BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

APPLICATION FOR LICENSE FOR MAJOR PROJECT

SUSITNA HYDROELECTRIC PROJECT

VOLUME 1

D R A F T

EXHIBIT A

HARZA-EBASCO
SUSITNA JOINT VENTURE

Alaska Power Authority

BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

APPLICATION FOR LICENSE FOR MAJOR PROJECT

SUSITNA HYDROELECTRIC PROJECT
DRAFT LICENSE APPLICATION

VOLUME 1

EXHIBIT A
PROJECT DESCRIPTION

November 1985

INITIAL STATEMENT

BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION:
APPLICATION FOR LICENSE FOR A
MAJOR UNCONSTRUCTED PROJECT OR MAJOR MODIFIED PROJECT

1. The Alaska Power Authority applies to the Federal Energy Regulatory Commission for a licnese for the Susitna Hydroelectric Water Power Project, as described in the attached exhibits.

2. The location of the proposed project is:

State:	Alaska
Borough:	Matanuska-Susitna
Stream or other Body of Water:	Susitna River

3. The exact name, business address and telephone number of the applicant is:

Alaska Power Authority
334 West 5th Avenue
Anchorage, Alaska 99501
(907) 276-0001

The exact names, business addresses and telephone numbers of the persons authorized to act as agents for the applicant in this application are:

Mr. James B. Dischinger
Project Manager
Alaska Power Authority
334 West 5th Avenue
Anchorage, Alaska 99501
(907) 276-0001

and

Charles B. Curtis, Esq.
Van Ness, Feldman, Sutcliffe & Curtis
1050 Thomas Jefferson Street, NW
Seventh Floor
Washington, D.C. 20007
(202) 331-9400

4. The applicant is a public corporation of the State of Alaska in the Department of Commerce and Economic Development but with separate and independent legal existence.

5. (i) The statutory or regulatory requirements of the state in which the project would be located and that affect the project as

proposed with respect to bed and banks and to the appropriation, diversion, and use of water for power purposes, and with respect to the right to engage in the business of developing, transmitting, and distributing power and in any other business necessary to accomplish the purposes of the license under the Federal Power Act, are:

(A) ALASKA STAT. §§44.83.010-44.83.425 (1984) ("Alaska Power Authority") (including §§44.83.300- 44.83.360, entitled "Susitna River Hydroelectric Project"); ALASKA ADMIN. CODE, tit. 3, §94.010-94.900 (Apr. 1982).

These statutory provisions and regulations establish the Alaska Power Authority as a legal entity, the purpose of which is "to promote, develop and advance the general prosperity and economic welfare of the people of Alaska by providing a means of constructing, acquiring, financing and operating power projects," including hydroelectric facilities. ALASKA STAT. §§44.83.070 (1)(1984). The Alaska Power Authority has a number of specific powers, including (1) the right to perform reconnaissance studies, feasibility studies, and engineering and design with respect to power projects, 2) the right to enter into contracts, (3) the right to issue bonds, (4) the right to exercise the power of eminent domain and (5) the right to construct and operate power projects. See ALASKA STAT. §§44.83.080 (1984).

Sections 44.83.300-44.83.360 deal specifically with the Susitna River Hydroelectric Project, the purpose of which is to generate, transmit and distribute electric power in a manner that will (1) minimize market area electrical power costs, (2) minimize adverse environmental and social impacts while enhancing environmental values to the extent possible and (3) safeguard both life and property. ALASKA STAT. §§44.83.300-44.83.310 (1984). The Alaska Power Authority is permitted to contract for preliminary work on the Susitna Project (including preparation of plans and studies, preparation and submission of license applications, and other types of work necessary before actual construction of the project can begin) without seeking state legislative approval. See ALASKA STAT. §§44.83.325 (1984) (Editor's note). Additionally, the Alaska Power Authority is required to obtain approval by the state legislature of its preliminary report on the Susitna Project, as provided in ALASKA STAT. §§44.83.325 (1984) before contracting for preparation of the site or contracting for actual construction of the project. See Alaska Sess. Laws, Ch. 133,§21. In addition, state legislative approval of the financing of the project is required. See ALASKA STAT. §§44.83.360 (1977)

(B) ALASKA STAT. §§46.15.030-46.15.185 (1982) ("Appropriation and Use of Water"); ALASKA ADMIN. CODE tit. 11, §§93.040-93.140 (Jan. 1980) ("Appropriation of Water").

These statutory provisions and regulations set forth the manner in which a right to appropriate water in Alaska may be acquired. They require that application for a permit to appropriate be made to the Department of Natural Resources. See ALASKA STAT. §46.15.040 (1982); ALASKA ADMIN. CODE tit. 11, §93.040 (Apr. 1985). They also list certain criteria which must be considered when evaluating the application. See ALASKA STAT. §46.15.080 (1982); ALASKA ADMIN. CODE titl. 11, §93.120 (Apr. 1985). In addition, the cited statute and regulations specify under what conditions one who has been granted a permit to appropriate shall be granted a certificate of appropriation.

(C) ALASKA ADMIN. CODE tit. 11, §§93.150-93.200.185 (Jan. 1980) ("Dam Safety and Construction").

These regulations (also promulgated pursuant to ALASKA STAT. §46.15.030-46.15.185 (1982), discussed in (B) above) require a "certificate of approval" to be obtained from the Department of Natural Resources prior to construction of dams as large as those proposed for the Susitna Project. Approval is based on information contained in drawings and design data submitted with the application for the certificate.

(D) ALASKA STAT. §16.05.870 (1983) ("Protection of Fish and Game").

This section required that any person or governmental agency intending to "use, divert... or change the natural flow or bed" of a river, lake or stream, such as the Susitna River, which has been designed as important to the spawning, rearing or migration of anadromous fish (1) notify the Department of that intent and (2) await its approval of the construction.

(E) ALASKA STAT. §§16.10.010-16.10.020 (1983) ("Interference With Salmon Spawning Streams and Waters", "Grounds for Permit or License").

These sections essentially require that any person who will erect a dam which may affect salmon spawning streams or waters first apply for and obtain a permit or license from the Department of Environmental Conservation. One purpose for which a permit or license may be granted is the development of power. As a condition for such a permit adequate fishways may be required.

(F) ALASKA STAT. §16.05.840 (1983) ("Fishway Required").

The Commissioner of the Department of Fish and Game may require that a fishway be provided for a dam built across a stream frequented by salmon or other fish. In the event that a fishway is considered necessary, plans and specifications must be submitted for approval.

(G) ALASKA ADMIN. CODE tit. 18, §§15.130-15.180 (Jan. 1978) ("Certification").

Under Federal law, an applicant for a Federal license to construct or operate a facility must make application to obtain from the State a certification of compliance with the Federal Water Pollution Control Act. 33 U.S.C. §1341 (1977). Issuance of such a certificate is governed by ALASKA ADMIN. CODE tit. 18, §§15.130-15.180. The procedures governing that certification process are set forth in these sections of the Code.

(H) ALASKA STAT. §38.05.020-38.05.330 (1984) ("Alaska Lands Act").

These sections of the Alaska Statutes provide the methods by which the Alaska Power Authority may obtain use of state lands. The Department of Natural Resources may lease, sell or otherwise dispose of state land to a state or political subdivision for less than its appraised value if such action is found by the Department to be fair and proper and in the best interests of the public. ALASKA STAT. §38.05.810 (1984). The Department may issue permits, rights-of-way or easements on state land for roads and electric transmission and distribution lines. ALASKA STAT. §38.05.810 (1984). Prior to disposing of state land which is adjacent to a body of water or a waterway, the Department must determine whether the body of water or waterway is navigable or public water or neither. If it is navigable or public water, the Department may provide for easements or rights-of-way. ALASKA STAT. §38.05.127 (a)(1984).

(I) ALASKA STAT. §§46.40.030-46.40.040; §§46.40.090-46.40.100 (1982) ("Development of Alaska Coastal Management Program"); ALASKA ADMIN. CODE tit. 6, §50.011-50.190 (Apr. 1984) ("Project Consistency with Alaska Coastal Management Program").

These sections require that the Alaska Coastal Policy Council, state agencies, and municipalities administer the resources within a coastal area in a manner consistent with the applicable district coastal management plan. The Susitna Project is located within a designated coastal resource district.

(J) ALASKA ADMIN. CODE tit. 18, §§15, 50 (Jan. 1984)("Air Quality Control").

These regulations provide for permit applications for various facilities as described in ALASKA ADMIN. CODE tit. 18, §50.300(a). Applications for permits from the Department of Environmental Conservation must include information set forth in ALASKA ADMIN. CODE tit. 18, §§50.300(b), (c), (d), and (e).

(K) ALASKA ADMIN. CODE tit. 18, §72 (Jan. 1983) ("Waste Water Disposal").

These regulations provide for permits issued by the Department of Environmental Conservation for the disposal of domestic wastewater into or onto waters or lands in Alaska, as well as general permits for activities producing wastewater. ALASKA ADMIN. CODE tit. 18, §§72.015 and 72.920.

5. (ii) The steps which the applicant has taken, or plans to take, to comply with each of the laws cited above are:

(A) ALASKA STAT. §§44.83.010-44.83.425 (1977), 1982 Supp.).

The Alaska Power Authority has sought legislative approval of its preliminary report on the Susitna Project.

(B) ALASKA STAT. §§46.15.030-46.15.185 (1982); ALASKA ADMIN. CODE tit. 11, §§93.040-93.140 (Apr. 1985).

An investigation of existing water rights has been completed in connection with the permit required by the cited statute and regulations. The results indicate that the project would have a materially adverse impact on existing water rights. In addition, the Alaska Power Authority has applied for a permit to appropriate water for the Susitna Project. In addition, the Alaska Power Authority has applied for a permit to appropriate water for the Susitna Project from the Department of Natural Resources, and has been in cooperation with the Department in providing the necessary information to establish that such appropriation is in the public interest.

(C) ALASKA ADMIN. CODE tit. 11, §§93.150-93.200 (Apr. 1985).

The required drawings and design data are contained in Exhibits B, F, and G of this Initial Statement. The Alaska Power Authority has applied for a certificate of approval.

(D) ALASKA STAT. §16.05.870 (1983).

The Alaska Power Authority has notified the Department of Fish and Game of its intent to construct the project on the Susitna River.

(E) ALASKA STAT. §§16.10.010-16.10.020 (1977).

The Alaska Power Authority has apprised the appropriate Departments of the Susitna Project and requested a ruling of its permitting requirements pursuant to these sections. Authorization pursuant to ALASKA STAT. §16.14.010 has been received from the Department of Environmental Conservation.

(F) ALASKA STAT. §16.05.840 (1977).

The Alaska Power Authority has notified the Department of Fish and Game of the Susitna Project.

(G) ALASKA ADMIN. CODE tit. 18, §§15.130-15.180 (Jan. 1978).

The Alaska Power Authority has notified the Department of Environmental Conservation that it will seek a certificate of compliance with the Federal Water Pollution Control Act. Under Alaska regulations, application for such a certificate is made by serving on the Department a copy of the Federal license application contemporaneously with submission of the application to the Federal agency. ALASKA ADMIN. CODE tit. 18, §15.180(c). The Alaska Power Authority has complied with this requirement.

(H) ALASKA STAT. §38.05.020-38.05.030 (1982 Supp.).

The Alaska Power Authority has requested a right-of-way for transmission lines from the Department of Natural Resources. Rights-of-way may be requested for an access road and a railroad spur. If any state land acquired for the Susitna Project is adjacent to public or navigable waters, the Department of Natural Resources will determine whether easements or rights-of-way shall be provided.

(I) ALASKA STAT. §§46.40.030-46.40.040; §§46.40.040-46.40.100 (1982); ALASKA ADMIN. CODE tit. 6 §§50.010-50.190 (Apr. 1984).

The Susitna Project will be reviewed for consistency with the coastal management plan of the borough of Matanuska. This review process is initiated when federal permit-granting agencies forward copies of the Susitna application to the the Govenor of the State of Alaska (Office of Management and Budget) as part of the federal permit process.

(J) ALASKA ADMIN. CODE tit. 18, §§15, 50 (Jan. 1984).

The Alaska Power Authority has requested a permit from the Department of Environmental Conservation, and has submitted a proposed air quality control program along with supplemental information including a proposed monitoring program.

(K) ALASKA ADMIN. CODE tit. 18, §72 (Jan. 1983).

The Alaska Power Authority has requested a wastewater disposal permit from the Department of Environmental Conservation.

IN WITNESS WHEREOF, the applicant, Alaska Power Authority, has caused its name to be signed below by Robert B. Heath, its Executive Director, and its seal to be affixed hereto by _____, its _____, this _____ day of _____, 1985.

ALASKA POWER AUTHORITY

By _____
Robert B. Heath
Executive Director

(SEAL)

ALASKA STATUTES

Chapter 83. Alaska Power Authority.

Article 1. Creation and Organization.

Sec. 44.83.010. Legislative finding and policy. (a) The legislature finds, determines and declares that

(1) there exist numerous potential hydroelectric and fossil fuel gathering sites in the state;

(2) the establishment of power projects at these sites is necessary to supply power at the lowest reasonable cost to the state's municipal electric, rural electric, cooperative electric, and private electric utilities, and regional electric authorities, and thereby to the consumers of the state, as well as to supply existing or future industrial needs;

(3) the achievement of the goals of lowest reasonable consumer power costs and beneficial long-term economic growth and of establishing, operating and developing power projects in the state will be accelerated and facilitated by the creation of an instrumentality of the state with powers to construct, acquire, finance, and operate power projects.

(b) It is declared to be the policy of the state, in the interests of promoting the general welfare of all the people of the state, and public purposes, to reduce consumer power costs and otherwise to encourage the long-term economic growth of the state, including the development of its natural resources, through the establishment of power projects by creating the public corporation with powers, duties and functions as provided in this chapter. (§ 1 ch 278 SLA 1976; am § 1 ch 156 SLA 1978)

Revisor's notes. — Formerly AS 44.56.010. Renumbered in 1980.

Sec. 44.83.020. Creation of authority. There is created the Alaska Power Authority. The authority is a public corporation of the state in the Department of Commerce and Economic Development but with separate and independent legal existence. (§ 1 ch 278 SLA 1976)

Revisor's notes. — Formerly AS 44.56.020. Renumbered in 1980.

Sec. 44.83.030. Membership of the authority. The authority shall consist of the following directors:

(1) three public directors to be appointed by the governor and confirmed by the legislature; only one director may be appointed from each judicial district described in AS 22.10.010;

(2) the director of the office of management and budget, or the director's designee within that office, and three commissioners of principal executive departments appointed by the governor. (§ 1 ch 278 SLA 1976; am § 2 ch 156 SLA 1978; am § 2 ch 118 SLA 1981; am § 25 ch 63 SLA 1983)

Revisor's notes. — Formerly AS 44.56.030. Renumbered in 1980.

Cross references. — For transitional provisions related to the authority's 1981 reorganization, see § 15, ch. 118, SLA 1981.

Effect of amendments. — The 1981 amendment deleted the subsection designation (a) and repealed subsection (b) which read "The commissioners of community and regional affairs, natural resources, transportation and public facilities, and revenue shall have the rights and privileges of directors except for the right to vote and may not be considered for purposes of quorum or voting." The amendment also substituted "three public" for "four" preceding "directors," deleted "at large" preceding "to be appointed" and added "only one director may be appointed from each judicial district described in AS 22.10.010" in paragraph (1) and substituted "the director of the division of budget and management and three commissioners of principal executive departments appointed by the governor" for "the commissioner of commerce and economic development" in paragraph (2).

The 1983 amendment, in paragraph (2) substituted "office of management and budget, or the director's designee within that office," for "division of budget and management."

Sec. 44.83.040. Officers; meetings; quorum. (a) The directors shall elect one of their number as chairman and may elect other officers they determine desirable. The powers of the authority are vested in the directors, and four directors of the authority constitute a quorum. Action may be taken and motions and resolutions adopted by the authority at a meeting by the affirmative vote of a majority of the directors. The directors of the authority serve without compensation, but they shall receive the same travel pay and per diem as provided by law for board members.

(b) The board may meet and transact business by an electronic medium if

(1) public notice of the time and locations where the meeting will be held by an electronic medium has been given in the same manner as if the meeting were held in a single location;

(2) participants and members of the public in attendance can hear and have the same right to participate in the meeting as if the meeting were conducted in person; and

(3) copies of pertinent reference materials, statutes, regulations, and audio-visual materials are reasonably available to participants and to the public.

(c) A meeting by an electronic medium as provided in this section has the same legal effect as a meeting in person.

(d) A director of the authority may not vote on a resolution of the authority relating to a lease or contract to be entered into by the authority under this chapter if the director is a party to the lease or contract or has a direct ownership or equity interest in a firm, partnership, corporation, or association that is a party to the contract or lease. When abstaining from voting, the director must disclose the reason for the abstention. A director who is a member of an electric cooperative that is organized under or subject to the Electric and Telephone Cooperative Act (AS 10.25) may vote on a resolution relating to a contract or lease to which that cooperative is a party. The director shall disclose

the cooperative membership at the time of voting. A resolution of the authority that is approved by a majority of the directors present who are not barred from voting under this subsection is a valid action of the authority for all purposes. (§ 1 ch 278 SLA 1976; am § 3 ch 156 SLA 1978; am § 3 ch 118 SLA 1981; am §§ 1, 2 ch 89 SLA 1983)

Revisor's notes. — Formerly AS 44.56.040. Renumbered in 1980.

Effect of amendments. — The 1981 amendment substituted "directors" for "director," substituted "their number" for "the directors at large" and added "may elect" preceding "other officers" in the first sentence and substituted "four" for "three" preceding "directors" in the second sentence.

The 1983 amendment substituted "a majority of the directors" for "at least three directors" at the end of the third sentence of subsection (a) and added subsections (b)-(d).

Sec. 44.83.045. Qualifications, powers, and duties of officers and directors. (a) The public directors shall be residents and qualified voters of Alaska and shall comply with the requirements of AS 39.50.010 — 39.50.200 (conflict of interests). The public directors shall serve overlapping four-year terms.

(b) A vacancy in a directorship occurring other than by expiration of a term shall be filled in the same manner as the original appointment, but for the unexpired portion of the term only.

(c) The authority shall employ an executive director who may, with the approval of the authority, employ additional staff as necessary. In addition to its staff of regular employees, the authority may contract for and engage the services of legal and bond counsel, consultants, experts, and financial and technical advisors the authority considers necessary for the purpose of conducting studies, investigations, hearings, or other proceedings. The board of directors shall establish the compensation of the executive director. The executive director of the authority is subject to the provisions of AS 39.25.010 — 39.25.220. (§ 4 ch 156 SLA 1978; am § 4 ch 118 SLA 1981)

Revisor's notes. — Formerly AS 44.56.045. Renumbered in 1980.

Effect of amendments. — The 1981 amendment added "public" preceding "directors" and substituted "shall" for "at large must" preceding "be residents" in the first sentence, added "public" preceding "directors," deleted "at large" following "directors" and added "overlapping" preceding "four-year terms" in the second sentence and deleted the former third sentence which read "The four original directors at large have terms of one, two, three, and four years, respectively."

Sec. 44.83.050. Staff. [Repealed, § 23 ch 156 SLA 1978.]

Article 2. Purpose and Powers.

Sec. 44.83.070. Purpose of the authority. The purpose of the authority is to promote, develop and advance the general prosperity and economic welfare of the people of Alaska by providing a means of constructing, acquiring, financing and operating

(1) power projects; and

(2) facilities that recover and use waste energy. (§ 1 ch 278 SLA 1976; am § 5 ch 156 SLA 1978; am § 1 ch 133 SLA 1982)

Revisor's notes. — Formerly AS 44.56.070. Renumbered in 1980.

Effect of amendments. — The 1982 amendment substituted paragraphs (1) and (2) for "power production facilities limited to fossil fuel, wind power, tidal, geothermal, hydroelectric, or solar energy production and waste energy conservation facilities."

Sec. 44.83.080. Powers of the authority. In furtherance of its corporate purposes, the authority has the following powers in addition to its other powers:

(1) to sue and be sued;

(2) to have a seal and alter it at pleasure;

(3) to make and alter bylaws for its organization and internal management;

(4) to adopt regulations governing the exercise of its corporate powers;

(5) to acquire, whether by construction, purchase, gift or lease, and to improve, equip, operate, and maintain power projects;

(6) to issue bonds to carry out any of its corporate purposes and powers, including the acquisition or construction of a project to be owned or leased, as lessor or lessee, by the authority, or by another person, or the acquisition of any interest in a project or any right to capacity of a project, the establishment or increase of reserves to secure or to pay the bonds or interest on them, and the payment of all other costs or expenses of the authority incident to and necessary or convenient to carry out its corporate purposes and powers;

(7) to sell, lease as lessor or lessee, exchange, donate, convey or encumber in any manner by mortgage or by creation of any other security interest, real or personal property owned by it, or in which it has an interest, when, in the judgment of the authority, the action is in furtherance of its corporate purposes;

(8) to accept gifts, grants or loans from, and enter into contracts or other transactions regarding them, with any person;

(9) to deposit or invest its funds, subject to agreements with bondholders;

(10) to enter into contracts with the United States or any person and, subject to the laws of the United States and subject to concurrence of the legislature, with a foreign country or its agencies, for the financing, construction, acquisition, operation and maintenance of all or any part of a power project, either inside or outside the state, and for the sale or

transmission of power from a project or any right to the capacity of it or for the security of any bonds of the authority issued or to be issued for the project;

(11) to enter into contracts with any person and with the United States, and, subject to the laws of the United States and subject to the concurrence of the legislature, with a foreign country or its agencies for the purchase, sale, exchange, transmission, or use of power from a project, or any right to the capacity of it;

(12) to apply to the appropriate agencies of the state, the United States and to a foreign country and any other proper agency for the permits, licenses, or approvals as may be necessary, and to construct, maintain and operate power projects in accordance with the licenses or permits, and to obtain, hold and use the licenses and permits in the same manner as any other person or operating unit;

(13) to perform reconnaissance studies, feasibility studies, and engineering and design with respect to power projects;

(14) to enter into contracts or agreements with respect to the exercise of any of its powers, and do all things necessary or convenient to carry out its corporate purposes and exercise the powers granted in this chapter;

(15) to exercise the power of eminent domain in accordance with AS 09.55.240 — 09.55.460;

(16) to recommend to the legislature

(A) the issuance of general obligation bonds of the state to finance the construction of a power project if the authority first determines that the project cannot be financed by revenue bonds of the authority at reasonable rates of interest;

(B) the pledge of the credit of the state to guarantee repayment of all or any portion of revenue bonds issued to assist in construction of power projects;

(C) an appropriation from the general fund

(i) for debt service on bonds or other project purposes; or

(ii) to reduce the amount of debt financing for the project;

(D) an appropriation to the power project fund for a power project;

(E) *[Repealed, § 16 ch 161 SLA 1984.]*

(F) development of a project under financing arrangements with other entities using leveraged leases or other financing methods;

(G) an appropriation for a power project acquired or constructed under the energy program for Alaska (AS 44.83.380 — 44.83.425). (§ 1 ch 278 SLA 1976; am §§ 6 — 11 ch 156 SLA 1978; am §§ 16, 17 ch 83 SLA 1980; am § 5 ch 118 SLA 1981; am § 16 ch 161 SLA 1984)

Revisor's notes. — Formerly AS 44.56.080. Renumbered in 1980.

