environmental Policy Act of 1969 requires, among other things, all Federal agencies to include a detailed environmental statement in every recommendation or report on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment.

(b) Therefore, in compliance with the National Environmental Policy Act of 1969 the Commission staff shall make a detailed environmental statement when the regulatory action taken by us under the Federal Power Act and Natural Gas Act will have a significant environmental impact. A "detailed statement" prepared in compliance with the requirements of §§ 2.81 through 2.82 of this Part shall fully develop the five factors listed hereinafter in the context of such considerations as the proposed activity's direct and indirect effect on the air and water environment of the project or natural gas pipeline facility; on the land, air, and water biota; on established park and recreational areas; and on sites of natural, historic, and scenic values and resources of the area. The statement shall discuss the extent of the conformity of the proposed activity with all applicable environmental standards. The statement shall also fully deal with alternative courses of action to the proposal and, to the maximum extent practicable, the environmental effects of each alternative. Further, it shall specifically discuss plans for future development related to the application under consideration.

The above factors are listed to merely illustrate the kinds of values that must be considered in the statement. In no respect is this listing to be construed as covering all relevant factors.

The five factors which must be specifically discussed in the detailed statement are:

(1) the environmental impact of the proposed action,
(2) any adverse environmental effects which cannot be avoided should the proposal be implemented;
(3) alternatives to the proposed action,
(4) the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and
(5) any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented.

(c) (i) To the maximum extent practicable no final administrative action is to be taken sooner than ninety days after a draft environmental statement has been circulated for comment or thirty days after the final text of an environmental statement has been made available to the Council on Environmental Quality and the public.

(c) (ii) Upon a finding that it is necessary and appropriate in the public interest, the Commission may dispense with any time period specified in §§ 2.80-2.82.

§ 2.81 Compliance with the National Environmental Policy Act of 1969 under Part I of the Federal Power Act

(a) All applications for major projects (those in excess of 2,000 horsepower) or for reservoirs only providing regulatory flows to downstream (major) hydroelectric projects under Part I of the Federal Power Act for license or relicense, shall be accompanied by Exhibit W, the applicant's detailed report of the environmental factors specified in § 2.80 and 4.41. All applications for surrender or amendment of a license proposing construction, or operating change of a project shall be accompanied by the applicant's detailed report of the environmental factors specified in § 2.80. Notice of all such applications shall continue to be made as prescribed bv law.

(b) The staff shall make an initial review of the applicant's report and, if necessary, require applicant to correct deficiencies in the report. If the proposed action is determined to be a major Federal action significantly affecting the quality of the human environment, the staff shall conduct a detailed independent analysis of the action and prepare a draft environmental impact statement which shall be made available to the Council on Environmental Quality, the Environmental Protection Agency, other appropriate governmental bodies, and to the public, for comment. The statement shall also be served on all parties to the proceeding. The Secretary of the Federal Power Commission shall cause prompt publication in the Federal Register of notice of the availability of the staff's draft environmental statement. Written comments shall be made within 45 days of the date the notice of availability appears in the Federal Register. If any governmental entity, Federal, state, or local, or any member of the public, fails to comment within the time provided, it shall be assumed, absent a request for a specific extension of time, that such entity or person has no comment to make. Extensions of time shall be granted only for good cause shown. All entities filing comments with the Commission will submit ten copies of such comments to the Council on Environmental Quality. Upon expiration of the time for comment the staff shall consider all comments received and revise as necessary and finalize its environmental impact statement which, together with the comments received, shall accompany the proposal through the agency review and decision-making process and shall be made available to the parties to the proceeding, the Council on Environmental Quality, and the public. In the event the proposal is the subject of a hearing the staff's environmental statement will be placed in evidence at that hearing.

(c) Any person may file a petition to intervene on the basis of the staff draft environmental statement. All interveners taking a position on environmental matters shall file timely comments, in accordance with paragraph (b) of this section, on the draft statement with the Commission including, but not limited to, an analysis of their environmental position in the context of the factors enumerated in 2.80, and specifying any differences with staff's position upon which intervener wishes to be heard. Nothing herein shall preclude an intervener from filing a detailed environmental impact statement.

(d) In the case of each contested application, the applicant, staff, and all interveners taking a position on environmental matters shall offer evidence for the record in support of their environmental position. The applicant and all such interveners shall specify any differences with the staff's position, and shall include, among other relevant factors, a discussion of their position in the context of the factors enumerated in §2.80.