Effect of amendments. — The 1980 amendment inserted in the middle of paragraph (13), "feasibility studies, and engineering and design," and added paragraph (16).

The 1981 amendment added subparagraph (G) of paragraph (16).

The 1984 amendment repealed paragraph (16)(E).

Sec. 44.83.090. Power contracts and the Alaska Public Utilities Commission. (a) The authority shall, in addition to the other methods which it may find advantageous, provide a method by which municipal electric, rural electric, cooperative electric, or private electric utilities and regional electric authorities, or other persons authorized by law to engage in the distribution of electricity may secure a reasonable share of the power generated by a project, or any interest in a project, or for any right to the power and shall sell the power or cause the power to be sold at the lowest reasonable prices which cover the full cost of the electricity or services, including capital and operating costs, debt coverage as considered appropriate by the authority, and other charges that may be authorized by AS 44.83.010 — 44.83.425. Except for a contract or lease entered into under AS 44.83.380 — 44.83.425, a contract or lease for the sale, transmission and distribution of power generated by a project or any right to the capacity of it shall provide:

(1) for payment of all operating and maintenance expenses of a project and costs of renewals, replacements and improvements of it;

(2) for interest on and amortization charges sufficient to retire bonds of the authority issued for the project and reserves for them, plus a debt service coverage factor as may be determined by the authority to be necessary for the marketability of its bonds;

(3) for monitoring of the project by the authority or its agents;

(4) for full and complete disclosure to the authority of all factors of costs in the transmission and distribution of power, so that rates to any persons may be fixed initially in the contract or lease and may be adjusted from time to time on the basis of true cost data;

(5) for periodic revisions of the service and rates to persons on the basis of accurate cost data obtained by the accounting methods and systems approved by the directors and in furtherance and effectuation of the policy declared in AS 44.83.010 — 44.83.425;

(6) for the cancellation and termination of a contract or lease upon violation of its terms by any person;

(7) for security for performance as the authority may consider practicable and advisable, including provisions assuring the continuance of the distribution and transmission of power generated by a project and the use of its facilities for these purposes; and

(8) other terms not inconsistent with the provisions and policy of this chapter as the authority may consider advisable.

(b) The authority is not subject to the jurisdiction of the Alaska Public Utilities Commission. Nothing in AS 44.83.010 — 44.83.425 grants the authority any jurisdiction over the services or rates of any public utility or diminishes or otherwise alters the jurisdiction of the Alaska Public Utilities Commission with respect to any public utility, including any right the commission may have to review and approve or disapprove contracts for the purchase of electricity by a public util-

ity. (§ 1 ch 278 SLA 1976; am § 12 ch 156 SLA 1978; am § 6 ch 118 SLA 1981)

Revisor's notes. — Formerly AS 44.56.090. Renumbered in 1980.

Effect of amendments. — The 1981 amendment substituted "except for a contract or lease entered into under AS 44.83.380 — 44.83.425, a" for "a" preceding "contract" and added "or lease" preceding "for the sale" in the second sentence of subsection (a) and added "or lease" following "contract" in paragraphs (4) and (6) of subsection (a).

Sec. 44.83.092. Authority for municipalities and utilities to enter into power sales contracts. The authority and any municipality or public or private entity operating an electric utility, or a municipality or private entity and another municipality or private entity, may enter into a contract providing for or relating to the sale of electric power by the authority to the municipality or entity, or by the municipality or entity to another municipality or entity. The contract may provide

(1) that the amounts payable under the contract are operating expenses of the utility and are valid and binding obligations of the municipality or other entity payable from the gross revenues of the utility;

(2) for one or more appropriations of the amounts payable under the contract;

(3) for the municipality or other entity to assume the obligations of another contracting party in the event of a default by that party;

(4) that after completion of a project the municipality or other entity is obligated to make payments notwithstanding a suspension or reduction in the amount of the power supplied by the project; or

(5) that payments under the contract are not subject to reduction by offset or otherwise. (§ 3 ch 89 SLA 1983)

Article 3. Financial Provisions.

Sec. 44.83.100. Bonds of the authority. (a) The authority may borrow money and may issue bonds, including but not limited to bonds on which the principal and interest are payable (1) exclusively from the income and receipts or other money derived from the project financed with the proceeds of the bonds; (2) exclusively from the income and

receipts or other money derived from designated projects whether or not they are financed in whole or in part with the proceeds of the bonds; (3) from its income and receipts or other assets generally, or a designated part or parts of them; or (4) from one or more revenue-producing contracts including a contract providing for the security of the bonds made by the authority with any person. The authority may issue bonds to pay, fund or refund the principal of, or interest or redemption premiums on, bonds issued by it, whether or not the bonds or interest to be funded or refunded have become due.

(b) Bonds shall be authorized by resolution of the authority, and shall be dated and shall mature as the resolution may provide, except that no bond may mature more than 50 years from the date of its issue. Bonds shall bear interest at the rates, be in the denominations, be in the form, either coupon or registered, carry the registration privileges, be executed in the manner, be payable in the medium of payment, at the places, and be subject to the terms of redemption which the resolution or a subsequent resolution may provide.

(c) All bonds, regardless of form or character, shall be negotiable instruments for all the purposes of the Uniform Commercial Code.

(d) All bonds may be sold at public or private sale in the manner, for the price or prices, and at the time or times which the authority may determine. (§ 1 ch 278 SLA 1976)

Revisor's notes. — Formerly AS 44.56.100. Renumbered in 1980.

Sec. 44.83.105. Bonds for power projects under the energy program for Alaska. The authority may borrow money and issue its bonds for the acquisition or construction of power projects to be acquired or constructed under the energy program for Alaska. The principal of and interest on the bonds are payable from money derived from the sale of wholesale power from power projects financed under AS 44.83.380 — 44.83.425 from the power development fund or from a source referred to in AS 44.83.100 as the authority determines. The bonds may be issued if

(1) appropriations to the power development fund for the power project are insufficient to cover the cost of acquiring or constructing the power project; and

(2) the authority determines that the amount of interest the authority will pay on its bonds is not more than alternative costs of securing money from other sources, except for the general fund, to pay for the acquisition or construction of the power project. (§ 7 ch 118 SLA 1981; am § 4 ch 89 SLA 1983)

Effect of amendments. — The 1983 amendment, divided the section into three sentences; in the first sentence, substituted "may borrow" for "shall borrow," deleted "shall" preceding "issue its bonds," and substituted the language beginning

"for the acquisition or construction" for "on which" at the end; in the second sentence, inserted "of" following "principal" and added "on the bonds" following "and interest" and added the language beginning "or from a source" to the end; and in the third sentence, added "The bonds may be issued" at the beginning, added "the authority determines that" at the beginning of paragraph (2), and inserted "from other sources, except for the general fund" in paragraph (2).

Sec. 44.83.110. Trust indentures and trust agreements. (a) In the discretion of the authority, an issue of bonds may be secured by a trust indenture or trust agreement between the authority and a corporate trustee (which may be a trust company, bank, or national banking association, with corporate trust powers, located inside or outside the state) or by a secured loan agreement or other instrument or under a resolution giving powers to a corporate trustee by means of which the authority may

(1) make and enter into any and all the covenants and agreements with the trustee or the holders of the bonds that the authority may determine to be necessary or desirable, including, without limitation, covenants, provisions, limitations and agreements as to

(A) the application, investment, deposit, use and disposition of the proceeds of bonds of the authority or of money or other property of the authority or in which it has an interest;

(B) the fixing and collection of rentals, charges, fees or other consideration for, and the other terms to be incorporated in, contracts with respect to a project or to generated power;

(C) the assignment by the authority of its rights in contracts with respect to a project or to generated power or in a mortgage or other security interest created with respect to a project or generated power to a trustee for the benefit of bondholders;

(D) the terms and conditions upon which additional bonds of the authority may be issued;

(E) the vesting in a trustee of rights, powers, duties, funds or property in trust for the benefit of bondholders, including, without limitation, the right to enforce payment, performance, and all other rights of the authority or of the bondholders, under a lease, power of contract, contract of sale, mortgage, security agreement, or trust agreement with respect to a project by injunction or other proceeding or by taking possession of by agent or otherwise and operating a project and collecting rents or other consideration and applying the same in accordance with the trust agreement;

(2) pledge, mortgage or assign money, leases, agreements, property or other rights or assets of the authority either presently in hand or to be received in the future, or both; and

(3) provide for any other matters of like or different character which in any way affect the security or protection of the bonds.

(b) Notwithstanding any other provisions of this chapter, the trust indenture, trust agreement, secured loan agreement, or other instrument or the resolution constituting a contract with bondholders

shall contain a covenant by the authority that it will at all times maintain rates, fees or charges sufficient to pay, and that a contract entered into by the authority for the sale, transmission or distribution of power shall contain rates, fees or charges sufficient to pay the costs of operation and maintenance of the project, the principal of and interest on bonds issued under the trust agreement as the same severally become due and payable, to provide for debt service coverage as considered necessary by the authority for the marketing of its bonds and to provide for renewals, replacements and improvements of the project, and to maintain reserves required by the terms of the trust agreement. This subsection does not require a covenant that varies from a covenant entered into in accordance with the provisions of AS 44.83.380 — 44.83.425.

(c) For the purpose of securing any one or more issues of its bonds, the authority may establish one or more special funds, called "capital reserve funds", and shall pay into those capital reserve funds the proceeds of the sale of its bonds and any other money that may be made available to the authority for the purposes of those funds from any other source. The funds shall be established only if the authority determines that the establishment would enhance the marketability of the bonds. All money held in a capital reserve fund, except as provided in this section, shall be used as required, solely for (1) the payment of the principal of, and interest on, bonds or of the sinking fund payments with respect to those bonds, (2) the purchase or redemption of bonds, or (3) the payment of a redemption premium required to be paid when those bonds are redeemed before maturity; however, money in a fund may not be withdrawn from it at any time in an amount that would reduce the amount of that fund to less than the capital reserve requirement set out in (2) of this subsection, except for the purpose of making, with respect to those bonds, payment, when due, of principal, interest, redemption premiums and the sinking fund payments for the payment of which other money of the authority is not available. Income or interest earned by, or increment to, a capital reserve fund, due to the investment of the fund or any other amounts in it, may be transferred by the authority to other funds or accounts of the authority to the extent that the transfer does not reduce the amount of the capital reserve fund below the capital reserve fund requirement.

(d) If the authority decides to issue bonds secured by such a capital reserve fund, the bonds may not be issued if the amount in the capital reserve fund is less than such an amount as may be established by resolution of the authority (called the "capital reserve fund requirement"), unless the authority, at the time of issuance of the obligations, deposits in the capital reserve fund from the proceeds of the obligations to be issued or from other sources, an amount which, together with the amount then in the fund, will not be less than the capital reserve fund requirement.

(e) In computing the amount of a capital reserve fund for the purpose of this section, securities in which all or a portion of the funds are invested shall be valued by some reasonable method established by the authority by resolution. Valuation on a particular date shall include the amount of any interest earned or accrued to that date.

(f) The chairman of the authority shall annually, no later than January 2, make and deliver to the governor and the legislature a certificate stating the sum, if any, required to restore any capital reserve fund to the capital reserve fund requirement. The legislature may appropriate such a sum, and all sums appropriated during the then current fiscal year by the legislature for such restoration shall be deposited by the authority in the proper capital reserve fund. Nothing in this section creates a debt or liability of the state.

(g) When the authority has created and established a capital reserve fund, the commissioner of revenue may lend surplus money in the general fund to the authority for deposit in a capital reserve fund in an amount equal to the capital reserve fund requirement. The loans shall be made on such terms and conditions as may be agreed upon by the commissioner of revenue and the authority, including without limitation terms and conditions providing that the loans need not be repaid until the obligations of the authority secured and to be secured by the capital reserve fund are no longer outstanding.

(h) If the authority decides to covenant to issue or to issue bonds secured by a capital reserve fund, the bonds may not be issued until 10 days after the authority has mailed notification to the State Bond Committee and the Legislative Budget and Audit Committee by certified mail of its intention to establish a capital reserve fund to secure the bond issue. The notification shall include the amount of the capital reserve fund to be established, the amount of bonds proposed to be issued, and the total cost of the project for which the bonds are to be issued. The notification shall be accompanied by an estimate by the authority of the need to withdraw money from the capital reserve fund during the term of the bond issue, the amount that it may be necessary to withdraw, and the time at which withdrawals are estimated to be needed. The authority shall annually prepare a revised estimate, considering the same factors, and a statement of all withdrawals that have occurred from the date of issuance of the bonds to the end of the calendar year. The revised estimate and statement shall be submitted to the State Bond Committee and the Legislative Budget and Audit Committee by January 30 of the succeeding year. (§ 1 ch 278 SLA 1976; am §§ 13, 14 ch 156 SLA 1978; am § 2 ch 133 SLA 1982; am § 5 ch 89 SLA 1983)

Revisor's notes. — Formerly AS 44.56.110. Renumbered in 1980.

Effect of amendments. — The 1982 amendment added subsection (h).

The 1983 amendment, in subsection (b), substituted the language beginning "the trust indenture, trust agreement" and ending "constituting a contract with

bondholders" for "the trust agreement" near the beginning of the first sentence and added the second sentence.

Sec. 44.83.120. Validity of pledge. It is the intention of the legislature that a pledge made in respect of bonds is considered perfected and is valid and binding from the time the pledge is made; that the money or property so pledged and thereafter received by the authority shall immediately be subject to the lien of the pledge without physical delivery or further act; and that the lien of the pledge shall be valid and binding as against all parties having claims of any kind in tort, contract or otherwise against the authority irrespective of whether the parties have notice. Neither the resolution, trust agreement nor any other instrument by which a pledge is created need be recorded or filed under the provisions of the Uniform Commercial Code to be perfected or to be valid, binding or effective against the parties. (§ 1 ch 278 SLA 1976; am § 6 ch 89 SLA 1983)

Revisor's notes. — Formerly AS 44.56.120. Renumbered in 1980.

Effect of amendments. — The 1983 amendment, substituted "is considered perfected and is valid" for "shall be valid" near the beginning of the first sentence and inserted "perfected or to be" in the second sentence.

Sec. 44.83.130. Nonliability on bonds. (a) Neither the members of the authority nor a person executing the bonds is liable personally on the bonds or is subject to personal liability or accountability by reason of the issuance of the bonds.

(b) The bonds issued by the authority do not constitute an indebtedness or other liability of the state or of a political subdivision of the state, except the authority, but shall be payable solely from the income and receipts or other funds or property of the authority. The authority may not pledge the faith or credit of the state or of a political subdivision of the state, except the authority, to the payment of a bond and the issuance of a bond by the authority does not directly or indirectly or contingently obligate the state or a political subdivision of the state to apply money from, or levy or pledge any form of taxation whatever to the payment of the bond. (§ 1 ch 278 SLA 1976)

Revisor's notes. — Formerly AS 44.56.130. Renumbered in 1980.

Sec. 44.83.140. Pledge of the state. The state pledges to and agrees with the holders of bonds issued under this chapter and with the federal agency which loans or contributes funds in respect to a project, that the state will not limit or alter the rights and powers vested in the authority by this chapter to fulfill the terms of a contract made by the authority with the holders or federal agency, or in any way impair the rights and remedies of the holders until the bonds, together with the

interest on them with interest on unpaid installments of interest, and all costs and expenses in connection with an action or proceeding by or on behalf of the holders, are fully met and discharged. The authority is authorized to include this pledge and agreement of the state, insofar as it refers to holders of bonds of the authority, in a contract with the holders, and insofar as it relates to a federal agency, in a contract with the federal agency. (§ 1 ch 278 SLA 1976)

Revisor's notes. — Formerly AS 44.56.140. Renumbered in 1980.

Sec. 44.83.150. Tax exemption. All property of the authority is public property devoted to an essential public and governmental function and purpose and is exempt from all taxes of the state or a political subdivision of the state; however, the authority may make payments in place of taxes in amounts equal to the real and personal property taxes which would be assessed on its real and personal property by each political subdivision in which its property is located to the same extent as if that property were private property and the authority were a non-public corporation. All bonds issued under this chapter are issued by a body corporate and public of this state and for an essential public and governmental purpose and the bonds and the interest and income on and from the bonds and all income of the authority are exempt from taxation except for transfer, inheritance and estate taxes. (§ 1 ch 278 SLA 1976; am § 15 ch 156 SLA 1978)

Revisor's notes. — Formerly AS 44.56.150. Renumbered in 1980.

Sec. 44.83.160. Bonds legal investments for fiduciaries. The bonds of the authority are securities in which all public officers and bodies of the state and all municipalities and municipal subdivisions, all insurance companies and associations and other persons carrying on any insurance business, all banks, bankers, trust companies, savings banks, savings associations, including savings and loan associations and building and loan associations, investment companies and other persons carrying on a banking business, all administrators, guardians, executors, trustees and other fiduciaries, and all other persons whatsoever who are now or may hereafter be authorized to invest in bonds or other obligations of the state, may properly and legally invest funds including capital in their control or belonging to them. Notwithstanding any other provisions of law, the bonds of the authority are also securities which may be deposited with and may be received by all public officers and bodies of this state and all municipalities and minicipal subdivisions for any purpose for which the deposit of bonds or other obligations of the state is now or may hereafter be authorized. (§ 1 ch 278 SLA 1976)

Revisor's notes. — Formerly AS 44.56.160. Renumbered in 1980.

Article 4. Power Cost Equalization Program.

Sec. 44.83.162. Power cost equalization. (a) The power cost equalization fund is established as a separate fund for the purpose of equalizing power cost per kilowatt-hour statewide at a cost close or equal to the mean of the cost per kilowatt-hour in Anchorage, Fairbanks, and Juneau by paying money from the fund to eligible electric utilities in the state. The fund shall be administered by the authority as a fund distinct from the other funds of the authority. The fund is composed of money appropriated for the purpose of providing power cost equalization to eligible electric utilities.

(b) The costs used to calculate the amount of power cost equalization for all electric utilities eligible under this section include all allowable costs, except return on equity, used by the commission to determine the revenue requirement for electric utilities subject to rate regulation under AS 42.05. The costs used in determining the power cost equalization per kilowatt-hour shall exclude any other type of assistance that reduces the customer's costs of power on a kilowatt-hour basis and that is provided to the electric utility within 60 days before the commission determines the power cost equalization per kilowatt-hour of the electric utility.

(c) An eligible electric utility is entitled to receive power cost equalization

(1) for sales of power to local community facilities, calculated in the aggregate for each community served by the electric utility, for actual consumption of not more than 70 kilowatt-hours per month for each resident of the community; and

(2) for actual consumption of not more than 750 kilowatt-hours per month sold to each customer in all classes served by the electric utility except to customers of the utility under (1) of this subsection.

(d) The amount of power cost equalization provided per kilowatt-hour under (c) of this section may not exceed 95 percent of the power costs, or the average rate per eligible kilowatt-hour sold, whichever is less, as determined by the commission. However,

(1) during the state fiscal year that begins July 1, 1984 the power costs for which power cost equalization may be paid to an electric utility are limited to minimum power costs of more than 8.5 cents per kilowatt-hour and less than 52.5 cents per kilowatt-hour;

(2) during each following state fiscal year, the power costs for which power cost equalization may be paid to an electric utility shall be adjusted by the commission, considering the rate of change in fuel cost and power demand; and

(3) the power cost equalization per kilowatt-hour may be determined for a utility without historical kilowatt-hour sales data by using kilowatt hours generated.

(e) An electric utility whose customers receive power cost equalization under this section shall set out in its tariff the rates without the power cost equalization and the amount of power cost equalization per kilowatt-hour sold. The rate charged to the customer shall be the difference between the two amounts. Power cost equalization paid under this section shall be used to reduce the cost of all power sold to local community facilities, in the aggregate, to the extent of 70 kilowatt-hours per month per resident of the community, and to reduce the cost of the first 750 kilowatt-hours per customer per month for all other classes served by the electric utility.

(f) The power cost equalization program shall be administered by the authority based on a determination by the commission under (b) and (d) of this section of power cost equalization per kilowatt-hour for each eligible electric utility.

(g) An eligible electric utility may not be denied power cost equalization because complete cost information is not available. An eligible electric utility that is exempt from rate regulation under AS 42.05 shall be assisted by the commission to provide the cost information the commission considers necessary to comply with the requirements of this section. Only power costs that are supportable may be considered in calculating power cost equalization. Each electric utility is responsible for keeping records that provide the information necessary to comply with the requirements of this section including, but not limited to, records of monthly kilowatt-hour sales or generation, monthly fuel balances, fuel purchases, and monthly utility fuel consumption.

(h) For each eligible electric utility, the determination of the cost of fuel by the commission shall be in accordance with the procedure for approving fuel cost rate adjustments of electric utilities subject to rate regulation under AS 42.05.

(i) Each electric utility receiving power cost equalization approved by the commission shall

(1) report monthly to the authority within the time and in the form the authority requires; and

(2) use operational equipment designed to meter individual utility customer power consumption and to determine and record the utility's overall fuel consumption.

(j) The authority shall review the report required under (i)(1) of this section and may submit the report to the commission for additional

review before payment. After review and approval of the report by the authority, the authority shall, subject to appropriation, pay to each eligible electric utility an amount equal to the power cost equalization per kilowatt-hour determined by the commission under (b) and (d) of this section, multiplied by the number of kilowatt-hours eligible for power cost equalization that were sold during the preceding month to all customers of the utility in accordance with (c) of this section. Payment shall be made by the authority within 30 days after receipt from the utility of the report required under (i) of this section. However, if there is a dispute between the authority and the utility relating to the payment, the authority shall submit the report to the commission for review within 30 days after its receipt by the authority. When a report is submitted to the commission for review under this section, payment shall be made by the authority within 30 days after submission, based on a commission determination. If appropriations are insufficient for payment in full, the amount paid to each electric utility is reduced on a pro rata basis.

(k) If an electric utility receives power cost equalization under this section, the utility shall either

(1) give the following notice to its electric service customers eligible under this program for each period for which the payment is received:

NOTICE TO CUSTOMER

For the current billing period the utility will be paid under the State of Alaska's power cost equalization program (AS 44.83.162) to assist the utility and its customers in reducing the high cost of generation of electric energy.

Your total electrical service cost	$. . . . .
Less state equalization	$. . . . .
Your charge	$. . . . . ; or

(2) give to its electric service customers a notice approved by the authority, which notice provides electric service customers the same information provided by the notice in (1) of this subsection.

(*l*) In order to qualify for power cost equalization, each electric utility must make every reasonable effort to minimize administrative, operating, and overhead costs, including using the best available technology consistent with sound utility management practices. In reviewing applications for power cost equalization, the commission has the authority to require the elimination of duplicative or otherwise unnecessary operating expenses. Each eligible electric utility shall cooperate with appropriate state agencies to implement cost-effective energy conservation measures, and to plan for and implement feasible alternatives to diesel generation.

(m) For purposes of (c) of this section, the number of residents of the community equals the number of residents of the community deter-

mined by the Department of Community and Regional Affairs in accordance with AS 29.88.015.

(n) If the authority receives a petition requesting power cost equalization, signed by at least 25 percent of the customers of an electric utility that is subject to rate regulation under AS 42.05 and that has not applied for power cost equalization under this section, the authority shall require the utility to submit a power cost equalization application. Upon a determination of eligibility for power cost equalization, the utility, as a part of its service, shall receive power cost equalization and pass power cost equalization benefits to its customers in accordance with this section.

(o) In this section

(1) "commission" means the Alaska Public Utilities Commission;

(2) "community facility" means a water and sewer facility, public outdoor lighting, charitable educational facility, or community building whose operations are not paid for by the state, the federal government, or private commercial interests;

(3) "eligible electric utility" or "electric utility" means each corporation (whether public, cooperative, or otherwise), company, individual, or association of individuals, their lessees, trustees, or receivers appointed by a court, that

(A) owns, operates, manages, or controls a plant or system for the furnishing, by generation, transmission or distribution, of electric service to the public for compensation;

(B) during calendar year 1983 had a residential consumption level of power eligible for power cost equalization under this chapter of less than 7,500 megawatt hours or had a residential consumption level of power eligible for power cost equalization under this chapter of less than 15,000 megawatt hours if the utility served two or more municipalities or unincorporated communities; and

(C) during calendar year 1984 used diesel-fired generators to produce more than 75 percent of the electrical consumption of the utility; an electric utility that is a subsidiary of another electric utility is an "eligible electric utility" if the operations of the subsidiary, considered separately, meet the eligibility requirements of this section; if an electric utility did not receive power cost assistance in 1983 but is otherwise eligible for power cost equalization under this section, the utility is an "eligible electric utility";

(4) "energy conservation measures" include weatherization and other insulating methods, utilization of waste heat, appropriate sizing of new generating equipment, and other programs of the state or federal government intended and available for the purpose of energy conservation;

(5) "feasible energy projects" include projects that are selected after a field reconnaissance study under AS 44.83.177 and after completion of a feasibility study according to the criteria in AS 44.83.181 to determine cost benefit in comparison to existing power generating methods and other alternatives considered in reconnaissance studies;

(6) "fund" means the power cost equalization fund established under (a) of this section;

(7) "power costs" means costs used in determining power cost equalization in accordance with (b) and (d) of this section. (§ 42 ch 83 SLA 1980; am § 8 ch 118 SLA 1981; am § 3 ch 79 SLA 1983; am § 1 ch 133 SLA 1984)

Revisor's notes. — Formerly AS 44.56.162. Renumbered in 1980.

Cross references. — For transitional provisions relating to the 1981 amendments, see § 16, ch. 118, SLA 1981.

Effect of amendments. — The 1981 amendment rewrote this section.

The 1983 amendment, in subsection (*l*), deleted "including but not limited to the Alaska Public Utilities Commission, the Alaska Power Authority, the Alaska Energy Center, and the division of energy and power development in the Department of Commerce and Economic Development" following "appropriate state agencies" in the last sentence.

The 1984 amendment rewrote this section.

Sec. 44.83.163. Adjustments to power cost equalization. (a) The power cost equalization per kilowatt-hour determined under AS 44.83.162 payable to an electric utility that is subject to rate regulation under AS 42.05 may be adjusted by the commission if

(1) an increase or decrease in the electric utility's cost of fuel has resulted in the approval of a fuel cost rate adjustment by the commission;

(2) a permanent or interim rate increase or decrease has been approved by the commission, thereby establishing a higher or lower power cost;

(3) an adjustment is required after the authority has discovered discrepancies in its review of monthly data submitted by the electric utility; or

(4) the authority determines that appropriations are insufficient to finance full payments to eligible electric utilities.

(b) An electric utility that is eligible to receive power cost equalization under this section and that receives power cost equalization per kilowatt-hour approved by the commission shall report monthly to the authority within the time and in the form the authority requires. An electric utility shall report

(1) the power cost equalization per kilowatt-hour approved by the commission;

(2) the total kilowatt-hours sold to each class of customer during the preceding month;

(3) the total kilowatt-hours eligible for power cost equalization under this section sold to each class of customer during the preceding month;

(4) the total kilowatt-hours generated during the preceding month, if available;

(5) any commission-approved amendments to the schedule of rates in effect during the preceding month; and

(6) an increase or decrease in the current unit price of fuel from the base price used by the commission in the determination of power costs which may be expected to result in a subsequent power cost equalization adjustment.

(c) The provisions of AS 44.83.162 relating to the determination of the amount of power cost equalization and payment of the equalization assistance apply to equalization assistance under this section. (§ 9 ch 118 SLA 1981; am § 2 ch 133 SLA 1984)

Effect of amendments. — The 1984 amendment substituted "power cost equalization" for "power cost assistance" in the introductory language of subsection (a), in two places in the first sentence of subsection (b), in paragraphs (1), (3) and (6) of subsection (b), and in subsection (c); and inserted "equalization" preceding "assistance" in two places in subsection (c).

Sec. 44.83.164. Equalization assistance to utilities not regulated by Public Utilities Commission. (a) An electric utility that is not subject to rate regulation by the commission may receive power cost equalization if the utility is otherwise eligible for equalization assistance under AS 44.83.162 and if the utility

(1) files with the commission financial data necessary to determine the power cost equalization per kilowatt-hour as prescribed by the commission and that is in compliance with AS 44.83.162;

(2) reports monthly to the authority, within the time and in the form the authority requires, the information required in (b) of this section;

(3) sets rates

(A) that consider the power cost equalization provided under AS 44.83.162 by subtracting from its revenue requirements for electric services the power cost equalization per kilowatt-hour that it is eligible to receive; and

(B) under which the power cost equalization provided in AS 44.83.162 is applied as a credit only against the cost of kilowatt-hours eligible for equalization assistance under AS 44.83.162 that are consumed by each customer in any month;

(4) allows audits that the commission determines are necessary to ensure compliance with this section; and

(5) furnishes its electric service customers eligible under this program a notice as specified in AS 44.83.162(k).

(b) An electric utility that is eligible to receive power cost equalization under this section shall report in accordance with (a)(2) of this section

(1) the power cost equalization per kilowatt-hour approved by the commission;

(2) the total kilowatt-hours sold to each class of customer during the preceding month;

(3) the total kilowatt-hours eligible for power cost equalization under this section sold to each class of customer during the preceding month;

(4) the total kilowatt-hours generated during the preceding month, if available;

(5) any amendments to the schedule of rates in effect during the preceding month; and

(6) an increase or decrease in the current unit price of fuel from the base price used by the commission in the determination of power costs that may be expected to result in a subsequent equalization assistance level adjustment.

(c) An electric utility that is eligible to receive power cost equalization under this section may have its power cost equalization per kilowatt-hour determination changed by the commission if

(1) an increase or decrease in the electric utility's cost of fuel has been verified by the commission;

(2) an increase in rates has occurred based on an increase in costs and has been verified by the commission;

(3) an adjustment is required after the authority has discovered discrepancies in its review of monthly data submitted by the electric utility; or

(4) the authority determines that appropriations are insufficient to finance full payments to eligible electric utilities.

(d) The provisions of AS 44.83.162 relating to the determination of the amount of power cost equalization and payment of the equalization assistance apply to equalization assistance under this section.

(e) An application for power cost equalization by an electric utility that is eligible to receive power cost under this section does not extend the jurisdiction of the commission beyond that established by AS 42.05. (§ 42 ch 83 SLA 1980; am § 10 ch 118 SLA 1981; am § 3 ch 133 SLA 1984)

Revisor's notes. — Formerly AS 44.56.164. Renumbered in 1980.

Effect of amendments. — This 1981 amendment rewrote this section.

The 1984 amendment substituted "power cost equalization" for "power cost assistance" in the introductory language of subsection (a), in paragraph (a)(1), throughout paragraph (a)(3), in the introductory language of subsection (b), in paragraphs (b)(1) and (b)(3), in two places in the introductory language of subsection (c), and in subsections (d) and (e); inserted "equalization" preceding "assistance" in the introductory language of subsection (a), in paragraph (a)(3)(B), and in two places in subsection (d); and made a minor word change in paragraphs (a)(1), (a)(4) and paragraph (b)(6).

Sec. 44.83.165. Continuing appropriation for power cost equalization. The sum of $16,300,000 is appropriated on July 1, 1984, and the sum of $21,700,000 is appropriated on July 1 of each subsequent fiscal year from the general fund to the power cost equalization fund (AS 44.83.162). (§ 314 ch 171 SLA 1984)

Editor's notes. — Section 316, ch. 171, SLA 1984, provides that the appropriations made in §§ 313-315 and 319 of ch. 171, SLA 1984, which enacted this section, are not one-year appropriations and do not lapse under AS 37.25.010.

Article 5. Power Project Fund.

Section

170. Power project fund

Sec. 44.83.170. Power project fund. (a) There is established as a separate fund the power project fund which shall be distinct from any other money or funds of the authority, and which includes only money appropriated by the legislature.

(b) The authority may make loans from the power project fund

(1) to electric utilities, regional electric authorities, municipalities, cities, boroughs, regional and village corporations, village councils, and nonprofit marketing cooperatives to pay the costs of

(A) reconnaissance studies, feasibility studies, license and permit applications, preconstruction engineering, and design of power projects;

(B) constructing, equipping, modifying, improving, and expanding small-scale power production facilities, conservation facilities, bulk fuel storage facilities, and transmission and distribution facilities, including energy production, transmission and distribution, and waste energy conservation facilities which depend on fossil fuel, wind power, tidal, geothermal, biomass, hydroelectric, solar or other non-nuclear energy sources; and

(C) reconnaissance studies, preconstruction engineering, design, construction, equipping, modification, and expansion of potable water supply including surface storage and groundwater sources and transmission of water from surface storage to existing distribution systems;

(2) to a borrower for a power project if

(A) the loan is entered into under a leveraged lease financing arrangement;

(B) the party which will be responsible for the power project is an electric utility, regional electric authority, municipality, city, borough, regional or village corporation, village council, or nonprofit marketing cooperative; and

(C) the borrower seeking the loan demonstrates to the authority that the financing arrangement for the power project will reduce project financing costs below costs of comparable public power projects.

(c) Before making a loan from the power project fund, the authority shall, by regulation, specify

(1) standards for the eligibility of borrowers and the types of projects to be financed with loans;

(2) standards regarding the technical and economic viability and revenue self-sufficiency of eligible projects;

(3) collateral or other security required for loans;

(4) the terms and conditions of loans;

(5) criteria to establish financial feasibility and to measure the amount of state assistance necessary for particular projects to meet the financial feasibility criteria; and

(6) other relevant criteria, standards or procedures.

(d) Any loan made by the authority must be made according to the standards, criteria, and procedures established by regulation under this section.

(e) Repayment of the loans shall be secured in any manner which the authority determines is feasible to assure prompt repayment under a loan agreement entered into with the borrower. The authority may make an unsecured loan from the power project fund to a borrower regulated by the Alaska Public Utilities Commission under AS 42.05 if the borrower has a substantial history of repaying long-term loans and the capacity to repay the loan. Under a loan agreement, repayment may be deferred for 10 years or until the project for which the loan is made has achieved earnings from its operations sufficient to pay the loan, whichever is earlier.

(f) Power projects are subject to the following limitations on interest and specific restrictions:

(1) Power projects for which loans are outstanding from the former water resources revolving loan fund (former AS 45.86) on July 13, 1978, may receive additional financing from the power project fund; the additional financing, if granted,

(A) shall be granted for a term not exceeding 50 years;

(B) shall be granted at an interest rate of not less than three or more than five percent a year on the unpaid balance;

(C) shall be conditioned on the repayment of loan principal and interest to begin on the earlier of

(i) the date of the start of commercial operation of the project; or

(ii) 10 years from the date the loan is granted.

(2) Loans for power projects

(A) shall be granted for a term not to exceed 50 years; and

(B) shall be granted at an interest rate which is not less than five percent and which is the lesser of

(i) a rate equal to the percentage which is the average weekly yield of municipal bonds for the 12 months preceding the date of the loan, as determined by the authority from municipal bond yield rates reported in the 30-year revenue index of the Weekly Bond Buyer; or

(ii) a rate determined by the authority which allows the project to meet criteria of financial feasibility established under AS 44.83.170(c).

(g) Loan repayments and interest earned by loans from the power project fund shall be deposited in the state general fund.

(h) The legislature may forgive the repayment of a loan made from the power project fund for a reconnaissance study or a feasibility study when the authority finds that the power project for which the loan was made is not feasible. (§ 1 ch 278 SLA 1976; am § 16 ch 156 SLA 1978; am §§ 19 — 23 ch 83 SLA 1980)

Revisor's notes. — Formerly AS 44.56.170. Renumbered in 1980.

In 1984, "former" was inserted before "water resources revolving loan fund" and the reference to AS 45.86. That section was repealed by sec. 44, ch. 83, SLA 1980.

Effect of amendments. — The 1980 amendment rewrote subsections (a) through (c), (e), and (f), and added subsections (g) and (h).

Article 6. General Provisions.

Sec. 44.83.177. Reconnaissance study. (a) To identify power project alternatives and energy consumption patterns and needs for a community or region, the authority shall, after consultation with other state agencies and after review of information on alternative sources of energy, complete a reconnaissance study for each proposed new power project or combination of projects.

(b) A reconnaissance study shall

(1) identify the present and anticipated electrical and thermal energy requirements of a community or region;

(2) survey all electrical and thermal energy sources and combinations of sources available to the community or region and evaluate the relative economic merits of alternative sources of power and heat, including energy conservation;

(3) assess the effect of development of alternative sources of power and heat on the environment; and

(4) include public comment from residents of the community and adjacent area.

(c) The authority, in consultation with the office of management and budget, shall adopt regulations defining

(1) the methods which it shall apply to determine that the information required by (b) of this section is obtained; and

(2) standard criteria and measures for comparative analysis of alternative energy sources.

(d) In completing a reconnaissance study, the authority shall consult with the Department of Community and Regional Affairs to determine the information that each may require for energy planning and the development of technology. (§ 24 ch 83 SLA 1980; am § 11 ch 118 SLA 1981; am §§ 3 — 5 ch 133 SLA 1982; am § 4 ch 79 SLA 1983; am § 28 ch 63 SLA 1983)

Revisor's notes. — Formerly AS 44.56.177. Renumbered in 1980.

Cross references. — For transitional provisions related to current and pending projects as of 1980, see § 47, ch. 83, SLA 1980.

Effect of amendments. — The 1981 amendment added subsection (d).

The 1982 amendment, in subsection (a), inserted "and energy consumption patterns and needs" and "or region," substituted "sources of energy" for "sources of power," and added "or combination of projects" to the end. The amendment also rewrote subsection (b), which defines the scope of a reconnaissance study, and substituted "alternative energy sources" for "alternative power sources" in paragraph (2) of subsection (c).

The first 1983 amendment, substituted "office of management and budget" for "division of budget and management" in subsection (c).

The second 1983 amendment, substituted "Department of Community and Regional Affairs" for "division of energy and power development in the Department of Commerce and Economic Development" in subsection (d).

Sec. 44.83.179. Review of reconnaissance study by office of management and budget. (a) The office of management and budget in the Office of the Governor shall review reconnaissance studies for proposed projects of the authority.

(b) The review shall examine each reconnaissance study for compliance with the requirements of AS 44.83.177(b) and (c). The office of management and budget may approve or disapprove a reconnaissance study. If the office of management and budget disapproves of a reconnaissance study, it shall return the reconnaissance study to the authority together with a comprehensive statement of the reasons for its disapproval. The authority may amend the portions of the reconnaissance study which the office of management and budget identifies as deficient and resubmit the reconnaissance study to the office of management and budget for reconsideration.

(c) For purposes of this section, a power project is approved if the reconnaissance study for the project has not been disapproved by the office of management and budget within 30 days of submission of the reconnaissance study for the project to it by the authority. (§ 24 ch 83 SLA 1980; am § 28 ch 63 SLA 1983)

Revisor's notes. — Formerly AS 44.56.179. Renumbered in 1980.

Cross references. — For transitional provisions related to current and pending projects as of 1980, see § 47, ch. 83, SLA 1980.

Effect of amendments. — The 1983 amendment, substituted "office of management and budget" for "division of budget and management" throughout this section.

Sec. 44.83.180. Assessment, proposal, and construction of projects. [Repealed, § 44 ch 83 SLA 1980.]

Sec. 44.83.181. Feasibility study and finance plan. (a) Unless the reconnaissance study has been disapproved by the office of management and budget under AS 44.83.179, the authority shall complete a feasibility study and plan of finance for each proposed project.

(b) A feasibility study shall include

(1) information about the proposed project, including but not limited to estimates of total project construction costs, total project operating costs, the costs of transmission systems and reserve power requirements, the timing and amount of anticipated returns from the completed project, a benefit-to-cost ratio, the potential effect of the project on the environment of the area that will be served by the project when completed, and the availability of alternative government financing;

(2) a statement of all assumptions which affect the economic feasibility of the project, including but not limited to the discount rate and interest rate of amounts of money to be used for the project, anticipated fuel prices, an escalation rate, state and local electric load growth, and estimates of indirect costs and benefits;

(3) a comparative analysis of all reasonable alternatives to construction of the proposed project; and

(4) information based on engineering and design work that meets the requirements for submission of a license application for the project to the Federal Energy Regulatory Commission.

(c) The plan of finance shall include recommendations of the most appropriate means to finance a project, including, but not limited to,

(1) the issuance of revenue bonds of the authority;

(2) the issuance of

(A) general obligation bonds of the state; or

(B) revenue bonds of the authority that are guaranteed or partially guaranteed by the state;

(3) an appropriation from the general fund

(A) to pay debt service on bonds or for other project purposes; or

(B) to reduce the amount of debt financing for the project;

(4) a loan from the general fund;

(5) financing arrangements with other entities using leveraged leases or other financing methods;

(6) assistance from any federal agency, including, but not limited to, the Rural Electrification Administration;

(7) a loan from the power project fund (AS 44.83.170(a)); or

(8) any combination of financing arrangements listed in this subsection.

(d) When financial assistance from the state is necessary for a project to meet financial feasibility criteria, the plan of finance shall include an estimate of the minimum amount of financial assistance required from the state. The plan of finance shall include an estimate of the present value of the financial assistance from the state, computed as the difference between

(1) a market rate of interest, which is

(A) the rate determined under AS 44.83.170(f)(2)(B)(i); or

(B) the estimated interest rate for revenue bonds to be issued by the authority for the project; and

(2) the effective rate of interest because of state financial assistance provided.

(e) The authority, in consultation with the office of management and budget, shall adopt regulations defining

(1) the techniques which it shall apply to determine that the information required by (b) — (d) of this section is obtained; and

(2) standard criteria and measures for comparative analysis of alternative financing arrangements. (§ 24 ch 83 SLA 1980; am § 6 ch 133 SLA 1982; am § 28 ch 63 SLA 1983; am § 14 ch 161 SLA 1984)

Revisor's notes. — Formerly AS 44.56.181. Renumbered in 1980.

Cross references. — For transitional provisions related to current and pending projects as of 1980, see § 47, ch. 83, SLA 1980.

Effect of amendments. — The 1982 amendment inserted "the costs of transmission systems and reserve power requirements" in paragraph (1) of subsection (b).

The 1983 amendment, substituted "office of management and budget" for "division of budget and management" in subsections (a) and (e).

The 1984 amendment substituted "that" for "which" in paragraph (c)(2)(B) and deleted "or from the renewable resources investment fund (AS 37.11.050)" following the reference to the power project fund in paragraph (c)(7).

Sec. 44.83.183. Review of feasibility studies and plans of finance by office of management and budget. (a) The office of management and budget in the Office of the Governor shall review the feasibility study and plan of finance for a project of the authority for compliance with the provisions of AS 44.83.181(b) — (d).

(b) In its review under this section, the office of management and budget may obtain an independent evaluation of a feasibility study and plan of finance to determine compliance with the provisions of AS 44.83.181(b) — (d).

(c) When the office of management and budget has completed a review of the feasibility study and the plan of finance for a project under this section, it shall submit a report to the governor. The report shall examine the feasibility study and plan of finance for compliance with the requirements of AS 44.83.181(b) — (d). The report of the office of management and budget shall include a recommendation to the governor and legislature for approval or disapproval of the project based on the office's review of the feasibility study and plan of finance for compliance with the requirements of AS 44.83.181(b) — (d).

(d) The report required by (c) of this section shall be prepared and submitted not later than 60 days after the feasibility study and plan of finance for a proposed project have been received by the office of management and budget.

(e) The report required by (c) of this section shall include a financial analysis of the proposed project of the authority that evaluates proposed bond resolutions or other financial arrangements or financial plans, security plans and arrangements, cost and demand uncertainties, and debt volume, as they relate to the total direct and

indirect indebtedness of the state. In preparing the financial analysis required by this section the office of management and budget may use the services of outside agencies or institutions that are not otherwise involved in the project. (§ 24 ch 83 SLA 1980; am § 7 ch 133 SLA 1982; am § 28 ch 63 SLA 1983)

Revisor's notes. — Formerly AS 44.56.183. Renumbered in 1980.

Cross references. — For transitional provisions related to current and pending projects as of 1980, see § 47, ch. 83, SLA 1980.