(e) In the case of each contested application, the initial and reply briefs filed by the applicant, the staff and all interveners taking a position on environmental matters must specifically analyze and evaluate the evidence in the light of the environmental criteria enumerated in § 2.80. Furthermore, the Initial Decision of the Presiding Administrative Law Judge in such cases, and the final order of the Commission dealing with the application on the merits in all cases, shall include an evaluation of the environmental factors enumerated in § 2.80 and the views and comments expressed in conjunction therewith by the applicant and all those making formal comment pursuant to the provisions of this section.

§ 2.82 Compliance with the National Environmental Policy Act of 1969 Under the Natural Gas Act.

(a) All certificate applications filed under Section 7(c) of the Natural Gas Act (15 U.S.C. 717f(c)) for the construction of pipeline facilities, except abbreviated applications filed pursuant to Sections 157.7(b), (c) and (d) of Commission Regulations and producer applications for the sale of gas filed pursuant to Sections 157.23-29 of Commission Regulations, shall be accompanied by the applicant's detailed report of the environmental factors specified in § 2.80. Notice of all such applications shall continue to be made as prescribed by law.

(b) The staff shall make an initial review of the applicant's report and, if necessary, require applicant to correct deficiencies in the report. If the proposed action is determined to be a major Federal action significantly affecting the quality of the human environment, the staff shall conduct a detailed independent analysis of the action and prepare a draft environmental impact statement which shall be made available to the Council on Environmental Quality, the Environmental Protection Agency, other appropriate governmental bodies, and to the public, for comment. The statement shall also be served on all parties to the proceeding. The Secretary of the Federal Power Commission shall cause prompt publication in the Federal Register of notice of the availability of the staff's draft environmental statement. Written comments shall be made within 45 days of the date the notice of availability appears in the Federal Register. If any governmental entity, Federal, state, or local, or any member of the public, fails to comment within the time provided, it shall be assumed, absent a request for a specific extension of time, that such entity or person has no comment to make. Extensions of time shall be granted only for good cause shown. All entities filing comments with the Commission shall submit ten copies of such comments to the Council on Environmental Quality. Upon expiration of the time for comment the staff shall consider all comments received and revise as necessary and finalize its environmental impact statement which, together with the comments received, shall accompany the proposal through the agency review and decision-making process and shall be made available to the parties to the proceeding, the Council on Environmental Quality, and the public. In the event the proposal is the subject of a hearing, the staff's environmental statement will be placed in evidence at that hearing.

(c) Any person may file a petition to intervene on the basis of the staff draft environmental statement. All interveners taking a position on environmental matters shall file timely comments, in accordance with paragraph (b) of this section, on the draft statement with the Commission including, but not limited to, an analysis of their environmental position in the context of the factors enumerated in § 2.80, and specifying any differences with staff's position upon which intervener wishes to be heard. Nothing herein shall preclude an intervener from filing a detailed environmental impact statement.

(d) In the case of each contested application, the applicant, staff, and all interveners taking a position on environmental matters shall offer evidence for the record in support of their environmental position. The applicant and all such interveners shall specify any differences with the staff's position, and shall include, among other relevant factors, a discussion of their position in the context of the factors enumerated in §2.80.

(e) In the case of each contested application, the initial and reply briefs filed by the applicant, the staff, and all interveners taking a position on environmental matters must specifically analyze and evaluate the evidence in the light of the environmental criteria enumerated in § 2.80. Furthermore, the Initial Decision of the Presiding Administrative Law Judge in such cases, and the final order of the Commission dealing with the application on the merits in all cases, shall include an evaluation of the environmental factors enumerated in § 2.80 and the views and comments expressed in conjunction therewith by the applicant and all those making formal comment pursuant to the provisions of this section.

FEDERAL POWER COMMISSION
RULES OF PRACTICE AND PROCEDURE
18 CFR 1.8 Intervention

"(a) Initiation of intervention. Participation in a proceeding as an intervener may be initiated as follows:

(1) By the filing of a notice of intervention by a State Commission, including any regulatory body of the State or municipality having jurisdiction to regulate rates and charges for the sale of electric energy, or natural gas, as the case may be, to consumers within the intervening State or municipality.

(2) By order of the Commission upon petition to intervene.

(b) Who may petition. A petition to intervene may be filed by any person claiming a right to intervene or an interest of such nature that intervention is necessary or appropriate to the administration of the statute under which the proceeding is brought. Such right or interest may be:

(1) A right conferred by statute of the United States:

(2) An interest which may be directly affected and which is not adequately represented by existing parties and as to which petitioners may be bound by the Commission's action in the proceeding (the following may have such an interest; consumers served by the applicant, defendant, or respondent; holders of securities of the applicant, defendant, or respondent; and competitors of the applicant, defendant, or respondent).

(3) Any other interest of such nature that petitioner's participation may be in the public interest.

(c) Form and contents of petitions. Petitions to intervene shall set out clearly and concisely the facts from which the nature of the petitioner's alleged right or interest can be determined, the grounds of the proposed intervention, and the position of the petitioner in the proceeding, so as fully and completely to advise the parties and the Commission as to the specific issues of fact or law to be raised or controverted, by admitting, denying or otherwise answering specifically and in detail, each material allegation of fact or law asserted in the proceeding, and citing by appropriate reference the statutory provisions or other authority relied on: Provided, that where the purpose of the proposed intervention is to obtain an allocation of natural gas for sale and distribution by a person or municipality engaged or legally authorized to engage in the local distribution of natural or artificial gas to the public, the petition shall comply with the requirements of Part 156 of this chapter (i.e., Regulations Under the Natural Gas Act). Such petitions shall in other respects comply with the requirements of §§1.15 to 1.17, inclusive.

(d) Filing and service of petitions. Petitions to intervene and notices of intervention may be filed at any time following the filing of a notice of rate or tariff change, or of an application, petition, complaint, or other document seeking Commission action, but in no event later than the date fixed for the filing of petitions to intervene in any order or notice with respect to the proceedings issued by the Commission or its Secretary, unless, in extraordinary circumstances for good cause shown, the Commission authorizes a late filing. Service shall be made as provided in §1.17. Where a person has been permitted to intervene notwithstanding his failure to file his petition within the time prescribed in this paragraph, the Commission or officer designated to preside may where the circumstances warrant, permit the waiver of the requirements of §1.26(c)(5) with respect to copies of exhibits for such intervener.

(e) Answers to petitions. Any party to the proceeding or staff counsel may file an answer to a petition to intervene, and in default thereof, may be deemed to have waived any objection to the granting of such petition. If made, answers shall be filed within 10 days after the date of service of the petition, but not later than 5 days prior to the date set for the commencement of the hearing, if any, unless for cause the Commission with or without motion shall perscribe a different time. They shall in all other respects conform to the requirements of §§1.15 to 1.17, inclusive.

(f) Notice and action on petitions

(1) Notice and service. Petitions to intervene, when tendered to the Commission for filing, shall show service thereof upon all participants to the proceeding in conformity with §1.17(b).

(2) Action on petitions. As soon as practicable after the expiration of the time for filing answers to such petitions or default thereof, as provided in paragraph (e) of this section, the Commission will grant or deny such petition in whole or in part or may, if found to be appropriate, authorize limited participation. No petitions to intervene may be filed or will be acted upon during a hearing unless permitted by the Commission after opportunity for all parties to object thereto. Only to avoid detriment to the public interest will any presiding officer tentatively permit participation in a hearing in advance of, and then only subject to, the granting by the Commission of a petition to intervene.

(g) Limitation in hearings. Where there are two or more interveners having substantially like interests and positions, the Commission or presiding officer may, in order to expedite the hearing, arrange appropriate limitations on the number of attorneys who will be permitted to cross-examine and make and argue motions and objections on behalf of such interveners."

ATTACHMENT II

Form L-2
(Revised October, 1975)

FEDERAL ENERGY REGULATORY COMMISSION

TERMS AND CONDITIONS OF LICENSE FOR UNCONSTRUCTED MAJOR PROJECT
AFFECTING LANDS OF THE UNITED STATES

Article 1. The entire project, as described in this order of the Commission, shall be subject to all of the provisions, terms, and conditions of the license.

Article 2. No substantial change shall be made in the maps, plans, specifications, and statements described and designated as exhibits and approved by the Commission in its order as a part of the license until such change shall have been approved by the Commission: Provided, however, That if the Licensee or the Commission deems it necessary or desirable that said approved exhibits, or any of them, be changed, there shall be submitted to the Commission for approval a revised, or additional exhibit or exhibits covering the proposed changes which, upon approval by the Commission, shall become a part of the license and shall supersede, in whole or in part, such exhibit or exhibits theretofore made a part of the license as may be specified by the Commission.