Effect of amendments. — The 1982 amendment added subsection (e).

The 1983 amendment, substituted "office of management and budget" for "division of budget and management" throughout this section.

Sec. 44.83.185. Submission to the legislature. (a) The authority shall submit a feasibility study and plan of finance, including a cost estimate from an independent source, for a proposed new project to the legislature. When the report of the office of management and budget examining the feasibility study and plan of finance is completed as required by AS 44.83.183, it shall be submitted to the legislature.

(b) The authority may not proceed with work on the engineering or design phase of a proposed new project for which legislative approval is required until the legislature approves the proposed new project. However, the authority may proceed with the engineering or design work necessary to meet the requirements for submission of a license application for the proposed new project to the Federal Energy Regulatory Commission without obtaining legislative approval of the proposed new project.

(c) The legislature shall consider and must approve all proposed new projects except proposed new projects that are exempt under AS 44.83.187. The legislature may approve a proposed new project only by enacting law that authorizes the project and approves a construction cost for that project. (§ 24 ch 83 SLA 1980; am § 8 ch 133 SLA 1982; am § 28 ch 63 SLA 1983; am § 7 ch 89 SLA 1983)

Revisor's notes. — Formerly AS 44.56.185. Renumbered in 1980.

Effect of amendments. — The 1982 amendment substituted "that authorizes the project and approves a construction cost for" for "authorizing" in the second sentence of subsection (c).

The first 1983 amendment, substituted "office of management and budget" for "division of budget and management" in subsection (a).

The second 1983 amendment, inserted "including a cost estimate from an independent source" in the first sentence of subsection (a).

Sec. 44.83.186. Final cost estimate and reauthorization by the legislature. [Repealed, § 27 ch 89 SLA 1983.]

Sec. 44.83.187. Applicability of sections. (a) The provisions of AS 44.83.177 — 44.83.185 and 44.83.189 apply only to a proposed new project that will generate more than 1.5 megawatts of power and

(1) requires an appropriation more from the state general fund, from the power project fund, or from the renewable resources funds; or

(2) is based on a plan of finance which requires the issuance of general obligation bonds or other pledge of the credit of the state.

(b) The provisions of AS 44.83.177 — 44.83.185 and 44.83.189 apply to a project that generates more than 25 megawatts of power for which the authority will issue its revenue bonds for costs of construction.

(c) The provisions of AS 44.83.177 — 44.83.183 do not apply when a reconnaissance study and a feasibility study for a proposed new project have been prepared by an agency of the federal government, if the authority determines that the reconnaissance study and the feasibility study prepared by the agency of the federal government provide information sufficient to permit the authority to finance and construct the proposed new project in accordance with the requirements of this chapter. When a reconnaissance study and feasibility study are prepared for a proposed new project by an agency of the federal government and the authority proposes to finance and construct the proposed new project, the authority shall provide copies of the studies and a proposed plan of finance to the office of management and budget in the Office of the Governor. The office of management and budget shall review the studies and plan of finance. Within 60 days after its receipt of the studies and plan of finance, the office of management and budget shall submit a report to the governor and legislature. The report shall examine the feasibility study and plan of finance and comment upon compliance of the feasibility study and plan of finance with the requirements of AS 44.83.181. Approval of the legislature under AS 44.83.185 is required for a proposed new project that is exempt from the requirements of AS 44.83.177 — 44.83.183 under this subsection. The authority may not proceed with engineering or design work for a project until legislative approval of the project has been given under AS 44.83.185(c), except that the authority may undertake engineering or design work necessary to submit a license application for the project to the Federal Energy Regulatory Commission without first obtaining legislative approval of the project.

(d) The provisions of AS 44.83.177 — 44.83.185 do not apply to

(1) an addition, modification, repair, reconstruction, design, acquisition or construction for the purpose of completing a project;

(2) the construction of an electrical transmission or distribution facility that is estimated to cost less than $3,000,000. (§ 24 ch 83 SLA 1980; am § 1 ch 169 SLA 1980; am § 28 ch 63 SLA 1983)

Revisor's notes. — Formerly AS 44.56.187. Renumbered in 1980.

Effect of amendments. — The 1980 amendment added "will generate more than 1.5 metawatts of power and" at the end of the introductory paragraph of subsection (a), and substituted "funds" for "investment fund and the appropriation exceeds (A) $3,000,000, for projects for which legislative approval is sought during 1981; (B) $3,000,000 multiplied by a factor equal to a ratio determined by dividing the construction cost index of the engineering news record determined for

January of the year during which a project is submitted for legislative approval, by the construction cost index of the engineering news record for March, 1980, for projects for which legislative approval is sought after December 31, 1981" at the end of paragraph (1) of subsection (a).

The 1983 amendment, substituted "office of management and budget" for "division of budget and management" in subsection (c).

Editor's notes. — Section 3, ch. 169, SLA 1980 provides: "The projects authorized in sec. 48 of House CS for CS for Senate Bill No. 438 (Finance) am H, Eleventh Legislature, Second Session, are exempt from the amendments made in sec. 1 of this Act."

Sec. 44.83.189. Project construction. If a new project is to be designed, acquired and constructed by the authority, it shall be designed, acquired and constructed as a public work of the state. For the purpose of this section and AS 44.83.187 a new project does not include

(1) an addition or modification to an existing project unless the total cost of the addition or modification exceeds $1,000,000;

(2) repair or reconstruction of a project; or

(3) design, acquisition or construction necessary to complete a project for which bonds have been issued. (§ 24 ch 83 SLA 1980)

Revisor's notes. — Formerly AS 44.56.189. Renumbered in 1980.

Sec. 44.83.190. Annual audit. The authority shall have its financial records audited annually by a certified public accountant. The legislative auditor may prescribe the form and content of the financial records of the authority and shall have access to these records at any time. (§ 1 ch 278 SLA 1976)

Revisor's notes. — Formerly AS 44.56.190. Renumbered in 1980.

Sec. 44.83.191. Limitations on issuance of bonds by the authority. The authority may not issue bonds except after 60 days notification of its intent to issue bonds is given to the governor and to the legislature, if the legislature is in session, or to the Legislative Budget and Audit Committee, if the legislature is not in session. (§ 24 ch 83 SLA 1980)

Revisor's notes. — Formerly AS 44.56.191. Renumbered in 1980.

Sec. 44.83.192. Insurance requirements in construction contracts. In requesting bids and awarding construction contracts under this chapter the authority may not require a contractor to obtain workers' compensation, general liability, or other required insurance from a particular insurer, agent, or broker and may not agree to provide insurance to a contractor who is awarded a construction contract. (§ 8 ch 89 SLA 1983)

Sec. 44.83.195. Operation of projects. (a) When a project is operated by the authority, the authority shall enter into one or more contracts for the sale of electrical power, energy, transmission capacity, or service from the project. Unless the contract is entered into under AS 44.83.380 — 44.83.425, a contract entered into under this section shall meet all requirements of AS 44.83.090.

(b) *[Repealed, § 27 ch 89 SLA 1983.]* (§ 24 ch 83 SLA 1980; am §§ 9, 27 ch 89 SLA 1983)

Revisor's notes. — Formerly AS 44.56.195. Renumbered in 1980.

Effect of amendments. — The 1983 amendment, in subsection (a), inserted "energy, transmission capacity, or service" in the first sentence and added "Unless the contract is entered into under AS 44.83.380 — 44.83.425" to the beginning of the second sentence. The amendment also repealed subsection (b).

Sec. 44.83.200. Annual report. Before March 1 of each year, the authority shall submit to the governor and the legislature a comprehensive report describing operations, income and expenditures for the preceding 12-month period. (§ 1 ch 278 SLA 1976)

Revisor's notes. — Formerly AS 44.56.200. Renumbered in 1980.

Sec. 44.83.210. Appropriations and reports. (a) Notwithstanding any other provision in this chapter, the authority is subject to the provisions of the Executive Budget Act (AS 37.07).

(b) The authority shall, by the 15th day of each regular legislative session, present to the legislature a report detailing project status, original costs and projected costs, particularly highlighting any costs in excess of the original cost estimates submitted for each project when that project was originally approved by the legislature. (§ 1 ch 278 SLA 1976; am § 19 ch 156 SLA 1978)

Revisor's notes. — Formerly AS 44.56.210. Renumbered in 1980.

Sec. 44.83.220. Public records; open meetings. The provisions of AS 09.25.110 — 09.25.120 and AS 44.62.310 — 44.62.312 apply to the authority. The authority shall publish a proposed agenda of its meetings and afford the public an opportunity to be heard in accordance with AS 44.62.312. (§ 1 ch 278 SLA 1976)

Revisor's notes. — Formerly AS 44.56.220. Renumbered in 1980.

Sec. 44.83.224. Long-term energy plan. The Department of Commerce and Economic Development, assisted by the authority, shall, after public hearings, prepare and annually revise a long-term energy

plan. The plan, and its annual revisions, shall be submitted to the commissioners of the departments of the executive branch of the government for review and to the governor for the governor's approval. After approval, the plan shall be submitted to the legislature not later than Feburary 1 of each year. The plan, and its annual revisions, shall include

(1) an "end-use" study examining and reporting on the nature and amount of energy used and the purpose of its use; and

(2) an energy development component for meeting projected thermal, electrical and transportation energy needs in the state at the lowest reasonable cost, including environmental and social costs, consistent with acceptable standards of reliability, giving an equal consideration as practicable to all types of energy sources (except those based on nuclear fuels) which are technologically feasible, and which promote the efficient use of facilities and fuels consistent with energy conservation goals, and the considerations specified in AS 44.83.180(e);

(3) an energy conservation component, including but not limited to,

(A) conservation goals for reducing consumption of energy, identifying the region for which applicable, and the source or type of energy to which the goals are applicable; and

(B) specific methods and means of achieving the goals of (A) of this paragraph;

(4) a component for emergency energy conservation measures applicable during times of emergency; and

(5) a report on areas or subjects of research and development and demonstration projects involving alternative energy systems, local energy sources, and energy conservation. (§ 20 ch 156 SLA 1978; am § 25 ch 83 SLA 1980)

Revisor's notes. — Formerly AS 44.56.224. Renumbered in 1980.

In 1984, "former" was inserted before the reference to AS 44.83.180 in paragraph (2). That section was repealed by § 44, ch. 83, SLA 1980.

Effect of amendments. — The 1980 amendment rewrote the section.

Sec. 44.83.230. Definitions. In this chapter, unless the context requires otherwise,

(1) "authority" means the Alaska Power Authority established by this chapter;

(2) "bonds" means bonds, notes, or other obligations of the authority issued under this chapter;

(3) "power" includes any and all electrical energy generated, distributed, bought or sold for purposes of lighting, heating, power and every other useful purpose;

(4) "power project" or "project" means a plant, works, system, or facility, together with related or necessary facilities and appurtenances, including a divided or undivided interest in or a right to the capacity of a power project or project, that is used or is useful for the purpose of

(A) electrical or thermal energy production other than nuclear energy production;

(B) waste energy utilization and energy conservation; or

(C) transmission, purchase, sale, exchange, and interchange of electrical or thermal energy, including district heating or interties;

(5) "public agency" means any city or other municipal corporation, political subdivision, governmental unit, or public corporation created by or under the laws of this state or of another state of the United States, and any state or the United States, and any person, board or other body declared by the laws of any state or the United States to be a department, agency, or instrumentality of them;

(6) "person" includes a public agency in addition to the entities set out in AS 01.10.060(7);

(7) "reconnaissance study" means a study conducted for the purpose of assessing the present and future electrical and thermal energy needs of an area under AS 44.83.177;

(8) "feasibility study"

(A) means a study conducted for the purpose of establishing the economic and environmental practicality of completing a proposed power project under AS 44.83.181;

(B) includes engineering and design work to meet the requirements for submission of a license application for a proposed new project to the Federal Energy Regulatory Commission;

(9) "small-scale power production facility" means a facility which, by design, is to produce less than 25 megawatts of power. (§ 1 ch 278 SLA 1976; am §§ 21, 22 ch 156 SLA 1978; am §§ 26, 27 ch 83 SLA 1980; am §§ 10, 11 ch 133 SLA 1982)

Revisor's notes. — Formerly AS 44.56.230. Renumbered in 1980.

Effect of amendments. — The 1980 amendment rewrote paragraph (7), and added paragraphs (8) and (9).

The 1982 amendment rewrote the definition for "power project" or "project" in paragraph (4) and substituted "electrical and thermal energy needs" for "power needs" in paragraph (7).

Sec. 44.83.240. Short title. This chapter may be cited as the Alaska Power Authority Act. (§ 1 ch 278 SLA 1976)

Revisor's notes. — Formerly AS 44.56.240. Renumbered in 1980.

Article 7. Susitna River Hydroelectric Project.

Sec. 44.83.300. Description of project. The Susitna River hydroelectric project consists of dams and related reservoirs, and power plants located in the Upper Susitna River Basin, and related transmission lines, facilities, and load centers, as described in the Alaska Power Authority's report required by AS 44.83.320(b). (§ 2 ch 169 SLA 1980)

Revisor's notes. — Enacted as AS 44.56.300. Renumbered in 1980.

Sec. 44.83.310. Purpose of project. The primary purpose of the Susitna River hydroelectric project is to generate, transmit and distribute electric power in a manner which will

(1) minimize market area electrical power costs;

(2) minimize adverse environmental and social impacts while enhancing environmental values to the extent possible; and

(3) safeguard both life and property. (§ 2 ch 169 SLA 1980)

Revisor's notes. — Enacted as AS 44.56.310. Renumbered in 1980.

Sec. 44.83.320. Preliminary reports. (a) By March 30, 1981, the authority shall prepare and submit to the governor and to the legislature a preliminary report recommending whether work should continue on the Susitna River hydroelectric project, and, if the recommendation is to continue on the project, the report shall explain in detail

(1) economic evaluations and preliminary environmental impact assessments for the Susitna River hydroelectric project and all viable alternatives;

(2) the federal and state permits required to be obtained before construction can begin and the expected construction start date; and

(3) any other information the authority considers appropriate or necessary to adequately inform the governor and the legislature of the status of the Susitna River hydroelectric project.

(b) By April 30, 1982, the authority shall prepare and submit to the governor and to the legislature a preliminary report recommending whether work should continue on the Susitna River hydroelectric project, and other valuable alternatives. If the recommendation is to continue on the Susitna River hydroelectric project, the report shall explain in detail

(1) the proposed conceptual design and phases of construction of the Susitna River hydroelectric project;

(2) the expected completion date of each phase of construction;

(3) the expected cost of each phase of construction;

(4) the costs to the state and consumers of the project under alternative methods of project financing, including revenue bonds, general obligation bonds, and general fund appropriations; and

(5) any other information the authority considers appropriate or necessary to adequately inform the governor and the legislature of the status of the Susitna River hydroelectric project.

(c) The preliminary reports required under (a) and (b) of this section are in addition to any reports required under former AS 44.83.180 — 44.83.224. (§ 2 ch 169 SLA 1980)

Revisor's notes. — Enacted as AS 44.56.320(a)-(c). Renumbered in 1980.

In 1984, "former" was inserted before the reference to AS 44.83.180. That section was repealed by sec. 44, ch. 83, SLA 1980.

Sec. 44.83.325. Restrictions on contracting. The authority may not enter into contracts under AS 44.83.300 — 44.83.360 other than those contracts necessary to complete (1) feasibility studies, (2) the preliminary reports required by AS 44.83.320, or (3) construction of the Anchorage-Fairbanks intertie, until the legislature approves by law the preliminary report required under AS 44.83.320(b). (§ 2 ch 169 SLA 1980)

Revisor's notes. — Enacted as AS 44.56.320(d). Renumbered in 1980.

Editor's note. — Section 21, ch. 133, SLA 1982, provides: "Notwithstanding the provisions of AS 44.83.325, the Alaska Power Authority may enter into contracts under AS 44.83.300 — 44.83.360 for preliminary work without the approval required by AS 44.83.325. In this section, 'preliminary work' means the preparation of plans and studies and the preparation and submission of license applications, as well as other types of work, that must be completed before actual construction of the Susitna River hydroelectric project, described in AS 44.83.300, may begin. This section does not authorize the Alaska Power Authority to enter into contracts for the actual construction of the Susitna River hydroelectric project or for the preparation of the site of the Susitna River hydroelectric project without the approval required by AS 44.83.325."

Sec. 44.83.330. Construction, maintenance and operation of project. Within one year after approval of its preliminary report submitted under AS 44.83.320(b), the authority may enter into a contract for the construction of the Susitna River hydroelectric project in a manner consistent with the purpose of the project as described in AS 44.83.310. (§ 2 ch 169 SLA 1980)

Revisor's notes. — Enacted as AS 44.56.330. Renumbered in 1980.

Sec. 44.83.340. Annual report. (a) If the Susitna River hydroelectric project is approved by the legislature under AS 44.83.325, beginning in 1983 the authority shall prepare an annual report which explains in detail

(1) the status of construction on the Susitna River hydroelectric project;

(2) the completion date of any phase of the Susitna River hydroelectric project which has been completed and the reasons for any

deviation between the completion date and the expected completion date stated in the preliminary report required under AS 44.83.320(b);

(3) the actual cost of any phase of the Susitna River hydroelectric project which has been completed and the reasons for any deviation between the actual cost and the expected cost stated in the preliminary report required under AS 44.83.320(b);

(4) the federal and state permits necessary to begin or continue construction of the Susitna River hydroelectric project, the actual dates on which the federal and state permits necessary to begin or continue construction were obtained, and the reasons for any deviation between the actual dates and the expected dates stated in the preliminary report required under AS 44.83.320(a) or in the earlier annual reports required under this section;

(5) any other information the authority considers appropriate or necessary to adequately inform the governor and the legislature of the status of the Susitna River hydroelectric project.

(b) The annual report required under (a) of this section is in addition to any reports required under AS 44.83.180 — 44.83.224 and shall be submitted by March 30 of each year to the governor and to each member of the legislature. (§ 2 ch 169 SLA 1980)

Revisor's notes. — Enacted as AS 44.56.340. Renumbered in 1980.

Sec. 44.83.350. Legislative and executive oversight. The legislature or the governor may provide for ongoing oversight, review and selected in-depth analysis of the Susitna River hydroelectric project plan of study. The authority shall provide all data, analyses, reports, and other information to whoever conducts the oversight, review, or analysis activities. Selected in-depth analyses shall include assessments of the power alternatives, financing, and power marketing sections of the Susitna River hydroelectric project plan of study. (§ 2 ch 169 SLA 1980)

Revisor's notes. — Enacted as AS 44.56.350. Renumbered in 1980.

Sec. 44.83.360. Project financing. The Susitna River hydroelectric project shall be financed by general fund appropriations, general obligation bonds, revenue bonds, or other plans of finance as approved by the legislature. (§ 2 ch 169 SLA 1980)

Revisor's notes. — Enacted as AS 44.56.360. Renumbered in 1980.

Article 8. Rural Electrification Revolving Loan Fund.

Section

Sec. 44.83.361. Rural electrification revolving loan fund. (a) The rural electrification revolving loan fund is established in the Alaska Power Authority. The fund consists of

(1) appropriations made to the fund; and

(2) principal payments on loans made under this section.

(b) The authority may make loans from the rural electrification revolving loan fund to electric utilities certified by the Alaska Public Utilities Commission. A loan from the fund may be made only for the purpose of extending new electric service into an area of the state that an electric utility may serve under a certificate of public convenience and necessity issued by the Alaska Public Utilities Commission. A loan may be made from the fund to an electric utility if the utility invests the money necessary to provide one pole, one span of line, one transformer, and one service drop for each consumer for whom immediate service would be provided by the extension of electric service. However, a loan may not be made from the fund unless

(1) the loan is recommended by a loan advisory committee appointed under AS 44.83.363; and

(2) the extension of electric service would provide immediate service to at least three consumers.

(c) A loan from the rural electrification revolving loan fund shall bear an annual rate of interest of two percent of the unpaid balance of the loan. Interest received on a loan made under this section must be transferred monthly to the commissioner of revenue for deposit in the general fund.

(d) When a loan is made by the authority under this section, the electric utility receiving the loan

(1) shall, in addition to the rates that it is authorized to charge, charge the consumers served by the electric service extended with the loan proceeds an amount sufficient to pay the interest costs of the loan;

(2) shall pay to the authority annually an amount equal to

(A) interest of two percent on the unpaid balance of the loan; and

(B) payments on the unpaid balance of the principal of the loan for each new consumer served by the electric service extended with the loan proceeds; payments on the unpaid balance of the principal of the loan shall be made at a rate equal to the difference between the actual cost of making the service connection to the consumers and the minimum investment per consumer required of the utility before a loan is made under (b) of this section.

(e) The authority shall

(1) adopt regulations necessary to carry out the provisions of this section;

(2) administer the rural electrification revolving loan fund; and

(3) submit to the legislature within the first 10 days of each regular legislative session a report of actions taken by the authority under this section and an accounting of the rural electrification revolving loan fund.

(f) In this section,

(1) "consumer" means a person, as defined in AS 01.10.060(7), or a governmental agency, if the person or governmental agency requests and offers to pay for electrical service to a facility or part of a facility; the authority shall consider a person who, or a governmental agency that, offers to pay for electrical service to several facilities to be a separate consumer for each facility, if each facility is physically separate from another facility, other than through electric service lines, and if the person or governmental agency requests and offers to pay for electrical service to each facility;

(2) "facility" means a structure capable of receiving and using electrical energy; and

(3) "governmental agency" includes, with respect to the state or federal government or a municipal government, a legislative body, board of regents, administrative body, board, commission, committee, subcommittee, authority, council, agency, public corporation, school board, department, division, bureau, or other subordinate unit, whether advisory or otherwise, of the state, federal, or municipal government. (§ 1 ch 118 SLA 1981; am §§ 10 — 13 ch 89 SLA 1983)

Effect of amendments. — The 1983 amendment, deleted "and interest" following "principal" in paragraph (a)(2), added the second sentence of subsection (c), substituted "extended with the loan proceeds" for "during the preceding year for which the loan was made" in paragraph (d)(2)(B), and added subsection (f).

Sec. 44.83.363. Loan advisory committee. When an application for a rural electrification loan is submitted to the authority under AS 44.83.361, the authority shall appoint a local advisory committee from persons residing in the area that the applicant utility is certified to serve. The loan advisory committee shall consider the loan application, and shall recommend whether the loan application is to be approved or disapproved. A favorable recommendation from the loan advisory committee shall be based on a determination that development in the area of the proposed extension of electric service is likely to provide for full repayment of the loan under AS 44.83.361(d) within 10 years. In making that determination the committee shall consider

(1) permanence of the premises to be served by the extension;

(2) land use patterns in the area;

(3) access for the line that would be installed with loan proceeds;
(4) availability of other utility service in the area; and
(5) the economic feasibility of the extension of electric service with the proceeds of the loan. (§ 1 ch 118 SLA 1981)

Article 9. Energy Program for Alaska.