Article 3. The project works shall be constructed in substantial conformity with the approved exhibits referred to in Article 2 herein or as changed in accordance with the provisions of said article. Except when emergency shall require for the protection of navigation, life, health, or property, there shall not be made without prior approval of the Commission any substantial alteration or addition not in conformity with the approved plans to any dam or other project works under the license or any substantial use of project lands and waters not authorized herein; and any emergency alteration, addition, or use so made shall thereafter be subject to such modification and change as the Commission may direct. Minor changes in project works, or in uses of project lands and waters, or divergence from such approved exhibits may be made if such changes will not result in a decrease in efficiency, in a material increase in cost, in an adverse environmental impact, or in impairment of the general scheme of development; but any of such minor changes made without the prior approval of the Commission, which in its judgment have produced or will produce any of such results, shall be subject to such alteration as the Commission may direct.

Upon the completion of the project, or at such other time as the Commission may direct, the Licensee shall submit to the Commission for approval revised exhibits insofar as necessary to show any divergence from or variations in the project area and project boundary as finally located or in the project works as actually constructed when compared with the area and boundary shown and the works described in the license or in the exhibits approved by the Commission, together with a statement in writing setting forth the reasons which in the opinion of the Licensee necessitated or justified variation in or divergence from the approved exhibits. Such revised exhibits shall, if and when approved by the Commission, be made a part of the license under the provisions of Article 2 hereof.

Article 4. The construction, operation, and maintenance of the project and any work incidental to additions or alterations shall be subject to the inspection and supervision of the Regional Engineer, Federal Energy Regulatory Commission, in the region wherein the project is located, or of such other officer or agent as the Commission may designate, who shall be the authorized representative of the Commission for such purposes. The Licensee shall cooperate fully with said representative and shall furnish him a detailed program of inspection by the Licensee that will provide for an adequate and qualified inspection force for construction of the project and for any subsequent alterations to the project. Construction of the project works or any feature or alteration thereof shall not be initiated until the program of inspection for the project works or any such feature thereof has been approved by said representative. The Licensee shall also furnish to said representative such further information as he may require concerning the construction, operation, and maintenance of the project, and of any alteration thereof, and shall notify him of the date upon which work will begin, as far in advance thereof as said representative may reasonably specify, and shall notify him promptly in writing of any suspension of work for a period of more than one week, and of its resumption and completion. The Licensee shall allow said representative and other officers or employees of the United States, showing proper credentials, free and unrestricted access to, through, and across the project lands and project works in the performance of their official duties. The Licensee shall comply with such rules and regulations of general or special applicability as the Commission may prescribe from time to time for the protection of life, health, or property.

Article 5. The Licensee, within five years from the date of issuance of the license, shall acquire title in fee or the right to use in perpetuity all lands, other than lands of the United States, necessary or appropriate for the construction, maintenance, and operation of the project. The Licensee or its successors and assigns shall, during the period of the license, retain the possession of all project property covered by the license as issued or as later amended, including the project area, the project works, and all franchises, easements, water rights, and rights of occupancy and use; and none of such properties shall be voluntarily sold, leased, transferred, abandoned, or otherwise disposed of without the prior written approval of the Commission, except that the Licensee may lease or otherwise dispose of interests in project lands or property without specific written approval of the Commission pursuant to the then current regulations of the Commission. The provisions of this article are not intended to prevent the abandonment or the retirement from service of structures, equipment, or other project works in connection with replacements thereof when they become obsolete, inadequate, or inefficient for further service due to wear and tear; and mortgage or trust deeds or judicial sales made thereunder, or tax sales, shall not be deemed voluntary transfers within the meaning of this article.

Article 6. In the event the project is taken over by the United States upon the termination of the license as provided in Section 14 of the Federal Power Act, or is transferred to a new licensee or to a non-power licensee under the provisions of Section 15 of said Act, the Licensee, its successors and assigns shall be responsible for, and shall make good any defect of title to, or of right of occupancy and use in, any of such project property that is necessary or appropriate or valuable and serviceable in the maintenance and operation of the project, and shall pay and discharge, or shall assume responsibility for payment and discharge of, all liens or encumbrances upon the project or project property created by the Licensee or created or incurred after the issuance of the license: Provided, That the provisions of this article are not intended to require the Licensee, for the purpose of transferring the project to the United States or to a new licensee, to acquire any different title to, or right of occupancy and use in, any of such project property than was necessary to acquire for its own purposes as the Licensee.

Article 7. The actual legitimate original cost of the project, and of any addition thereto or betterment thereof, shall be determined by the Commission in accordance with the Federal Power Act and the Commission's Rules and Regulations thereunder.

Article 8. The Licensee shall install and thereafter maintain gages and stream-gaging stations for the purpose of determining the stage and flow of the stream or streams on which the project is located, the amount of water held in and withdrawn from storage, and the effective head on the turbines; shall provide for the required reading of such gages and for the adequate rating of such stations; and shall install and maintain standard meters adequate for the determination of the amount of electric energy generated by the project works. The number, character, and location of gages, meters, or other measuring devices, and the method of operation thereof, shall at all times be satisfactory to the Commission or its authorized representative. The Commission reserves the right, after notice and opportunity for hearing, to require such alterations in the number, character, and location of gages, meters, or other measuring devices, and the method of operation thereof, as are necessary to secure adequate determinations. The installation of gages, the rating of said stream or streams, and the determination of the flow thereof, shall be under the supervision of, or in cooperation with, the District Engineer of the United States Geological Survey having charge of stream-gaging operations in the region of the project, and the Licensee shall advance to the United States Geological Survey the amount of funds estimated to be necessary for such supervision, or cooperation for such periods as may be mutually agreed upon. The Licensee shall keep accurate and sufficient records of the foregoing determinations to the satisfaction of the Commission, and shall make return of such records annually at such time and in such form as the Commission may prescribe.

Article 9. The Licensee shall, after notice and opportunity for hearing, install additional capacity or make other changes in the project as directed by the Commission, to the extent that it is economically sound and in the public interest to do so.

Article 10. The Licensee shall, after notice and opportunity for hearing, coordinate the operation of the project, electrically and hydraulically, with such other projects or power systems and in such manner as the Commission may direct in the interest of power and other beneficial public uses of water resources, and on such conditions concerning the equitable sharing of benefits by the Licensee as the Commission may order.

Article 11. Whenever the Licensee is directly benefited by the construction work of another licensee, a permittee, or the United States on a storage reservoir or other headwater improvement, the Licensee shall reimburse the owner of the headwater improvement for such part of the annual charges for interest, maintenance, and depreciation thereof as the Commission shall determine to be equitable, and shall pay to the United States the cost of making such determination as fixed by the Commission. For benefits provided by a storage reservoir or other headwater improvement of the United States, the Licensee shall pay to the Commission the amounts for which it is billed from time to time for such headwater benefits and for the cost of making the determinations pursuant to the then current regulations of the Commission under the Federal Power Act.

Article 12. The operations of the Licensee, so far as they affect the use, storage and discharge from storage of waters affected by the license, shall at all times be controlled by such reasonable rules and regulations as the Commission may prescribe for the protection of life, health, and property, and in the interest of the fullest practicable conservation and utilization of such waters for power purposes and for other beneficial public uses, including recreational purposes, and the Licensee shall release water from the project reservoir at such rate in cubic feet per second, or such volume in acre-feet per specified period of time, as the Commission may prescribe for the purposes hereinbefore mentioned.

Article 13. On the application of any person, association, corporation, Federal agency, State or municipality, the Licensee shall permit such reasonable use of its reservoir or other project properties, including works, lands and water rights, or parts thereof, as may be ordered by the Commission, after notice and opportunity for hearing, in the interests of comprehensive development of the waterway or waterways involved and the conservation and utilization of the water resources of the region for water supply or for the purposes of steam-electric, irrigation, industrial, municipal or similar uses. The Licensee shall receive reasonable compensation for use of its reservoir or other project properties or parts thereof for such purposes, to include at least full reimbursement for any damages or expenses which the joint use causes the Licensee to incur. Any such compensation shall be fixed by the Commission either by approval of an agreement between the Licensee and the party or parties benefiting or after notice and opportunity for hearing. Applications shall contain information in sufficient detail to afford a full understanding of the proposed use, including satisfactory evidence that the applicant possesses necessary water rights pursuant to applicable State law, or a showing of cause why such evidence cannot concurrently be submitted, and a statement as to the relationship of the proposed use to any State or municipal plans or orders which may have been adopted with respect to the use of such waters.

Article 14. In the construction or maintenance of the project works, the Licensee shall place and maintain suitable structures and devices to reduce to a reasonable degree the liability of contact between its transmission lines and telegraph, telephone and other signal wires or power transmission lines constructed prior to its transmission lines and not owned by the Licensee, and shall also place and maintain suitable structures and devices to reduce to a reasonable degree the liability of any structures or wires falling or obstructing traffic or endangering life. None of the provisions of this article are intended to relieve the Licensee from any responsibility or requirement whcih may be imposed by any other lawful authority for avoiding or eliminating inductive interference.