Sec. 44.83.380. Program established. (a) The energy program for Alaska is established. The program shall be administered by the Alaska Power Authority.

(b) The energy program for Alaska is a program by which the authority may acquire or construct power projects with money appropriated by the legislature to the power development fund established in AS 44.83.382. A power project may be acquired or constructed as part of the energy program for Alaska only if the project is submitted to and approved by the legislature in accordance with procedures set out in AS 44.83.177 — 44.83.187.

(c) The provisions of AS 36.10.010 — 36.10.125 apply to power projects constructed by the authority under AS 44.83.380 — 44.83.425. (§ 1 ch 118 SLA 1981)

Revisor's notes. — Enacted as AS 44.83.400. Renumbered in 1981.

Sec. 44.83.382. Power development fund established. (a) A power development fund is established in the Alaska Power Authority to carry out the purposes of the energy program for Alaska (AS 44.83.380 — 44.83.425).

(b) The fund includes

(1) money appropriated to it by the legislature; and

(2) *[Repealed, § 27 ch 89 SLA 1983.]* (§ 1 ch 118 SLA 1981; am § 27 ch 89 SLA 1983)

Revisor's notes. — Enacted as AS 44.83.410. Renumbered in 1981.

Effect of amendments. — The 1983 amendment, repealed paragraph (2) of subsection (b).

Sec. 44.83.384. Use of fund balance. (a) The fund may be used by the authority to provide money for

(1) reconnaissance and feasibility studies and power project finance plans prepared under AS 44.83.177 — 44.83.181;

(2) the cost of a power project, including but not limited to costs of acquiring necessary licenses, preparing engineering designs, obtaining land, and constructing the power project;

(3) the defeasance of bonds, or the payment of debt service on loans for or on an issue of bonds sold in connection with a power project;

(4) the cost of operating and maintaining power projects; and

(5) debt service on power projects.

(b) Money in the fund may be used under (a) of this section only for a power project that

(1) is economically feasible; and

(2) provides the lowest reasonable power cost to utility customers in the market area for the estimated life of the power project, whether operated by itself or in conjunction with other power projects in the market area, and that operates or will operate on one or more of the following:

(A) renewable energy resources, including but not limited to hydroelectric power, wind, biomass, geothermal, tidal or solar energy, or a method that uses temperature differentials or other physical properties of the ocean;

(B) coal or peat;

(C) energy derived from waste heat; or

(D) fossil fuel, including oil or natural gas.

(c) Notwithstanding (b)(1) of this section and AS 44.83.396 — 44.83.398, the fund may be used by the authority to provide money for the cost of a power project that is or was either constructed or owned by the United States government if the requirements of this subsection are met. The provisions of AS 44.83.177 — 44.83.187 do not apply to a power project financed under this subsection. The authority may use money in the fund for the cost of a power project under this subsection if

(1) the legislature enacts a law approving the project;

(2) the office of management and budget in the Office of the Governor reviews a feasibility study and a plan of finance for the project and determines that the feasibility study complies with the requirements for a feasibility study submitted under AS 44.83.181(b) and that the plan of finance complies with the requirements for a plan of finance submitted under AS 44.83.181(c); and

(3) the project meets the other requirements of this chapter. (§ 1 ch 118 SLA 1981; am § 12 ch 133 SLA 1982; am § 28 ch 63 SLA 1983; am §§ 14, 15 ch 89 SLA 1983)

Revisor's notes. — Enacted as AS 44.83.420. Renumbered in 1981.

Effect of amendments. — The 1982 amendment added subsection (c).

The first 1983 amendment, substituted "office of management and budget" for "division of budget and management" in paragraph (c)(2).

The second 1983 amendment, rewrote paragraph (1) of subsection (b) and substituted "AS 44.83.396 — 44.83.398" for "AS 44.83.394 — 44.83.398" and "or was either constructed or owned" for "constructed and owned" in the first sentence of subsection (c).

Sec. 44.83.386. Investment of fund. The Department of Revenue shall invest the money in the fund in accordance with AS 37.10.070 and 37.10.075. The Department of Revenue shall provide money in the fund to the authority only after costs have been incurred or amounts in the fund have been otherwise obligated under contracts for the acquisition and construction of a project. Amounts that have been obligated, but for which costs have not yet been incurred, may be segregated by the Department of Revenue or transferred to the authority only with the prior approval or agreement of the commissioner of revenue. Interest received on money that is segregated or transferred under this section must be deposited in the general fund. (§ 1 ch 118 SLA 1981; am § 16 ch 89 SLA 1983)

Revisor's notes. — Enacted as AS 44.83.430. Renumbered in 1981.

Effect of amendments. — The 1983 amendment, substituted the language beginning "costs have been incurred" for "a cost for a project is incurred" at the end of the second sentence and added the third and fourth sentences.

Sec. 44.83.388. Allotment to projects. (a) The authority shall maintain records of power project allocations from the fund for each power project

(1) approved in accordance with AS 44.83.185; and

(2) for which an allocation is made from an appropriation made by the legislature without specifying an appropriation to a project.

(b) Income earned from investment of money appropriated to the fund shall be deposited in the general fund and may be appropriated to the fund by the legislature. (§ 1 ch 118 SLA 1981)

Revisor's notes. — Enacted as AS 44.83.440. Renumbered in 1981.

Sec. 44.83.390. Reappropriation of fund balance. (a) If a power project designated by the legislature by law is not constructed, the amount appropriated to it may be reappropriated to other power projects by the legislature.

(b) The legislature may reappropriate money under (a) of this section only for a power project that is economically feasible under AS 44.83.181(b) and only if the project will serve the market area that would have been served by the power project designated by the legislature and not constructed. (§ 1 ch 118 SLA 1981)

Revisor's notes. — Enacted as AS 44.83.450. Renumbered in 1981.

Sec. 44.83.392. Lapse of excess appropriations. If at the end of construction of a power project appropriations for the power project exceed the amount required for construction of it, the excess lapses into the general fund. (§ 1 ch 118 SLA 1981)

Revisor's notes. — Enacted as AS 44.83.460. Renumbered in 1981.

Sec. 44.83.394. Revenue requirements. [Repealed, § 27 ch 89 SLA 1983.]

Sec. 44.83.396. Operation of power project. (a) A power project that is acquired or constructed as part of the energy program for Alaska is owned, and shall be administered, by the authority.

(b) When a power project has been acquired or constructed by the authority, the project may be operated for the authority under a contract or lease entered into by a qualified utility and the authority.

(c) The authority shall enter into a contract or lease under reasonable terms and conditions to permit the applicant utility to operate the power project when the applicant utility is the only wholesale power customer to be served directly by the power project unless the authority determines a utility making application for a contract or lease to operate a power project is not a qualified utility or is not capable of operating that power project efficiently and in a manner that is consistent with national standards for the industry and with agreements with bondholders.

(d) The authority shall adopt regulations to determine the manner of selecting a qualified utility to operate a power project under a contract or lease when there is more than one wholesale power customer to be served directly by the power project.

(e) When the authority permits a power project to be operated by a qualified utility under a contract or lease, the authority shall

(1) review and approve the annual budget for the operation and maintenance of the power project; and

(2) assure that the project is being operated efficiently and in a manner that is consistent with national standards for the industry and agreements with bondholders. (§ 1 ch 118 SLA 1981; am §§ 17 — 19 ch 89 SLA 1983)

Revisor's notes. — Enacted as AS 44.83.480. Renumbered in 1981.

Effect of amendments. — The 1983 amendment, deleted "by the state" following "is owned" in subsection (a), inserted "a qualified utility or is not" near the end of subsection (c), added the language beginning "efficiently and in a manner that is consistent" to the end of subsection (c), added "and" to the end of paragraph (1) of subsection (e), and added "and agreements with bondholders" to the end of paragraph (2) of subsection (e).

Sec. 44.83.398. Sale of power from power project. (a) The authority shall sell power produced from power projects acquired or constructed under the energy program for Alaska. For purposes of this section, Lake Tyee, Swan Lake, Solomon Gulch, and Terror Lake hydroelectric facilities are considered to be one power project. This power project is referred to as the initial project

(b) The authority shall establish a wholesale power rate structure applicable to sales of power to the customers of a power project as follows:

(1) The authority shall establish and maintain a separate wholesale power rate applicable to each power project that it has acquired or constructed under the energy program for Alaska, other than a project described in (f) of this section. The wholesale power rate established by the authority for the initial project shall be a rate calculated under this paragraph except that the portion of the rate applicable to (A) and (C) of this paragraph shall be adjusted for the hydroelectric facilities in the initial project as set out in (3) of this subsection. The wholesale power rate shall be computed by the authority annually, or more frequently as may be necessary, and shall equal the rate that the authority estimates is necessary to produce revenue that is sufficient to pay

(A) operation, maintenance, and equipment replacement costs of the power project;

(B) the power project's proportionate share of the debt service on state loans and bonds for all power projects in the energy program for Alaska, determined in accordance with (g) of this section;

(C) safety inspections and investigations of the power project by the authority.

(2) *[Repealed, § 7 ch 169 SLA 1984.]*

(3) For the purposes of determining amounts to be allocated to each hydroelectric facility in the initial project under (1)(A) and (1)(C) of this subsection, the authority shall determine for each hydroelectric facility its individual operation, maintenance, equipment replacement, safety inspection, and investigation costs.

(c) The authority shall transmit all the money that it receives under (a) of this section to the commissioner of revenue for deposit in the state general fund except for money it has pledged or otherwise covenanted to secure bonds.

(d) *[Repealed, § 8 ch 169 SLA 1984.]*

(e) After determining the wholesale power rate for a power project under the provisions of this section, the authority may adjust the rate or change the rate provisions to insure that the revenue derived from that power project and the aggregate revenues of the authority will be adequate to comply with the rate covenants and other agreements contained in any trust indenture or trust agreement entered into by the authority for the seurity of the holders of bonds issued to finance power projects in the energy program for Alaska. The authority may agree with a purchaser of power to limit rate increases caused by debt service payable by the authority on subsequent projects.

(f) The provisions of (b) of this section do not apply to an intertie that is authorized as a separate project under AS 44.83.380. The authority shall establish and maintain separate power rate schedules applicable to each intertie that it has acquired or constructed as a separate power project under the energy program for Alaska. The power rate schedules shall produce sufficient revenue from utilities connected by the intertie to pay (1) operation, maintenance, and equipment replacement costs of the intertie; (2) debt service of the intertie; and (3) safety inspections and investigations of the intertie by the authority. If the authority determines that an intertie has ceased to function as a separate project and has become a part of one or more other power projects and has become a part of one or more other power projects as a transmission line, the power rate schedules established under this subsection shall be terminated and a wholesale power rate applicable to the former intertie shall be calculated under (b) of this section for the project or projects of which it has become a part.

(g) For the purposes of (b)(1)(B) of this section, a power project's proportionate share of debt service on state loans and bonds for all power projects in the energy program for Alaska is equal to the state's investment in the power project divided by the state's investment in all power projects in the energy program for Alaska and multiplied by the debt service on state loans and bonds for all power projects in the energy program for Alaska. In this subsection

(1) "state's investment in the power project" includes all state money invested in a power project, including loans, grants, and proceeds from bonds, less the principal repayments on the project's proportionate share of debt service on state loans and bonds;

(2) "state's investment in all power projects in the energy program for Alaska" includes all state money invested in the power projects, other than interties, in the energy program for Alaska, including loans, grants, and proceeds from bonds, less the principal repayments on bonds and state loans issued for the power projects.

(h) Notwithstanding (g) of this section, in the 1983 state fiscal year the proportionate share of debt service under (b) of this section, expressed as a rate, for a power project for which a construction contract has been awarded before June 25, 1982 may not exceed the average debt service component of the wholesale power rate for all power projects in the energy program for Alaska. The limit imposed by this subsection shall be increased in the 1984 state fiscal year to four percent above the average debt service component of the wholesale power rate for all power projects in the energy program for Alaska and by an additional four percent above that average in each succeeding state fiscal year. If application of this subsection results in the production of insufficient revenue to pay the total debt service for all projects in the energy program for Alaska, a project that does not have its share of debt service limited under this subsection shall be subject to a rate

in addition to the rate established under (b) of this section. The additional rate is the rate that the authority estimates is necessary to produce revenue that is sufficient to pay the difference between the total debt service for all projects in the energy program for Alaska and the revenue actually produced to pay that debt service, multiplied by a fraction whose numerator is the total cost of the project and whose denominator is the total cost of all of the projects that are subject to the additional rate. In this subsection, "projects in the energy program for Alaska" does not include an intertie that is authorized as a separate project as described in (f) of this section.

(i) The authority may place in a separate interest bearing account money appropriated to the authority as a loan for the purpose of meeting the operating expenses of a facility in the initial project. The money may be used to replace amounts which were expected to be paid by a utility potentially served by a facility in the initial project, which has not entered into a power sales agreement with the authority. Repayment of the amount loaned must be made from revenues attributable to power sales from that facility, as limited by the terms of power sales agreements with power purchasers from that facility. A loan made in accordance with this subsection is not a state loan for purposes of calculating the wholesale power rate under (b)(1) of this section. (§ 1 ch 118 SLA 1981; am §§ 13 — 16 ch 133 SLA 1982; am §§ 20 — 23 ch 89 SLA 1983; am § 125 ch 6 SLA 1984; am §§ 2-8 ch 169 SLA 1984)

Revisor's notes. — Enacted as AS 44.83.490. Renumbered in 1981.

Effect of amendments. — The 1982 amendment, in subsection (b), substituted "a power project" for "the power project" in the introductory language, substituted "separate" for "single" and "each power project" for "all power projects" in the first sentence of paragraph (1), added "other than a project described in (f) of this section" to the end of the first sentence of paragraph (1), inserted "or more frequently as may be necessary" in the introductory language of the second sentence of paragraph (1), substituted "power project" for "power projects" in subparagraph (1)(A) and (C), added "the power project's proportionate share of the" to the beginning of subparagraph (1)(B), substituted the language beginning "on state loans and bonds" for "of the power projects" in subparagraph (1)(B), substituted "separate" for "single" and "each power project that is" for "all power projects that it has" in the first sentence of paragraph (2), inserted "or more frequently as may be necessary" in the introductory language of the second sentence of paragraph (2), substituted "power project" for "power projects" in subparagraph (2)(A) and (2)(B)(iii), and substituted the present provisions of subparagraph (2)(B)(ii) for the former provisions, which read: "debt service of power projects by the authority; and." In subsection (c), the amendment substituted "under (a) of this section" for "under (b) of this section" and "money it has pledged to secure bonds in accordance with contracts with bondholders" for "the money it receives under (b)(1)(A) and (B) and (b)(2)(B)(i) and (ii), or the money it would have received under (b)(1)(A) and (B) and (b)(2)(B)(i) and (ii) of this section if those items had been used in part to establish the wholesale power rate in effect at the time the money is received by the authority." In subsection (e), the amendment substituted "a wholesale" for "the wholesale" and "or (f)" in the first sentence and added the second sentence. The amendment also added subsections (f) — (h).

The 1983 amendment, substituted "July 1, 1991" for "July 1, 1986" near the beginning of paragraph (2) of subsection (b), substituted "or otherwise covenanted

to secure bonds" for "to secure bonds in accordance with contracts with bondholders" at the end of subsection (c), rewrote subsection (e), and added the last sentence of subsection (h).

The first 1984 amendment made a technical change in the last sentence in subsection (f).

The second 1984 amendment added subsection (i), repealed former paragraph (2) of subsection (b), relating to a separate wholesale power rate beginning July 1, 1991, and repealed former subsection (d), relating to industrial consumer rates. The 1984 amendment also, in subsection (a), deleted former paragraphs (1) and (2) and the former last sentence in the introductory paragraph, relating to a utility that purchases power produced by a power project of the authority, and, in the remaining language, added the last two sentences; in subsection (b), substituted "the customers" for "its customers at the busbar" in the introductory language, inserted the second sentence in the introductory paragraph of paragraph (1), and added paragraph (3); in subsection (e), added the second sentence and substituted "energy program" for "Energy Program" in the first sentence; and changed the internal reference in the first sentence in the introductory paragraph of subsection (g).

Sec. 44.83.400. Energy conservation. The authority shall ensure

(1) that communities that benefit from the energy program for Alaska implement cost-effective energy conservation measures for residences, commercial and public buildings, and industries; and

(2) that communities shall fulfill their responsibilities under (1) of this section by cooperating with state agencies concerned with development and conservation of energy, including but not limited to

(A) the Alaska Public Utilities Commission;

(B) the Department of Community and Regional Affairs; and

(C) the division of business loans, Department of Commerce and Economic Development. (§ 1 ch 118 SLA 1981; am § 5 ch 79 SLA 1983)

Revisor's notes. — Enacted as AS 44.83.500. Renumbered in 1981.

Effect of amendments. — The 1983 amendment, substituted "Department of Community and Regional Affairs" for "division of energy and power development, Department of Commerce and Economic Development" in paragraph (2)(B).

Sec. 44.83.410. Continuing appropriation for Susitna River Hydroelectric project. [Repealed effective June 30, 1991] The sum of $100,000,000 is appropriated on July 1, 1984 and the sum of $200,000,000 is appropriated on July 1 of each subsequent fiscal year from the general fund to the authority for deposit in the power development fund (AS 44.83.382) for the purpose of equity investment in, and rate stabilization for, the Susitna River hydroelectric project. (§ 314 ch 171 SLA 1984; r § 317 ch 171 SLA 1984)

Postponed repeal. — This section is repealed effective June 30, 1991.

Editor's notes. — Section 316, ch. 171, SLA 1984, provides that the appropriations made in §§ 313—315 and 319 of ch. 171, SLA 1984, which enacted this section, are not one-year appropriations and do not lapse under AS 37.25.010.

Sec. 44.83.420. Continuing appropriation for Bradley Lake hydroelectric project. [Repealed effective June 30, 1988.] The sum

of $50,000,000 is appropriated on July 1, of each fiscal year from the general fund to the authority for deposit in the power development fund (AS 44.83.382) for the purpose of equity investment in, and rate stabilization for, the Bradley Lake hydroelectric project. (§ 314 ch 171 SLA 1984; r § 318 ch 171 SLA 1984)

Postponed repeal. — This section is repealed effective June 30, 1988.

Editor's notes. — Section 316, ch. 171, SLA 1984, provides that the appropriations made in §§ 313—315 and 319 of ch. 171, SLA 1984, which enacted this section, are not one-year appropriations and do not lapse under AS 37.25.010.

Sec. 44.83.425. Definitions. In AS 44.83.380 — 44.83.425,

(1) "bus bar" means the substation that serves as the delivery point from the generation and transmission system of the authority to the transmission and distribution system of the utility;

(2) "debt service" means the amounts covenanted with respect to, or pledged to pay, bonds under a trust agreement securing bonds;

(3) "fund" means the power development fund established by AS 44.83.382;

(4) "industrial consumer" means a customer of a utility which customer has a peak power demand in excess of 500 kilowatts and uses the power principally for

(A) manufacturing;

(B) pipeline transportation;

(C) the recovery or processing of minerals;

(D) the processing of timber, agricultural, or seafood products or their by-products; or

(E) the operation of facilities owned by the federal government;

(5) "qualified utility" means an electric utility that is certified by the Alaska Public Utilities Commission to serve all or part of a market area that is served or will be served by the power project, and that the authority determines is capable of operating and maintaining the power project. (§ 1 ch 118 SLA 1981; am § 24 ch 89 SLA 1983)

Revisor's notes. — Enacted as AS 44.83.510. Renumbered in 1981.

Effect of amendments. — The 1983 amendment, rewrote the definition of "debt service" in paragraph (2).

NOTICE

A NOTATIONAL SYSTEM HAS BEEN USED
TO DENOTE DIFFERENCES BETWEEN THIS AMENDED LICENSE APPLICATION
AND
THE LICENSE APPLICATION AS ACCEPTED FOR FILING BY FERC
ON JULY 29, 1983

This system consists of placing one of the following notations beside each text heading:

(o) No change was made in this section, it remains the same as was presented in the July 29, 1983 License Application

(*) Only minor changes, largely of an editorial nature, have been made

(**) Major changes have been made in this section

(***) This is an entirely new section which did not appear in the July 29, 1983 License Application

VOLUME COMPARISON

VOLUME NUMBER COMPARISON

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PROJECT DESCRIPTION

The Susitna Hydroelectric Project will be comprised of two major developments on the Susitna River some 120 miles north and east of Anchorage, Alaska (see Figure A.1). The project will be constructed in three distinct phases hereinafter referred to as stages.

The following is a brief description of the three phases of the Project. A further description of Watana Stage I is presented in the following Sections 1 through 5; Devil Canyon Stage II is described in Sections 6 through 10. Watana Stage III is described in sections 11 through 15. Project lands for the entire project are discussed in Section 16. Reference drawings are in Exhibit F.

WATANA STAGE I

The Watana Initial Dam would be built to el. 2,025 with a maximum normal reservoir el. of 2,000 (see Exhibit F Figures). The internal zoning of the earthfill dam will include an inclined upstream impervious core. The inclination of the core will reduce the amount of shell material required for stability of the Stage III dam that will be submerged by the Stage I pool, and therefore placed during Stage I construction. When the dam is being raised, all the additional fill will then be placed in the dry during the seasonal drawdown of the reservoir. The raising of the Watana Dam causes no adverse effects on the safety of either the Stage I or Stage III dam, and no unusual construction operation is required during raising. An additional five feet of freeboard is added in Stage I to facilitate flood control with the small reservoir storage volume.

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

For Stage I, there would be one outlet facility structure and two power intake structures. The outlet facility, in conjunction with the four powerhouse units in Stage I, will discharge a 50-year flood before flow would be discharged over the spillway.

The power house in Stage I will have four generating units, each with a nominal capability at average operating head of 110 MW for a total of 440 MW. The December - January dependable capability of the Stage I installation will be 360 MW.

The construction schedule for Stage I will be one year shorter than the first stage of the two stage project. The shortening of the schedule

is a result of a decrease in the quantities of the fill material necessary for the Stage I construction.