Article 15. The Licensee shall, for the conservation and development of fish and wildlife resources, construct, maintain, and operate, or arrange for the construction, maintenance, and operation of such reasonable facilities, and comply with such reasonable modifications of the project structures and operation, as may be ordered by the Commission upon its own motion or upon the recommendation of the Secretary of the Interior or the fish and wildlife agency or agencies of any State in which the project or a part thereof is located, after notice and opportunity for hearing.

Article 16. Whenever the United States shall desire, in connection with the project, to construct fish and wildlife facilities or to improve the existing fish and wildlife facilities at its own expense, the Licensee shall permit the United States or its designated agency to use, free of cost, such of the Licensee's lands and interests in lands, reservoirs, waterways and project works as may be reasonably required to complete such facilities or such improvements thereof. In addition, after notice and opportunity for hearing, the Licensee shall modify the project operation as may be reasonably prescribed by the Commission in order to permit the maintenance and operation of the fish and wildlife facilities constructed or improved by the United States under the provisions of this article. This article shall not be interpreted to place any obligation on the United States to construct or improve fish and wildlife facilities or to relieve the Licensee of any obligation under this license.

Article 17. The Licensee shall construct, maintain, and operate, or shall arrange for the construction, maintenance, and operation of such reasonable recreational facilities, including modifications thereto, such as access roads, wharves, launching ramps, beaches, picnic and camping areas, sanitary facilities, and utilities, giving consideration to the needs of the physically handicapped, and shall comply with such reasonable modifications of the project, as may be prescribed hereafter by the Commission during the term of this license upon its own motion or upon the recommendation of the Secretary of the Interior or other interested Federal or State agencies, after notice and opportunity for hearing.

Article 18. So far as is consistent with proper operation of the project, the Licensee shall allow the public free access, to a reasonable extent, to project waters and adjacent project lands owned by the Licensee for the purpose of full utilization of such lands and waters for navigation and for outdoor recreational purposes, including fishing and hunting: Provided, That the Licensee may reserve from public access such portions of the project waters, adjacent lands, and project facilities as may be necessary for the protection of life, health, and property.

Article 19. In the construction, maintenance, or operation of the project, the Licensee shall be responsible for, and shall take reasonable measures to prevent, soil erosion on lands adjacent to streams or other waters, stream sedimentation, and any form of water or air pollution. The Commission, upon request or upon its own motion, may order the Licensee to take such measures as the Commission finds to be necessary for these purposes, after notice and opportunity for hearing.

Article 20. The Licensee shall consult with the appropriate State and Federal agencies and, within one year of the date of issuance of this license, shall submit for Commission approval a plan for clearing the reservoir area. Further, the Licensee shall clear and keep clear to an adequate width lands along open conduits and shall dispose of all temporary structures, unused timber, brush, refuse, or other material unnecessary for the purposes of the project which results from the clearing of lands or from the maintenance or alteration of the project works. In addition, all trees along the periphery of project reservoirs which may die during operations of the project shall be removed. Upon approval of the clearing plan all clearing of the lands and disposal of the unnecessary material shall be done with due diligence and to the satisfaction of the authorized representative of the Commission and in accordance with appropriate Federal, State, and local statutes and regulations.

Article 21. Timber on lands of the United States cut, used, or destroyed in the construction and maintenance of the project works, or in the clearing of said lands, shall be paid for, and the resulting slash and debris disposed of, in accordance with the requirements of the agency of the United States having jurisdiction over said lands. Payment for merchantable timber shall be at current stumpage rates, and payment for young growth timber below merchantable size shall be at current damage appraisal values. However, the agency of the United States having jurisdiction may sell or dispose of the merchantable timber to others than the Licensee: Provided, That timber so sold or disposed of shall be cut and removed from the area prior to, or without undue interference with, clearing operations of the Licensee and in coordination with the Licensee's project construction schedules. Such sale or disposal to others shall not relieve the Licensee of responsibility for the clearing and disposal of all slash and debris from project lands.

Article 22. The Licensee shall do everything reasonably within its power, and shall require its employees, contractors, and employees of contractors to do everything reasonably within their power, both independently and upon the request of officers of the agency concerned, to prevent, to make advance preparations for suppression of, and to suppress fires on the lands to be occupied or used under the license. The Licensee shall be liable for and shall pay the costs incurred by the United States in suppressing fires caused from the construction, operation, or maintenance of the project works or of the works appurtenant or accessory thereto under the license.

Article 23. The Licensee shall interpose no objection to, and shall in no way prevent, the use by the agency of the United States having jurisdiction over the lands of the United States affected, or by persons or corporations occupying lands of the United States under permit, of water for fire suppression from any stream, conduit, or body of water, natural or artificial, used by the Licensee in the operation of the project works covered by the license, or the use by said parties of water for sanitary and domestic purposes from any stream, conduit, or body of water, natural or artificial, used by the Licensee in the operation of the project works covered by the license.

Article 24. The Licensee shall be liable for injury to, or destruction of, any buildings, bridges, roads, trails, lands, or other property of the United States, occasioned by the construction, maintenance, or operation of the project works or of the works appurtenant or accessory thereto under the license. Arrangements to meet such liability, either by compensation for such injury or destruction, or by reconstruction or repair of damaged property, or otherwise, shall be made with the appropriate department or agency of the United States.

Article 25. The Licensee shall allow any agency of the United States, without charge, to construct or permit to be constructed on, through, and across those project lands which are lands of the United States such conduits, chutes, ditches, railroads, roads, trails, telephone and power lines, and other routes or means of transportation and communication as are not inconsistent with the enjoyment of said lands by the Licensee for the purposes of the license. This license shall not be construed as conferring upon the Licensee any right of use, occupancy, or enjoyment of the lands of the United States other than for the construction, operation, and maintenance of the project as stated in the license.

Article 26. In the construction and maintenance of the project, the location and standards of roads and trails on lands of the United States and other uses of lands of the United States, including the location and condition of quarries, borrow pits, and spoil disposal areas, shall be subject to the approval of the department or agency of the United States having supervision over the lands involved.

Article 27. The Licensee shall make provision, or shall bear the reasonable cost, as determined by the agency of the United States affected, of making provision for avoiding inductive interference between any project transmission line or other project facility constructed, operated, or maintained under the license, and any radio installation, telephone line, or other communication facility installed or constructed before or after construction of such project transmission line or other project facility and owned, operated, or used by such agency of the United States in administering the lands under its jurisdiction.

Article 28. The Licensee shall make use of the Commission's guidelines and other recognized guidelines for treatment of transmission line rights-of-way, and shall clear such portions of transmission line rights-of-way across lands of the United States as are designated by the officer of the United States in charge of the lands; shall keep the areas so designated clear of new growth, all refuse, and inflammable material to the satisfaction of such officer; shall trim all branches of trees in contact with or liable to contact the transmission lines; shall cut and remove all dead or leaning trees which might fall in contact with the transmission lines; and shall take such other precautions against fire as may be required by such officer. No fires for the burning of waste material shall be set except with the prior written consent of the officer of the United States in charge of the lands as to time and place.

Article 29. The Licensee shall cooperate with the United States in the disposal by the United States, under the Act of July 31, 1947, 61 Stat. 681, as amended (30 U.S.C. Sec. 601, *et seq*.), of mineral and vegetative materials from lands of the United States occupied by the project or any part thereof: *Provided*, That such disposal has been authorized by the Commission and that it does not unreasonably interfere with the occupancy of such lands by the Licensee for the purposes of the license: *Provided further*, That in the event of disagreement, any question of unreasonable interference shall be determined by the Commission after notice and opportunity for hearing.

Article 30. If the Licensee shall cause or suffer essential project property to be removed or destroyed or to become unfit for use, without adequate replacement, or shall abandon or discontinue good faith operation of the project or refuse or neglect to comply with the terms of the license and the lawful orders of the Commission mailed to the record address of the Licensee or its agent, the Commission will deem it to be the intent of the Licensee to surrender the license. The Commission, after notice and opportunity for hearing, may require the Licensee to remove any or all structures, equipment and power lines within the project boundary and to take any such other action necessary to restore the project waters, lands, and facilities remaining within the project boundary to a condition satisfactory to the United States agency having jurisdiction over its lands or the Commission's authorized representative, as appropriate, or to provide for the continued operation and maintenance of nonpower facilities and fulfill such other obligations under the license as the Commission may prescribe. In addition, the Commission in its discretion, after notice and opportunity for hearing, may also agree to the surrender of the license when the Commission, for the reasons recited herein, deems it to be the intent of the Licensee to surrender the license.

Article 31. The right of the Licensee and of its successors and assigns to use or occupy waters over which the United States has jurisdiction, or lands of the United States under the license, for the purpose of maintaining the project works or otherwise, shall absolutely cease at the end of the license period, unless the Licensee has obtained a new license pursuant to the then existing laws and regulations, or an annual license under the terms and conditions of this license.