DEVIL CANYON STAGE II

Stage II will be the construction of the Devil Canyon development consisting of a concrete double curvature thin arch dam with crest el. 1,463 (see Exhibit F Figures). The normal maximum reservoir will be at el. 1,455. The powerhouse will have four units each with a nominal capability at average operating head of 170 MW for a total of 680 MW. The December - January dependable capability of the Devil Canyon powerplant will be 600 MW. Outlet facilities will be provided to discharge the routed 1:50 year flood in conjunction with the power facilities. A gated chute spillway with flip bucket will be provided capable of passing the probable maximum flood. A saddle dam will be constructed on the right bank to el. 1,472 and adjacent to the arch dam. The saddle dam will be an embankment of similar construction to the Watana Dam. During construction, diversion of the river will be accomplished by construction of upstream and downstream fill cofferdams and a diversion tunnel with capacity to pass the 1:25 year flood routed through the Watana Stage I reservoir.

WATANA STAGE III

The Watana Initial Dam would be raised to el. 2,205 with a maximum normal reservoir el. of 2,185 (see Exhibit F Figures). During seasonal drawdown when the Stage I reservoir elevation is below el. 1,925 (the elevation of the upstream berm) rockfill would be in the dry on the upstream side of the dam.

The concrete spillway ogee crest would be raised to el. 2,135 and the spillway gates relocated to accommodate the higher ogee elevation.

The outlet facility structure and the two power intakes would be raised to el. 2,201. A third power intake would be built in Stage III with an inlet at el. 2,012.

Two additional units would be added to the powerhouse bringing the total number of units to six. After completion of Stage III, the nominal capacity of the powerhouse at average operating head would increase from 440 MW to 1,110 MW because of the increase in head on the four Stage I units and the addition of two 185 MW nominal capacity units. The December - January dependable capability of Watana in Stage III will be 1020 MW for a total project dependable capability of 1620 MW.

1 - PROJECT STRUCTURES - WATANA STAGE I (**)

1.1 - General Arrangement (**)

The Watana Stage I Dam will create a reservoir approximately 39 miles long, with a surface area of 20,000 acres, and a gross storage

capacity of 4,300,000 acre-feet at the normal maximum operating level of el. 2,000.

The maximum water surface elevation during flood conditions will be 2,017. The minimum operating level of the reservoir will be 1,850, providing 2,400,000 acre-feet of live storage during normal operation.

The dam will be an earth and rockfill embankment with an inclined impervious core. The nominal crest elevation of the dam will be 2,025, with a maximum height of approximately 700 feet above the foundation and a crest length of 2,700 feet. The embankment crest will initially be cambered to el. 2,027 in the zone of maximum dam height to allow for potential seismic and static settlement. The total volume of the structure will be approximately 32,110,000 cubic yards. During construction, the river will be diverted through two concrete-lined diversion tunnels on the north side of the river, each 36 feet in diameter and averaging 3,700 feet long.

The power intake will be located on the north bank with an approach channel excavated in rock. The intake will be a concrete structure with multi-level gates capable of operating over the full 150 foot drawdown range. From the intake structure, two 24 foot diameter concrete-lined power conduits and shafts will lead to an underground powerhouse complex, housing four generating units with Francis type turbines and synchronous generators. Near the powerhouse the conduits will branch into four 15-foot diameter steel-lined penstocks.

Access to the powerhouse complex will be by means of an unlined access tunnel and a road which will pass from the crest of the dam, down the south bank of the river valley and across a berm constructed on the downstream toe of the main dam. Turbine discharge will flow through four draft tube tunnels to a surge chamber downstream from the powerhouse. The surge chamber will discharge to the river through a 34 foot modified-horseshoe concrete-lined tailrace tunnel. A separate transformer gallery just upstream of the powerhouse cavern will house seven single-phase 15-345/ 1.73 kV transformers (three transformers per group of two generators, and one spare), and an SF_6 gas insulated substation. Each bank of transformers will be connected through generator circuit breakers by isolated phase bus located in individual bus tunnels. The HV bushings for the transformers will be connected to the 345 kV SF_6 gas insulated substation (GIS) by single-phase SF_6 gas insulated buses (GIB). The substation will provide switching for two transformer banks and two transmission lines. Two sets of single-phase SF_6 GIB will be carried from the GIS to the surface through a single vertical shaft. At the surface the GIB will be terminated at SF_6-to- air entrance bushings where they will be connected to overhead transmission lines.

Outlet facilities will also be located on the north bank with a capacity of approximately 24,000 cfs. A flood storage pool is provided

between el. 2,000 and el. 2,014. In combination with the average powerhouse flow of 9,200 cfs, the 50-year flood can be stored and released without raising the pool level above el. 2,014 and without requiring use of the spillway.

The spillway located on the north bank will consist of an upstream ogee control structure with three radial gates and an inclined concrete chute and flip bucket designed to pass a maximum discharge of 278,300 cfs. This spillway, together with the outlet facilities, will be capable of discharging the estimated Probable Maximum Flood (PMF) of 326,000 cfs, while maintaining eight feet of freeboard on the dam. Emergency release facilities will be located in one of the diversion tunnels after closure to allow lowering of the reservoir over a period of time for emergency inspection or repair of impoundment structures.

1.2 - Dam Embankment (**)

The Watana Stage I Dam embankment will be located at mile 184 above the mouth of the Susitna River, in a broad U-shaped valley approximately 2.5 miles upstream of the Tsusena Creek confluence. The dam will be of compacted earth and rockfill construction and will consist of an impervious core protected by fine and coarse filters upstream and downstream. The upstream and downstream outer shells will consist of rockfill. A typical cross section is shown on Plate F7 and is described below.

1.2.1. Typical Cross Section (**)

The thickness of the core at any horizontal section will be slightly more than 0.5 times the head of water at that section. Flaring will be required of the cross section at each end of the embankment.

The upstream and downstream filter zones are sized to provide protection against possible piping through transverse cracks that could occur because of settlement or resulting from internal displacement during a seismic event.

The shells of the dam will consist of rockfill obtained from required surface or underground excavations. The rockfill will minimize pore pressure generation and insure rapid dissipation of pore pressures should seismic shaking occur.

Protection against wave and ice action on the upstream slope will consist of a rock raked layer of large stone comprising quarried rock up to 36 inches in size.

The volume of material required to construct the Watana Dam is presently estimated as follows:

Material	Volume (cy)
Impervious	6,300,000
Fine filter	2,217,000
Coarse filter	2,000,000
Rockfill	21,590,000

1.2.2 - Crest Details and Freeboard (**)

The typical crest detail is shown in Plate F7. Because of the narrowing at the dam crest, the filter zones are reduced in width, but still protect the core material from damage by frost penetration and desiccation.

The nominal crest elevation of Watana Stage I will be 2,025.

Total settlement allowance has been made for post-construction settlement of the dam under its own weight, for the effects of saturation on the upstream rock fill when the reservoir is first filled, and for possible settlement from seismic shaking. Provision will be made during construction for placement of additional fill at the crest should settlements exceed the estimated amounts. At each abutment the crest elevation will be 2,025, while at the maximum section the crest elevation will be 2,027 allowing for two feet of settlement. Under normal operating conditions the minimum freeboard, relative to the maximum operating pool elevation of 2,000, will be approximately 25 feet, not including settlement allowances.

The freeboard allowance is eight feet above the PMF reservoir level and is based on the crest level after all settlement has taken place. Ultimate security against overtopping of the main dam will be provided by the spillway which is designed to pass the PMF without overtopping the dam.

1.2.3 - Grouting and Pressure Relief System (**)

A combination of consolidation grouting, grout curtain and installation of a downstream pressure relief (drainage) system will be undertaken in the bedrock foundation beneath Watana Dam.

The grout curtain and drilling for the pressure relief system will be largely carried out from galleries in the rock foundation in the abutments and beneath the dam. Details of the grouting, pressure relief and galleries are shown on Plate F8.

1.2.4 - Instrumentation (**)

Instrumentation will be installed to provide monitoring of performance of the dam and foundation during construction as well as during operation. Instruments for measuring internal vertical and horizontal displacements, stresses and strains, and total and fluid pressures, as well as surface monuments and markers, will be installed. Conservative quantity estimates for instrumentation have been made on the basis of currently available geotechnical data for the site. This instrumentation includes:

- o Piezometers
  - Piezometers will be used to measure hydrostatic pressure in the pore spaces of soil and rockfill, and in the rock foundation.
- o Internal Vertical Movement Devices
  - Cross-arm settlement devices,
  - Various versions of the taunt-wire devices which have been developed to measure internal settlement, and
  - Hydraulic-settlement devices of various kinds.
- o Internal Horizontal Movement Devices
  - Taunt-wire arrangements,
  - Cross-arm devices,
  - Inclinometers, and
  - Strain meters.
- o Other Measuring Devices
  - Stress meters,
  - Surface monuments and alignment markers,
  - Seismographic records and seismoscopes, and
  - Flow meters to record discharge from drainage and pressure relief system.

1.3 - Diversion (**)

1.3.1 - Tunnels (**)

Diversion of the river flow during construction will be accomplished with two 36-foot diameter circular diversion tunnels. The tunnels will be concrete-lined and located on the north bank of the river. The tunnels are 3,305 feet and 4,020 feet in length. The diversion tunnels are shown in plan and profile on Plate F9.

The tunnels are designed to pass a flood with a return frequency of 1:50 years, equivalent to peak inflow of 89,500 cfs. Routing effects are small, and thus at peak flow the tunnels will discharge 77,000 cfs. The estimated maximum water surface elevation upstream from the cofferdam for this discharge will be 1,532.

The upper tunnel (Tunnel No. 1) will be converted to the permanent emergency outlet after construction. A local enlarging of the tunnel diameter to 45 feet will accommodate the low-level outlet gates and expansion chamber.

1.3.2 - Cofferdams (**)

The upstream cofferdam will be a zoned embankment founded on the diversion dike (see Plate F10). The diversion dike will be constructed to el. 1,480, and will consist of finer material on the upstream side grading to coarser material on the downstream side. Provision has been made for a slurry trench cutoff through the river bed alluvium to bedrock to control seepage during dam construction. The slurry wall cutoff is shown on Plate F10.

The upstream cofferdam will receive the usual foundation treatment and will be a zoned embankment consisting of an impervious core, fine and coarse upstream and downstream filters, and rock and/or gravel supporting shell zones with slope protection on the upstream face to resist ice action. This cofferdam will be constructed to el. 1,550 and provide an 18-foot freeboard for wave run-up and ice protection.

The downstream cofferdam will be a zoned earth and rockfill embankment (see Plate F-10). The diversion dike will be constructed to el. 1,460, and will consist of random rock material placed on the downstream side of the cofferdam section. The cofferdam will be raised in the dry to its crest elevation of 1,495. The diversion scheme will allow an unwatering of the river reach between the cofferdams, so the slurry trench cut-off to bedrock may be constructed for control of under seepage.

1.3.3 - Tunnel Portals and Gate Structures (**)

A reinforced concrete gate structure will be located at the upstream end of each tunnel, each housing two closure gates (see Plate F11).

Each gate will be 36 feet high by 14 feet wide separated by a center concrete pier. The gates will be of the fixed-roller vertical lift type operated by a wire rope hoist. The gate hoist will be located in an enclosed, heated housing. Provision will be made for heating the gates and gate guides. The gate in

Tunnel No. 1 will be designed to operate with the reservoir at el. 1,532, a 64-foot operating head. The gate in Tunnel No. 2 will be designed to operate with the reservoir at el. 1,532, an 87-foot operating head. The gate structures for each tunnel will be designed to withstand external (static) heads of 160 feet (No. 2) and 500 feet (No. 1), respectively. The downstream portals will be reinforced concrete structures with guides for stoplogs.

1.3.4 - Final Closure and Reservoir Filling (**)

As discussed above, the upper diversion tunnel (No. 1) will be converted to a low-level outlet or emergency release facility during construction.

It is estimated that one year will be required to construct and install the permanent low-level outlet in the existing tunnel. This will require that the lower tunnel (No. 2) pass all flows during this period. The main dam will, at this time, be at an elevation sufficient to allow a 100-year recurrence interval flood (99,000 cfs) to pass through Tunnel No. 2. This flow will result in a reservoir elevation of approximately 1,618. During the construction of the low level outlet, the intake gates in the upper tunnel (No. 1) will be closed. Prior to commencing operation of the low-level outlet, coarse trashracks will be installed at the entrance to Tunnel No. 1 intake structure.

Upon commencing operation of the low-level outlet, the lower tunnel (No. 2) will be closed with the intake gates, and construction of the permanent plug and filling of the reservoir will commence.

When the lower tunnel (No. 2) is closed the main dam crest will have reached an elevation sufficient to start filling the reservoir and still have adequate storage available to store a 250-year recurrence period flood.

During the filling operation, the low-level outlet will pass summer flows of up to 12,000 cfs and winter flows of up to 800 cfs. In case of a large flood occurring during the filling operation, the low-level outlet would be opened to its maximum capacity of 30,000 cfs to maintain the reservoir pool at a safe level.

Reservoir filling is estimated to take one year to fill to a level required for testing, commissioning, and operating the first two units during the first winter. Completion of filling to el. 2,000 would occur during the second summer.

The filling sequence is based on the main dam elevation at any time during construction and the capability of the reservoir

storage to absorb the inflow volume from a 250-year recurrence period flood without overtopping the main dam.

1.4 - Emergency Release Facilities (**)

The upper diversion Tunnel No. 1 will be converted to a permanent low-level outlet, or emergency release facility. These facilities will be used to pass the required minimum discharge during the reservoir filling period and will also be used for draining the reservoir in an emergency.

During operation, energy will be dissipated by means of two gated concrete plugs separated by a 340-foot length of tunnel (see Plate F19). Each plug will contain three water passages.

Bonnetted type high pressure slide gates will be installed in each of the passages in the tunnel plugs. The gate arrangement will consist of one emergency gate and one operating gate in the upstream plug and one operating gate in the downstream plug. A 340-foot length of tunnel between plugs will act as an energy dissipating expansion chamber.

The 7.5-foot by 11.5-foot gates will be designed to withstand a total static head of about 720 feet; however, they will only be operated with a maximum head of about 420 feet.

During operation, the operating gate opening in the upstream plug will be equal to the opening of the corresponding gate in the downstream plug. This should effectively balance the head across the gates.

Each gate will have a hydraulic cylinder operator designed to raise or lower it against a maximum head of 600 feet. Three hydraulic units will be installed, one for the emergency gates, one for the upstream operating gates and one for the downstream operating gates. Each gate will have an opening/closing time of about 30 minutes. A grease injection system will be installed in each gate to reduce frictional forces when the gates are operated.

The design of the gate will be such that the hydraulic cylinder as well as the cylinder packing may be inspected and repaired without dewatering the area around the gate. All gates may be locally or remotely operated.

To prevent concrete erosion, the conduits in each of the tunnel plugs will be steel-lined. An air vent will be installed at the downstream side of the operating gate in the downstream plug. Energy dissipation at the downstream tunnel exit will be accomplished by means of a concrete flip bucket in the exit channel (Plate F20).

1.5 - Outlet Facilities (**)

The primary function of the outlet facilities will be to discharge floods with recurrence frequencies of up to once in 50 years after they have been routed through the Watana reservoir. The use of fixed-cone discharge valves will ensure that downstream erosion will be minimal and the dissolved nitrogen content in the discharges will be reduced sufficiently to avoid harmful effects on the downstream fish population. A secondary function will be to provide the capability to rapidly draw down the reservoir during an extreme emergency situation.

The facilities will be located on the north bank and will consist of a gate structure, pressure tunnel, and an energy dissipation and control structure housing located beneath the spillway flip bucket. This structure will accommodate six fixed-cone valves which will discharge into the river 105 feet below.

1.5.1 - Approach Channel and Intake (**)

The approach channel to the outlet facilities will be shared with the power intake and spillway. The channel at the maximum normal operating level of el. 2,000 will be 680 feet wide immediately upstream of the outlet facility's gate structure. The gate structure will be founded deep in the rock at the forebay end of the channel. The single intake passage will have an invert elevation of 1,915. It will be divided upstream by a central concrete pier which will support steel trashracks located on the face of the structure, spanning the openings to the water passage. The trashracks will be split into panels mounted one above the other and run in vertical steel guides installed at the upstream face. The trashrack panels can be raised and lowered for cleaning and maintenance by a mobile gantry crane located at deck level.

Two fixed-wheel gates will be located downstream of the trashracks between the pier and each of the sidewalls. These gates will be operated by a hydraulic hoist mounted in the gate shaft. The fixed-wheel gates will not be used for flow control but will function as closure gates to isolate the downstream tunnel and allow dewatering for maintenance of the tunnel or ring gates located in the discharge structure. Stoplog guides will be provided upstream from the two fixed-wheel gates to permit dewatering of the structure and access to the gate guides for maintenance.

1.5.2 - Intake Gates and Trashracks (**)

The gates will be of the fixed-wheel vertical lift type with upstream skinplate and seals. The nominal gate size will be 18

feet wide by 28 feet high. Each gate will be operated by a hydraulic hoist located above the gate in the gate shaft.

The gates will be capable of being lowered either from a remote control room or locally from the intake area. Gate raising will be from the hoist area only.

The trashracks will have a bar spacing of 6 inches and will be designed for a maximum differential head of 40 feet. The maximum net velocity through the racks will be approximately 7.5 ft/sec. Provision will be made for monitoring the head loss across the trashracks.

1.5.3 - Shaft and Tunnel (**)

Discharges will be conveyed from the upstream gate structure by a concrete-lined tunnel terminating in a steel liner and manifold. The manifold will branch into six steel-lined tunnels which will run through the main spillway flip bucket structure to the fixed-cone valves mounted in line with the downstream face.

The water passage will be 28 feet in diameter from the intake to the steel manifold. The upstream concrete-lined portion will run a short distance horizontally from the back of the intake structure before dipping at an angle of 55° to a lower level tunnel of similar cross section. The lower tunnel will run at a 5 percent gradient to a centerline elevation of 1,560 approximately 450 feet upstream of the flip bucket. At this point the depth of overlying rock is insufficient to withstand the large hydrostatic pressure which will occur within the tunnel. Downstream of this point the tunnel will be steel-lined. The steel liner will be 28 feet in diameter and embedded in concrete filling the space between the liner and the surrounding rock. The area between the outside face of the liner and the concrete will be contact grouted.

1.5.4 - Discharge Structure (**)

The concrete discharge structure is shown on Plate F15. It will form a part of the flip bucket for the main spillway and will house the fixed-cone valves and individual upstream ring follower gates. The valves will be set with a centerline elevation of 1,560 and will discharge into the river approximately 105 feet below. Openings for the valves will be formed in the concrete and the valves will be recessed within these openings sufficiently to allow enclosure for ease of maintenance and heating of the movable valve sleeves. An access gallery upstream from the valves will run the length of the discharge structure, and will terminate in the access tunnel and access road on either side of the structure.

Housing for the ring follower gates will be located upstream from the fixed-cone valve chambers. The ring follower gates will serve to isolate the discharge valves. Provision will be made for relatively easy equipment maintenance and removal by means of a 25-ton service crane, transfer trolley and individual 25-ton monorail hoists.

1.5.5 - Fixed-Cone Discharge Valves (**)

Six 78-inch diameter fixed-cone discharge valves will be installed at the downstream end of the outlet manifold, as shown on Plate F15. The valves will be operated by two hydraulic cylinder operators. The valves will be operated either locally or remotely.

1.5.6 - Ring Follower Gates (**)

A ring follower gate will be installed upstream from each valve and will be used:

- To permit inspection and maintenance of the fixed-cone valves;
- To relieve the hydrostatic pressure on the fixed-cone valves when they are in the closed position; and
- To close against flowing water in the event of malfunction or failure of the valves.

The ring follower gates will have a nominal diameter of 90 inches and will be designed to withstand a total static head of 630 feet.

The ring follower gates will be designed to be lowered under flowing water conditions and raised under balanced head conditions. A grease injection system will be installed in each gate to reduce frictional forces when the gates are operated. The gates will be operated by hydraulic cylinders from either a local or remote location.

1.5.7 - Discharge Area (**)

Immediately downstream from the discharge structure, the rock will be excavated at a slope of 2H:3V to a lower elevation of 1,510. This face will be heavily reinforced by rock bolts and protected by a concrete slab anchored to the face. The lower level will consist of unlined rock extending to the river.

1.6 - Spillway (**)

The spillway will provide discharge capability for floods exceeding the capacity of the outlet facilities (50-year flood). The combined total capacity of the spillway and outlet facilities will be sufficient to pass the PMF.

The spillway, shown on Plate F12, will be located on the north bank of the river and will consist of an approach channel, a gated ogee control structure, a concrete-lined chute, and a flip bucket.

The spillway is designed to discharge flows of up to 258,000 cfs with a corresponding reservoir elevation of 2,014. The total head dissipated by the spillway is approximately 545 feet.

1.6.1 - Approach Channel and Control Structure (**)

The approach channel at the spillway will be excavated to a depth of approximately 335 feet into rock. It will be located on the north side of the power and outlet facilities intakes, and will be integrated with the approach channels upstream of these intake structures.

The concrete control structure will be located at the end of the approach channel. Flows will be controlled by three 64-foot high by 44-foot wide radial gates, as shown on Plate F13. The structure will be constructed in individual monoliths separated by contraction joints. The main access route to the dam will pass across the roadway deck and along the dam crest.

Hydraulic model tests will be undertaken during the detailed design stage to confirm the precise geometry of the control structure.

The sides of the approach channel will be excavated to 1H:4V slopes. Only localized rock bolting and shotcrete support are expected. The control structure will be founded deep in sound rock and consolidation grouting is not anticipated. However, minor shear or fracture zones passing through the foundation may require dental excavation, concrete backfill and/or consolidation grouting.

The dam embankment grouting and drainage tunnel will join the control structure gallery. Access to the grouting tunnels will be via a vertical shaft within the control structure side wall and a gallery running through the ogee weir.

1.6.2 - Spillway Gates and Stoplogs (**)

The three spillway gates will be of the radial type operated by hydraulic hoists mounted at the sides of the piers downstream of the gates. The gate size is 44 feet wide by 64 feet high. Provision will also be made for heating the gate guides for winter operation.

An emergency engine will be provided to enable the gates to be raised in the event of loss of power to the spillway's gate hoist motor hydraulic system.

Stoplog guides will be installed upstream of each of the three spillway gates. One set of stoplogs will be provided to permit maintenance of the radial gates.

1.6.3 - Spillway Chute (**)

The control structure will discharge down an inclined chute that tapers uniformly until a width of 120 feet is reached near the flip bucket. Convergence of the chute walls as such will be gradual to minimize any shock wave development.

The chute section will be rectangular in cross section, excavated in rock, and lined with concrete anchored to the rock. An extensive underdrainage system will be provided to ensure stability of the structure. The dam grout curtain and drainage system will also extend under the spillway control structure utilizing a gallery through the mass concrete rollway. A system of box drains will be constructed in the rock under the concrete slab in a herringbone pattern at 20 feet spacing for the entire length of the spillway. A drainage trench will be excavated beneath the entire length of the spillway. Drain pipes will intersect the gallery. Drainage holes drilled into the high rock cuts will also ensure increased stability of excavations.

A series of four aeration galleries will be provided at intervals down the chute to prevent cavitation damage of the concrete. Details of these aeration devices are shown in Plate F14.

1.6.4 - Flip Bucket (**)

The function of the flip bucket will be to direct the spillway flow clear of the concrete structures and well downstream into the river below. A mass concrete block will form the flip bucket for the main spillway. Detailed geometry of the bucket, as well as dynamic pressures on the floor and walls of the structure, will be confirmed by model studies.

1.7 - This section deleted

1.8 - Power Intake (**)

1.8.1 - Intake Structure (**)

The power intake will be a concrete structure located deep in the bedrock on the north bank. Access to the structure will be by road from the south side of the spillway bridge.

In order to draw from the reservoir surface over a drawdown range of 150 feet, two openings at five levels will be provided in the upstream concrete wall of the structure for each of the two independent power intakes serving the four generating units. Openings can be closed off by sliding steel shutters operated in a common guide. All openings will be protected by upstream trashracks. A heated boom will operate in guides upstream from the racks following the water surface, keeping the racks ice free.

Two lower control gates will be provided in each intake unit. A single set of upstream bulkhead gates will be provided for routine maintenance of the two sets of intake gates.

The overall base width of the intake will be 150 feet, providing a minimum spacing of power tunnel excavations of 2.75 times the excavated diameter.

The upper level of the concrete structure will be set at el. 2,020. The level of the lowest intake is governed by the vortex criterion for flow into the penstock from the minimum reservoir level elevation of 1,850. The foundation of the structure will be approximately 400 feet below existing ground level and is expected to be in sound rock.

The wall between intake structures will be perforated with a series of holes (see Plate F24) in the section between the guides for the shutter gates and the bulkhead gate. These perforations will allow for a more uniform withdrawal distribution across the approach channel width when only one power tunnel is conveying water.

Mechanical equipment will be housed in a steel-frame building on the upper level of the concrete structure. The general arrangement of the power intake is shown on Plate F24.

1.8.2 - Approach Channel (**)

The overall width of the approach channel at the upper shutter gate level is governed by the combined width of the power intake outlet facilities gate structure and spillway control structure, and will be approximately 700 feet. The length of the channel will be 1,600 feet.

The maximum velocity in the intake approach channel will occur when four machines are operating with the reservoir drawn down to el. 1,850. The velocity in the approach channel will be 1.4 ft/sec, which will not cause any erosion problems. Velocities of 6.2 ft/sec may occur where the intake approach channel intersects the approach channel to the main spillway.

1.8.3 - Mechanical Arrangement (**)

(a) Ice Boom (**)

A heated boom will be installed in guides immediately upstream from the trashracks for each of the two power intakes. The boom will be operated by a movable hoist and will automatically follow the reservoir level. The boom will serve to minimize ice accumulation in the trashrack and intake shutter area, and prevent thermal ice-loading on the trashracks.

(b) Trashracks (**)

Each of the two power intakes will have five sets of trashracks, one set in front of each pair of intake openings. Each set of trashracks will be in two sections to facilitate handling by the intake service crane. Each set of trashracks will cover two openings each 24 feet wide by 25 feet. The trashracks will have a bar spacing of six inches and will be designed for a maximum differential head of 20 feet.

(c) Intake Shutters (**)

Each of the two power intakes will have four sets of intake shutters which will serve to prevent flow through the openings behind which the shutters will be installed. As the reservoir level drops, the sliding shutters will be removed as necessary using the intake service crane.

Each of the shutters will be designed for a differential head of 15 feet, and will incorporate a flap gate. This will prevent failure of the shutters in the event of accidental blocking of all intake openings.

The shutter guides will be heated to facilitate shutter removal in sub-freezing weather. In addition, a bubbler system will be provided in the intake behind the shutters to keep the intake structure water surface free of ice.

(d) Intake Service Crane (**)

A single overhead traveling-bridge type intake service crane will be provided in the intake service building. The crane will be used for:

- o Servicing the ice boom and ice boom hoist
- o Handling and cleaning the trashracks
- o Handling the intake shutters
- o Handling the intake bulkhead gates and
- o Servicing the intake gate and hoist

The overhead crane will have a double point lift and followers for handling the trashrack, shutters and bulkhead gates. The crane will be radio-controlled with a pendant or cab control for backup.

(e) Intake Bulkhead Gates (**)

One set of intake bulkhead gates will be provided for closing the two intakes upstream of the intake gates. The bulkhead gates will be used to permit inspection and maintenance of the intake gate and intake gate guides. The gates will be designed to withstand full differential pressure.

(f) Intake Gates (**)

The intake gates will close the two openings of 12 feet by 24 feet of each power intake. They will be of the vertical fixed-wheel lift type with upstream seals and skinplate.

Each gate will be operated by a hydraulic cylinder type hoist. The length of a cylinder will allow withdrawal of the gate from the water flow. The intake service crane will be used to raise the gate above deck level for maintenance. The gates will normally be closed under balanced flow conditions to permit dewatering of the power tunnel penstock water passages for inspection and maintenance. The gates will also be designed to close in an emergency with full turbine flow conditions in the event of loss of control of the turbine.

1.9 - Power Tunnels and Penstocks (**)

The general arrangement of the power tunnels and penstocks is shown on Plates F21 and F23.

Two power tunnels, each of which bifurcate to penstocks, are provided to convey water from the power intakes to the powerhouse, one penstock for each generating unit. The power tunnel geometry shall consist of a short horizontal reach, a 90 degree bend, a shaft, another 90 degree bend and a short horizontal reach before the bifurcation. The power tunnel will be concrete lined with internal diameter of 24 feet. Each penstock will be a concrete-lined tunnel 18 feet in internal diameter. The minimum concrete lining thickness will be 18 inches. The lateral spacing between power tunnels will be 75 feet on centers at the intake and the penstocks, and 60 feet on centers at the powerhouse. The difference in lateral spacing will be achieved by staggering the bifurcation point of each power tunnel.

The design static head on each penstock is 763 feet, the Stage III maximum normal reservoir level, at centerline distributor level (el. 1,422). An allowance of 35 percent has been made for pressure rise in the penstock caused by hydraulic transients.

1.9.1 - Steel Liner (**)

The rock immediately adjacent to the powerhouse cavern will be incapable of resisting the internal hydraulic forces within the penstocks. Consequently, the first 50 feet of each penstock upstream of the powerhouse will be reinforced by a steel liner designed to resist the maximum design head, without support from the surrounding rock. Beyond this section the steel liner will be extended a further 150 feet, and support from the surrounding rock will be assumed, up to a maximum of 50 percent of the design pressure.

The steel liner will be surrounded by concrete with a minimum thickness of 18 inches. The internal diameter of the steel lining will be 15 feet. A steel transition will be provided between the liner and the 18-foot diameter concrete-lined penstock.

1.9.2 - Concrete Lining (**)

The power tunnels and penstocks will be fully lined with concrete from the intake to the steel-lined section of the penstocks. The internal diameter of the concrete- lined penstock will be 18 feet. The minimum lining thickness will be 18 inches.

1.9.3 - Grouting and Pressure Relief System (**)

A comprehensive pressure relief system will protect the underground caverns against seepage from the high pressure penstock. The system will comprise small diameter boreholes set out to intercept the jointing in the rock. A grouting and drainage gallery will be located upstream from the transformer gallery.

1.10 - Powerhouse (**)

The underground powerhouse complex will be constructed beneath the north abutment of the dam. This will require the excavation in rock of three major caverns, the powerhouse, transformer gallery, and surge chamber, with interconnecting rock tunnels for the draft tubes and isolated phase bus ducts.

Unlined rock tunnels, with concrete inverts where appropriate, will be provided for vehicular access to the three main rock caverns and the penstock construction adit. Vertical shafts will be provided for personnel access to the underground powerhouse, for SF6 gas-insulated busses from the transformer gallery, for surge chamber venting, and for the heating and ventilation system.

The general layout of the powerhouse complex is shown in plan and section on Plates F25 and F26, and in isometric projection on Plate F24. The transformer gallery will be located on the upstream side of the powerhouse cavern; the surge chamber will be located on the downstream side.

The draft tube gate gallery and crane will be located in the surge chamber cavern, above the maximum anticipated surge level. Provision will also be made in the surge chamber for tailrace tunnel intake stoplogs, which will be handled by the same crane.

1.10.1 - Access Tunnels and Shafts (**)

Vehicular access to the underground facilities at Watana will be provided by a single unlined rock tunnel from the north bank area at el. 1,560, adjacent to the diversion tunnel portals. The access tunnel will descend to the south end of the powerhouse cavern at generator floor level, el. 1,463. Separate branch tunnels from the main tunnel will provide access to the transformer gallery at el. 1,507, and the surge chamber at el. 1,495. A separate penstock construction adit will be driven to el. 1,420 from immediately downstream of the diversion tunnel portals. The gradient will not exceed 0.3 percent at the construction access tunnel, and 9.5 percent at the permanent access tunnels, except for along the short transformer access tunnel where the gradient is 11 percent.

The cross section of the access tunnel has a modified horseshoe shape, 35 feet wide by 28 feet high. The access tunnel branch to the surge chamber and draft tube gallery will have a reduced section consistent with the anticipated size of vehicle and loading required.

The main access shaft will be at the north end of the powerhouse cavern, providing personnel access from the surface control building by elevator. Access tunnels will be provided from this shaft for pedestrian access and ventilation to the transformer gallery and the draft tube gate gallery and ventilation. Elevator access will also be provided to the fire protection head tank, located approximately 250 feet above powerhouse level. The main access shaft will be 20 feet in internal diameter with a concrete lining of 9 to 18 inches.

1.10.2 - Powerhouse Cavern (**)

The main powerhouse cavern will be designed to accommodate four vertical-shaft Francis turbines, in line, with direct coupling to synchronous generators. The length of the cavern will allow for a unit spacing of 60 feet, with a 95-foot long service bay at the south end for routine maintenance and for construction erection. Vehicular access will be by tunnel to the generator floor at the south end of the cavern; pedestrian access will be by elevator from the surface control building to the north end of the cavern. Multiple stairway access points will be available from the main floor to each gallery level. Access to the transformer gallery from the powerhouse will be by tunnel from the main access shaft, or by stairway through each of the isolated phase bus tunnels. A service elevator will be provided for access to the various powerhouse floors.

Hatches will be provided through all main floors for installation and maintenance of heavy equipment using the powerhouse cranes.

In order to minimize interruption to power generation during future Stage III extension, the powerhouse superstructure excavation will be extended by five feet, bringing the total Stage I excavation length to 365 feet above el. 1,441. Similarly, a 76 foot long drainage tunnel will be excavated to allow gravity drainage to occur from the future bays to Unit 4 sumps.

1.10.3 - Transformer Gallery (**)

The transformers will be located underground in a separate gallery, 120 feet upstream from the main powerhouse cavern, with two connecting tunnels for the isolated phase bus. There will be six single-phase transformers installed in groups of

three transformers for two generating units. Generator circuit breakers will be installed in the powerhouse on the generator floor level.

The transformer gallery will be 45 feet wide, 40 feet high, and 308 feet long; the bus tunnels will be 16 feet wide and 16 feet high.

Two sets of 345 kV SF6 gas-insulated busses will be taken to the surface by a single vertical shaft with an internal diameter of 9.0 feet. Provision will be made for installation of an inspection hoist in the shaft. A spare transformer will be located in the transformer gallery. The station service auxiliary transformers (2 MVA) and the surface auxiliary transformer (7.5/10 MVA) will be located in the bus tunnels. Generator excitation transformers will be located in the powerhouse on the main floor.

Vehicle access to the transformer gallery will be the main powerhouse access tunnel at the south end. Pedestrian access will be from the main access shaft or through each of the two isolated phase bus tunnels.

The transformer gallery will also be over-excavated by five feet similar to the powerhouse cavern bringing the total excavated Stage I length to 308 feet.

1.10.4 - Surge Chamber (**)

A surge chamber will be provided 120 feet downstream from the powerhouse cavern to control pressure fluctuations in the turbine draft tubes and tailrace tunnels under transient load conditions, and to provide storage of water for the machine start-up sequence. The chamber will be common to all four draft tubes, and will discharge into a tailrace tunnel. The overall surge chamber size is 290 feet long, 50 feet wide, and 150 feet high (including the draft tube gate gallery).

The draft tube gate gallery and crane will be located in the same cavern, above the maximum anticipated surge level. The crane has also been designed to allow installation of tailrace tunnel intake stoplogs for emergency closure of the tailrace tunnel.

The chamber will generally be an unlined rock excavation, with localized rock support as necessary for stability of the roof arch and walls. The gate guides for the draft tube gates and tailrace stoplogs will be embedded in reinforced concrete, and anchored to the rock by rock bolts.

Access to the draft tube gate gallery will be by an adit from the main access tunnel. This access will be widened locally for storage of tailrace tunnel intake stoplogs.

1.10.5 - Grouting and Pressure Relief System (**)

Control of seepage in the powerhouse area will be achieved by a grout curtain upstream from the transformer gallery and an arrangement of drain holes downstream from this curtain. In addition, drain holes will be drilled from the caverns extending to a depth greater than the rock anchors. Seepage water will be collected by surface drainage channels and directed into the powerhouse drainage system.

1.10.6 - SF6 Gas Insulated Bus Shaft (**)

The SF6 gas-insulated bus shaft will be 9 feet internal diameter. Although not required for rock stability, a 9-inch thick concrete lining has been specified for convenience of installing hoist, stairway and cable supports.

1.10.7 - Draft Tube Tunnels (**)

The draft tube tunnels will be shaped to provide a transition to a uniform horseshoe section with a 19-foot diameter and a concrete lining approximately two feet thick. The initial rock support will be concentrated at the junctions with the powerhouse and surge chamber where the two free faces give greatest potential for block instability.

1.11 - Tailrace (**)

The tailrace pressure tunnel will be provided to carry water from the surge chamber to the river. The tunnel will have a modified horseshoe cross section with a major internal dimension of 34 feet.

The tunnel will be fully concrete-lined throughout, with a minimum concrete thickness of 18 inches and a length of 1,430 feet. The tailrace tunnel will be arranged to discharge into the river between the dam and spillway. The tunnel will start at the downstream wall of the surge chamber and then turn parallel to it until joining the penstock construction adit. The tunnel portal will be used for the tailrace outlet. The tunnel will be concrete-lined for hydraulic considerations. A rock berm will be left in place to the south of the portal to separate the outlet and diversion tunnel channels.

The tailrace portal will be a reinforced concrete structure designed to reduce the outlet flow velocity, and hence the velocity head loss at the exit to the river.

1.12 - Main Access Plan (**)

1.12.1 - Access Objectives (*)

The primary objective of access is to provide a transportation system that will support construction activities and allow for the orderly development and maintenance of site facilities.

1.12.2 - Access Plan Selection (**)

Detailed access studies resulted in the development of eighteen alternative access plans within three distinct corridors. The three corridors were identified as:

- o A corridor running west to east from the Parks Highway to the damsites on the north side of the Susitna River;
- o A corridor running west to east from the Parks Highway to the damsites on the south side of the Susitna River; and
- o A corridor running north to south from the Denali Highway to the Watana damsite.

Criteria were established to evaluate the responsiveness of the plans to project objectives and the desires of the resource agencies and affected communities. The selected access plan (Plan 18, otherwise referred to as Denali-North) represents the most favorable solution to meeting both project related goals and minimizing impacts to the environment and the surrounding communities. Where adverse environmental impacts are unavoidable or project objectives compromised, mitigation and management measures have been formulated to reduce these impacts to a minimum. These mitigation measures are outlined in detail within Exhibit E of the license application.

1.12.3 - Description of Access Plan (**)

Access to the Watana damsite will connect with the existing Alaska Railroad at Cantwell where a railhead and storage facility occupying 40 acres will be constructed. This facility will act as the transfer point from rail to road transport and as a storage area for backup supply of materials and equipment. From the railhead facility the road will follow an existing route to the junction of the George Parks and Denali Highways (a distance of two miles), then proceed in an easterly direction for a distance of 21.3 miles along the Denali Highway. A new road, 41.6 miles in length, will be constructed from this point due south to the Watana camp site. On completion of the dam, access to Native lands on the south side of the Susitna River will be provided from the Watana camp site with the road crossing along

the top of the dam. This will involve the construction of an additional 2.6 miles of road bringing the total length of new road to 44.2 miles.

Plate F2 shows the proposed access plan route. Plate F3 shows details, for both the Watana and Devil Canyon developments, of typical road and railroad cross sections, railhead facilities, and the high-level bridge at Devil Canyon.

Assessment of projected traffic volumes and loadings during construction resulted in the selection of the following design parameters for the access roads.

Surfacing	Unpaved (Treated Gravel Surface)
Width of Running Surface	24 feet
Shoulder Width	4 feet
Design Speed	50 mph
Maximum Grade	5%
Maximum Curvature	$6\ ^{3}/_{4}°$
Stopping Site Distance	475 feet
Design Loading	
- during construction	80^{k} axle, 200^{k} total
- after construction	HS - 20

These design parameters were chosen for the efficient, economical, and safe movement of supplies and are in accordance with Federal Department of Transportation design standards.

In the community of Cantwell the road will be paved from the marshalling yard to four miles east of the junction of the George Parks and Denali Highways. This will eliminate any problem with dust and flying stones in the residential district. In addition, the following measures will be taken:

- o Speed restrictions will be imposed along the above segment;
- o A bike path will be provided along the same segment to safeguard children in transit to and from a school which is situated close to the road; and
- o Improvements will be made to the intersection of the George Parks and Denali Highways including pavement markings and traffic signals.

1.12.4 - Right-of-Way (**)

The 21.3 miles of existing road along the Denali Highway will be upgraded to approximately the aforementioned standards. The present alignment is such that any realignment required should be possible within the existing easement.

The majority of the new road will follow terrain and soil types which allow construction using side borrow techniques, resulting in a minimum of disturbance to areas away from the alignment. A berm type cross section will be formed, with the crown of the road being approximately two to three feet above the elevation of adjacent ground. To reduce the visual impact, the side slopes will be flattened and covered with excavated peat material. A 200-foot right-of-way will be sufficient for this type of construction. Although sidehill cuts must be minimized to avoid the effects of thawing permafrost and winter icing on the section of road running parallel to Deadman Creek, in isolated spots of extensive sidehill cutting it may be necessary to exceed the 200-foot width.

1.12.5 - Construction Schedule (**)

The overall schedule for the Watana development relies heavily on the ability to move supplies, materials and equipment to the site as soon as possible after the start of project construction. The selected plan involves the least mileage of new road construction and follows relatively level, open terrain in comparison with the alternative routes in the two other corridors. Consequently, construction of this route has the highest probability of meeting schedule and hence affords the least risk of project delay. It has been estimated that it will take approximately 1.5 years to construct the access road. One year will be required for completion and upgrading of the Denali Highway section.

1.13 - Site Facilities (**)

1.13.1 - General (**)

The construction of the Watana development will require various facilities to support the construction activities throughout the entire construction period. Following construction, the operation of the Watana hydroelectric development will require certain permanent staff and facilities to support the permanent operation and maintenance program.

The most significant item among the site facilities will be a construction camp and village that will be constructed and maintained at the project site. The camp/village will be a largely self- sufficient community housing up to 3,300 people during construction of the project. After Stage I construction is complete, it is planned to demobilize most of the camp facility for later use. The buildings and other items from the camp will be used during construction of Stage III. Other site facilities include contractors' work areas, site power, services, and communications. Items such as power and communications will

oe required for construction operations independent of camp operations. The same will be true regarding a hospital or first-aid room.

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

A conceptual plan for the permanent town is shown on Plate F37.

1.13.2 - Temporary Camp and Village (**)

The proposed location of the construction camp and village will be on the north bank of the Susitna River near Deadman Creek, approximately six miles northeast of the Watana Dam. The north side of the Susitna River was chosen because the main access will be from the north and south-facing slopes can be used for siting the structures. The location is shown in Plate F34.

The construction camp will consist of woodframe dormitories with mess halls, recreational buildings, bank, post office, fire station, warehouses, hospital, offices, etc. The camp will accommodate approximately 3,000 workers.

The village, accommodating approximately 300 families, will be grouped around a service core containing a school, gymnasium, stores, and recreation area.

The village and construction camp areas will be separated to provide a buffer zone between areas. The hospital will serve both the main camp and village.

The camp location will be separated from the work areas by approximately three miles. Travel time to the work area will generally be less than 15 minutes.

The camp/village will be constructed in stages to accommodate the peak work force. The facilities have been designed for the peak work force plus 10 percent for turnover. The turnover will include allowances for overlap of workers and vacations. The conceptual layouts for the camp and village are presented on Plates F36 and F37.

(a) Site Preparation (**)

Both the camp and the village areas will be cleared and in certain areas filter fabric may be installed and granular material placed over it for building foundations. At the

village site, selected areas will be left with trees and natural vegetation intact. Topsoil stripped from Borrow Site D will be utilized to reclaim camp and village sites.

Both the construction camp and the village site have been selected to provide well-drained land.

(b) Facilities (**)

Construction camp buildings will consist largely of factory-built modules assembled on site to provide the various facilities required. The modules will be fabricated complete with heating, lighting and plumbing services, interior finishes, furnishings, and equipment. Larger structures such as the central utilities building, warehouses and hospital will be pre-engineered, steel-framed structures with metal cladding.

1.13.3 - Permanent Town (**)

The permanent town which will be utilized during construction is designed around a small lake for aesthetic purposes. The permanent town will consist of permanently constructed buildings. The various buildings in the permanent town are as follows:

- o Single family dwellings;
- o Multi-family dwellings;
- o Hospital;
- o School;
- o Fire station;
- o A town center will be constructed and will contain the following: 1) a recreation center; 2) a gymnasium and swimming pool; and, 3) a shopping center.

1.13.4 - Site Power and Utilities (**)

(a) Power (**)

A 34.5 kV transmission line from the Cantwell substation will follow the Denali Highway and the access road to Watana for servicing during the Stage I construction activities. Two transformers will be installed at a Watana substation to reduce the line voltage to the desired voltage levels.