Article 32. The terms and conditions expressly set forth in the license shall not be construed as impairing any terms and conditions of the Federal Power Act which are not expressly set forth herein.

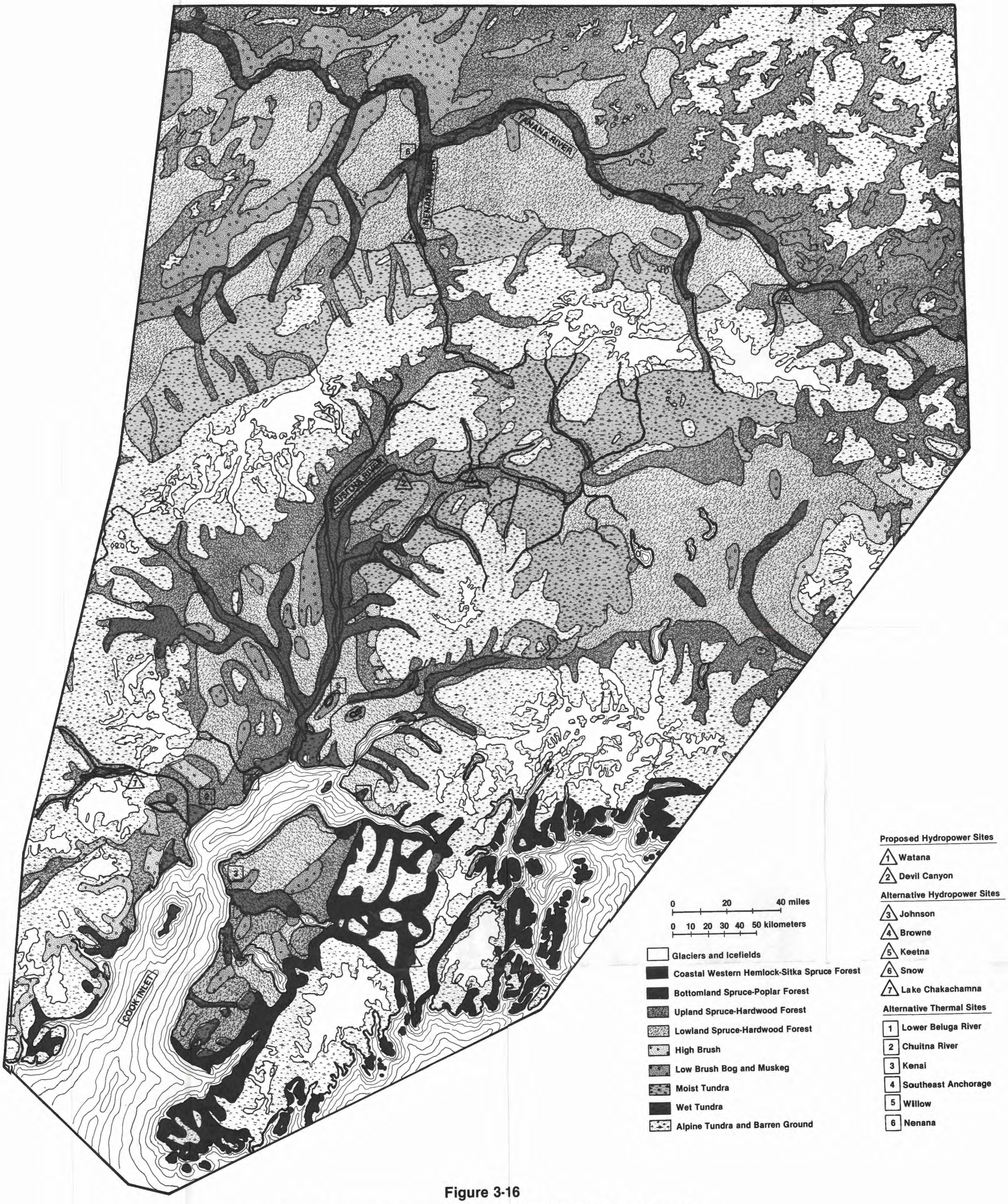

Figure 3-16

General Vegetation Distribution in Southcentral Alaska and Locations of Proposed Dam Sites, Non-Susitna Alternative Hydropower Sites, and Alternative Thermal Unit Sites. [Source: Adapted from Selkregg, 1974; 1977]