The peak demand during the peak camp population year is estimated at 20 MW for the camp/village and four MW for construction requirements. The distribution system in the camp/village and construction area will be 4.16 kV.

Power for the permanent town and during Stage III construction, will be supplied by station service system after the power plant is in operation.

(b) Water (**)

The water supply system will provide for potable water and fire protection for the camp/village and selected contractors' work areas. The estimated peak population to be served will be 3,338 (2,315 in the camp and 1,023 in the village).

The principal source of water will be Deadman Creek, with a backup system of wells drawing on ground water. The water will be treated in accordance with the U.S. Environmental Protection Agency's (EPA) primary and secondary requirements, and Drinking Water Standards of the State of Alaska, Department of Environmental Conservation (ADEC).

A system of pumps and storage reservoirs will provide the necessary system capacity. The distribution system will be contained within utilidors constructed using plywood box sections integral with the permawalks.

(c) Wastewater (**)

A wastewater collection and treatment system will serve the camp/village. One treatment plant will serve the camp/village. Gravity flow lines with lift stations will be used to collect the wastewater from all of the camp and village facilities. The "in-camp" and "in-village" collection systems will be run through the utilidors so that the collection system will be protected from freezing.

The chemical toilets located around the construction site will be serviced by sewage trucks, which will discharge directly into the sewage treatment plant. The sewage treatment system will be a biological system with lagoons designed to meet Alaska ADEC and Federal EPA standards. The sewage plant will discharge its treated effluent through a force main to Deadman Creek. All treated sludge will be disposed in a solid waste sanitary landfill.

The location of the treatment plant is shown in Plate F37. The location was selected to avoid unnecessary odors in the camp.

1.13.5 - Contractors' Area (**)

The on-site contractors facilities will require office, shop, and general work areas. Partial space required by the contractors for fabrication shops, maintenance shops, storage or warehouses, and work areas will be located between the main camp and the dam site road.

1.14 - Relict Channel (***)

A relict channel exists on the north bank of the Watana reservoir approximately 2,600 feet upstream from the dam. This channel runs from the Susitna River gorge to Tsusena Creek, a distance of about 1.5 miles. The surface elevation of the lowest saddle is approximately 2,210. Depths of up to 454 feet of glacial deposits have been identified. The maximum average hydraulic gradient along any flow path in the buried channel from the edge of the Stage I pool (el. 2,000) to Tsusena Creek is approximately two percent. Tsusena Creek at the relict channel outlet area is at least 120 feet above the natural river level. There are several surface lakes within the channel area, and some artesian water is present in places. Zones of permafrost have also been identified throughout the channel area.

To insure the integrity of the rim of the Watana reservoir and to control losses due to potential seepage, a number of conditions have been evaluated. Study types include settlement of the reservoir rim, subsurface flows, permafrost and liquefaction during earthquakes.

1.14.1 - Surface Flows (**)

Based on information gained from past exploration programs, the relict channel soils are either dense or cohesive and as such are not deemed to be subject to settlement resulting for seismic shaking. Therefore the low ground surface in the relict channel area will more than provide adequate freeboard as it is 185 feet above the Stage I dam crest which is el. 2,025.

1.14.2 - Subsurface Flows (**)

During Stage I, the potential for progressive piping and erosion in the area of discharge into the Tsusena Creek will be controlled by the placement of properly graded granular materials to form a filter blanket over any zones of emergence. Further field investigations will be carried-out to fully define critical areas, and only such areas will be treated. Subsequent to Stage I, the relict channel will receive continuous monitoring of the outlet area for a lengthy period after reservoir filling to ensure that a state of equilibrium is established with respect to permafrost and seepage gradients in the buried channel area.

1.14.3 - Permafrost (**)

Thawing of permafrost will occur in portions of the relict channel area. This thawing will have minimum impact on subsurface flows and ground settlement. Although no specific remedial work is foreseen; flows, groundwater elevation, and ground surface elevation in the buried channel area will be carefully and continuously monitored by means of appropriate instrumentation systems and any necessary maintenance work carried out to maintain freeboard and control seepage discharge.

1.14.4 - Liquefaction (***)

Underground information compiled to date indicates that the buried channel area is filled with outwash, glacial till and lacustrine deposits. Initial evaluations, outlined in the original license application indicated concern in regard to the upper outwash deposits because they did not appear dense enough to resist seismic shaking without experiencing considerable loss in stability.

The most likely prospects for liquefaction are saturated foundations consisting of fine grained, poorly graded, cohesionless deposits (sands and silts), that are not laterally confined and are loose or only moderately dense. Based on the Winter 1983 Exploration Program (HE 1983) and all other assembled data, an assessment of the liquefaction potential of the relict channel area indicates the deposits are either well graded, dense to very dense or cohesive and therefore have very low potential for liquefaction. Consequently no remedial measures are currently considered necessary as a precaution against the effects of liquefaction.

Further geotechnical studies will be carried out during Stage I design to fully define the extent and characteristics of the materials in the relict channel. Should this information indicate a potential problem, provisions will be made for treatment to cover the conditions identified.

1.14.5 - Remedial Work Influence on Construction Schedules (***)

Relict channel remedial treatment construction work, if necessary, will have practically no impact on the Watana Dam construction schedule. Because the relict channel work will be located in proximity to Borrow Site D, some coordination will be required between these two operations. Once this coordination has been accomplished, dam construction and the relict channel work can proceed concurrently.

1.14.6 - Relict Channel Treatment (***)

During future design investigations, additional boreholes and inspection trenches will be employed to further delineate the relict channel foundation. The area will be studied during Borrow Site D excavation. The area will also be thoroughly monitored by observation devices during the Stage I reservoir filling to assess actual hydrological conditions in the relict channel. In response to the unlikely event that construction remedial measures are considered necessary following those observations and data assessment, a positive remedial treatment such as a downstream toe drain will be employed.

2 - RESERVOIR DATA - WATANA STAGE I (**)

The Watana Reservoir, at normal operating level of 2,000 feet (mean sea level), will be approximately 39 miles long with a maximum width of approximately two miles. The total water surface area at normal operating level is 20,000 acres. The minimum reservoir level will be 1,850 feet during normal operation, resulting in a maximum drawdown of 150 feet. The reservoir will have a total capacity of 4.3 million acre-feet, of which 2.4 million acre-feet will be live storage.

3 - TURBINES AND GENERATORS - WATANA STAGE I (**)

3.1 - Unit Capacity (**)

The Watana powerhouse will have four generating units, each with a maximum generator output of 125 MW in Stage I corresponding to the maximum normal reservoir level (elevation 2,000) and a corresponding net head of 537 feet. The Stage I turbines will be designed to operate in Stage III without modification, and the turbines and generating units will therefore be capable of higher outputs when the head is raised in Stage III. Unit characteristics including generator outputs are described in Table F.1.

The net head on the plant will vary from 384 feet to approximately 537 feet in Stage I. This will increase to a maximum of 719 feet in Stage III with a corresponding increase in generating capacity.

The turbine design net head has been established at 590 feet to meet the operating requirements of Stage I and Stage III.

The generator rating has been selected as 223 MVA with a 90 percent power factor to match with the maximum turbine output of 204 MW under a net head of 719 feet at the third stage. The generator output is assumed to be 98% of the turbine output at full load.

3.2 - Turbines (***)

The turbines will be of the vertical-shaft Francis type with steel spiral casing and a steel lined concrete elbow-type draft tube. The draft tube will comprise a single water passage without a center pier.

The output of the turbine will be 150 MW at 590 feet design net head. Maximium and minimum net operating heads on the units will be 537 feet and 384 feet, respectively. The full gate output of each turbine will be approximately 128 MW at 537 feet net head and approximately 66 MW at 384 feet net head. For study purposes, the best efficiency (best-gate) output of the turbines has been assumed as 85 percent of the full gate turbine output.

Each turbine will be provided with a 12.5-foot diameter straight-flow type butterfly valve. These guard valves will be located within the powerhouse, just upstream of the turbines.

3.3 - Generators (**)

3.3.1 - Type and Rating (**)

Each of the four generators in the Watana powerhouse will be of the vertical-shaft, overhung type directly connected to a vertical Francis turbine.

There will be two generators per transformer bank, with each transformer bank comprising three single-phase transformers. The

generators will be connected to the transformers by isolated phase bus through generator circuit breakers.

Each generator will be provided with a high initial response static excitation system. The units will be controlled from the Watana surface control room, with local control facility also provided at the powerhouse floor. The units will be designed for black start operation.

The generators will be rated as follows to accomodate Stage I and Stage III operating conditions:

Rated Capacity	223 MVA, 0.9 power factor
Rated Power	200 MW
Rated Voltage	15 kV, 3 phase, 60 Hertz
Synchronous Speed	257 rpm
Inertia Constant	3.5 MW-sec/MVA
Transient Reactance	32 percent (calculated)
Short Circuit Ratio	1.1 (minimum)
Efficiency at Full Load	98 percent (minimum)

The generators will be of the air-cooled type, with water-to-air heat exchangers located on the stator periphery. The ratings given above are for a temperature rise of the stator and rotor windings not exceeding 75°C with cooling air at 40°C in accordance with ANSI C50.10, General Requirements for Synchronous Machines.

The generators will operate successfully at rated kVA, frequency, and power factor at any voltage not more than five percent above or below rated voltage.

3.3.2 - Unit Dimensions (**)

Approximate dimensions and weights of the principal parts of the generator are given below:

Stator pit diameter	38 feet
Rotor diameter	24 feet
Rotor length (without shaft)	7 feet
Rotor weight	385 tons
Total weight	740 tons

It should be noted that these are approximate figures and they will vary between manufacturers.

3.3.3 - Generator Excitation System (**)

The generator will be provided with a high initial response type static excitation system supplied with rectified excitation

power from transformers connected directly to the generator terminals. The excitation system will be capable of supplying 200 percent of rated excitation field (ceiling voltage) with a generator terminal voltage of 70 percent. The power rectifiers will have a one-third spare capacity to maintain generation even during failure of a complete rectifier module.

The excitation system will be equipped with a fully static voltage regulating system maintaining output from 30 percent to 115 percent, within $\pm$0.5 percent accuracy of the voltage setting. Manual control will be possible at the excitation board located on the powerhouse floor, although the unit will normally be under remote control.

3.4 - Governor System (o)

The governor system which controls the generating unit will include a governor actuator and a governor pumping unit. A single system will be provided for each unit. The governor actuator will be the electric hydraulic type and will be connected to the computerized station control system.

4 - APPURTENANT MECHANICAL AND ELECTRICAL EQUIPMENT - WATANA STAGE I (**)

4.1 - Miscellaneous Mechanical Equipment (**)

4.1.1 - Powerhouse Cranes (*)

Two overhead traveling-bridge type powerhouse cranes will be installed in the powerhouse. The cranes will be used for:

- o Installation of turbines, generators, and other powerhouse equipment; and
- o Subsequent dismantling and reassembly of equipment during maintenance overhauls.

Each crane will have a main and auxiliary hoist. The combined capacity of the main hoist for both cranes will be sufficient for the heaviest equipment lift, which will be the generator rotor, plus an equalizing beam. A crane capacity of 200 tons has been established. The auxiliary hoist capacity will be about 25 tons.

4.1.2 - Draft Tube Gates (**)

Draft tube gates will be provided to permit dewatering of the turbine water passages for inspection and maintenance of the turbines. The draft tube gate openings (one opening per unit) will be located in the surge chamber. The gates will be of the bulkhead type, installed under balanced head conditions using the surge chamber crane. Four sets of gates have been assumed for the four units. Each gate will be 20 feet wide by 10 feet high.

4.1.3 - Surge Chamber Gate Crane (*)

A crane will be installed in the surge chamber for installation and removal of the draft tube gates as well as the tailrace tunnel intake stoplogs. The crane will have a capacity of approximately 30 tons.

4.1.4 - Miscellaneous Cranes and Hoists (**)

In addition to the powerhouse cranes and surge chamber gate crane, the following cranes and hoists will be provided in the power plant:

- o A five-ton monorail hoist in the transformer gallery for transformer and SF6 gas-insulated equipment maintenance;

- o A four-ton monorail hoist in the circuit breaker gallery for handling the generator circuit breakers;
- o Small overhead jib or A-frame type hoists in the machine shop for handling material; and
- o A-frame or monorail hoists for handling miscellaneous small equipment in the powerhouse.

4.1.5 - Elevators (**)

Access and service elevators will be provided for the power plant as follows:

- o An access elevator from the control buildings to the powerhouse;
- o A service elevator in the powerhouse service bay; and
- o Inspection hoists in the SF6 gas insulated bus shaft.

4.1.6 - Power Plant Mechanical Service Systems (**)

The power plant mechanical service systems installed under Stage I will provide for future expansion under Stage III. The various systems common to all units will be designed to permit the necessary increase in capacity and the extension of piping and duct work to provide service to units added in Stage III.

(a) Station Water Systems (o)

The station water systems will include the water intake, cooling water systems, turbine seal water systems, and domestic water systems. The water intakes will supply water for the various station water systems in addition to fire protection water.

(b) Fire Protection System (**)

The power plant fire protection system will consist of fire hose stations located throughout the powerhouse, transformer gallery, and bus tunnels; sprinkler systems for the transformers and the oil rooms; CO_2 systems for the generators; and portable fire extinguishers located in strategic areas of the powerhouse and transformer gallery. A fire protection head tank has been indicated adjacent to the access shaft, 250 feet above the powerhouse roof level, but a pumping system may be adopted during detailed design.

(c) Compressed Air Systems (**)

Compressed air will be required in the powerhouse for the following:

- o Service air;
- o Instrument air;
- o Generator brakes;
- o Draft tube water level depression;
- o 345 kV SF6 gas insulated circuit breakers;
- o Generator circuit breakers; and
- o Governor accumulator tanks.

For the preliminary design, two compressed air systems have been assumed: a 100-psig air system for service air, brake air, and air for draft tube water level depression; and a 1,000-psig high-pressure air system for governor air. During detailed plant design, separate air systems for 345 kV SF_6 gas insulated circuit breakers and generator circuit breakers will be provided.

(d) Oil Storage and Handling (**)

Facilities will be provided for replacing oil in the transformers and for topping-off or replacing oil in the turbine and generator bearings and the governor pumping system. For preliminary design purposes, two oil rooms have been included, one in the transformer gallery and one in the powerhouse service bay. An oil separation sump has been indicated adjacent to unit/drainage sumps.

(e) Drainage and Dewatering Systems (**)

The drainage and dewatering systems will consist of:

- o A unit dewatering and filling system
- o A clear water discharge system
- o A sanitary drainage system.

The unit dewatering and filling systems will consist of two sumps each with two dewatering pumps and associated piping and valves from each of the units. To prevent station flooding, the sump will be designed to withstand maximum tailwater pressure. A valved draft tube drain line will connect to a dewatering header running below the drainage gallery. The spiral case will be drained by a valved line connecting the spiral case to the draft tube. It will be necessary to insure that the spiral case drain valve is not open when the spiral case is pressurized to headwater level. The dewatering pump discharge line will discharge water into

the surge chamber. The general procedure for dewatering a unit will be to close the butterfly guard valve, drain the penstock to tailwater level through the unit, then open the draft tube and spiral case drains to dewater the unit. Because the drainage dewatering header is below the bottom of the draft tube elbow, it will be possible to completely dewater the draft tube through the dewatering header.

Unit filling to tailwater level will be accomplished from the surge chamber through the dewatering pump discharge line (with a bypass around the pumps) and then through the draft tube and spiral case drain lines. Alternatively, the unit can be filled to tailwater level through the draft tube drain line from an adjacent unit. Filling the unit to headwater pressure will be accomplished by opening the butterfly guard valve.

(f) Heating, Ventilation, and Cooling (**)

The heating, ventilation, and cooling system for the underground power plant will be designed primarily to maintain suitable temperatures for equipment operation and to provide a safe and comfortable atmosphere for operating and maintenance personnel. The access shaft, vent shaft, and the access tunnel will be utilized for air circulation.

The power plant will be located in mass rock which has a constant year-round temperature of about 40°F. Considering heat given off from the generators and other equipment, the primary requirement will be for air cooling. Initially, some heating will be required to offset the heat loss to the rock, but after the first few years of operation an equilibrium will be reached with a powerhouse rock surface temperature of about 60 to 70°F.

4.1.7 - Surface Facilities Mechanical Service Systems (*)

The mechanical services at the control center on the surface will include:

- o A heating, ventilation, and air conditioning system for the control room;
- o Domestic water and washroom facilities; and
- o A halon fire protection system for the control room.

Domestic water will be supplied from the powerhouse domestic water system, with pumps located in the powerhouse and piping up through the access shaft. Sanitary drainage from the control

center will drain to the sewage treatment plant in the powerhouse through piping in the access tunnel.

The standby generator building will have the following services:

- o A heating and ventilation system;
- o A fuel oil system with buried fuel oil storage tanks outside the building, and transfer pumps and a day tank within the building; and
- o A fire protection system of the carbon dioxide or halon type.

4.1.8 - Machine Shop Facilities (o)

A machine shop and tool room will be located in the powerhouse service bay area with sufficient equipment to take care of all normal maintenance work at the plant, as well as machine shop work for the larger components at Devil Canyon.

4.2 - Accessory Electrical Equipment (**)

The accessory electrical equipment described in this section includes the following:

- o Main generator step-up 15/345 / 1.73 kV transformers,
- o Isolated phase bus connecting the generator and transformers,
- o Generator circuit breakers,
- o 345 kV SF6 busses from the transformer terminals to the transmission yard,
- o Control systems of the entire hydro plant complex, and
- o Station service auxiliary ac and dc systems.

Other equipment and systems described include grounding, lighting system, and communications.

The main equipment and connections in the power plant are shown in the single line diagram, Plate F30. The arrangement of equipment in the powerhouse, transformer gallery, and vertical shaft is shown on Plates F25 through F27.

4.2.1 - Transformers and HV Connections (**)

Six single-phase transformers and one spare transformer will be located in the transformer gallery. Each bank of three single-phase transformers will be connected to two generators through generator circuit breakers by an isolated phase bus located in individual bus tunnels. The H.V. bushings of the single-phase transformers will be of the SF6 to oil type. These

bushings will be star-connected by the SF6 compressed gas-insulated (CGI) bus system at 345 kV and to the gas-insulated switchgear (GIS). Two sets of CGI busses will be carried from the GIS to the surface through a single vertical shaft. Each set of busses consists of three single-phase busses sized to have sufficient capacity to carry the entire plant output. The buses will be terminated at the surface SF6-to-air entrance bushings where they will be connected to the two overhead transmission lines. The vertical shaft will be nine feet I.D. and about 530 feet high and will also contain the control and power cables between the powerhouse and the surface to the underground facilities.

The area at the surface, above the cable shaft, will accommodate conventional open-air equipment such as surge arresters, coupling capacitor voltage transformers, line traps and take-off structures for overhead transmission lines.

4.2.2 - Main Transformers (**)

The six single-phase transformers (three transformers per group of two generators) and one spare transformer will be of the two-winding, oil-immersed, forced-oil water-cooled (FOW) type, with ratings and electrical characteristics as follows:

Rated capacity	150 MVA
High voltage winding	345 /1.73 kV, Grounded Y
Basic insulation level (BIL) of H.V. winding	1300 kV
Low voltage winding	15 kV, Delta
Basic insulation level (BIL) of L.V. winding	95 kV
Taps H.V. winding at rated MVA	2-1/2% and 5% above and 2-1/2% and 5% below rated voltage
Transformer impedance	15 percent

The temperature rise above ambient (40°C) will be 55°C for the windings for continuous operation at the rated MVA.

To minimize fire hazard, each single-phase transformer will be separated by fire walls and will be provided with an automatic deluge system.

4.2.3 - Generator Isolated Phase Bus (**)

The isolated phase bus main connections will be located between the generator, generator circuit breaker, and the transformer.

Tap-off connections will be made to the surge protection and potential transformer cubicle, excitation transformers, and station service transformers. Bus duct ratings are as follows:

	Generator Connection	Transformer Connection
Rated current, amps	9,000	18,000
Short circuit current momentary, amps	240,000	240,000
Short circuit current, symmetrical, amps	150,000	150,000
Basic insulation level, kV (BIL)	110	110

The bus conductors will be designed for a temperature rise of 65°C above 40°C ambient. The short circuit ratings are tentative, and will depend on detailed analysis in the design stage.

4.2.4 - Generator Circuit Breakers (**)

The generator circuit breakers will be enclosed air circuit breakers suitable for mounting in line with the generator isolated phase bus ducts. They are rated as follows:

Rated Current	9,000 Amps
Voltage	24 kV class, 3-phase, 60 Hertz
Breaking capacity, symmetrical, amps	150,000

The short circuit rating is tentative and will depend on detailed analysis in the design stage.

4.2.5 - This section deleted.

4.2.6 - Control Systems (**)

(a) General (*)

A Susitna Area Control Center will be located at Watana to control both the Watana and the Devil Canyon power plants. The control center will be linked through the supervisory system to the Central Dispatch Control Center at Willow as described in Exhibit B, Section 3.6.

The supervisory control of the entire Alaska Railbelt system will be at the Central Dispatch Center in Willow. Using digital computers a high level of automation will be sought. However, complete computerized control of the Watana and Devil Canyon power plants will not be used. Independent operator controlled local-manual and local-auto operations

will still be possible at Watana and Devil Canyon power plants for testing/commissioning or during emergencies. The control system will be designed to perform the following functions at both power plants:

- o Start/stop and loading of units by operator;
- o Load-frequency control of units;
- o Reservoir/water flow control;
- o Continuous monitoring and data logging;
- o Alarm annunciation; and
- o Man-machine communication through visual display units (VDU) and console.

In addition, the computer system will be capable of retrieval of technical data, design criteria, equipment characteristics and operating limitations, schematic diagrams, and operating/ maintenance records of the unit.

The Susitna Area Control Center will be capable of completely independent control of the Central Dispatch Center in case of system emergencies. Similarly it will be possible to operate the Susitna units in an emergency from the Central Dispatch Center, although this should be an unlikely operation considering the size, complexity, and impact of the Susitna generating plants on the system.

The Watana and Devil Canyon plants will be capable of "black start" operation in the event of a complete blackout or collapse of the power system. The control systems of the two plants and the Susitna Area Control Center complex will be supplied by a non-interruptible power supply.

(b) Unit Control System (*)

The unit control system will permit the operator to initiate an entire sequence of actions by pushing one button at the control console, provided all preliminary plant conditions have been first checked by the operator, and system security and unit commitment have been cleared through the central dispatch control supervisor. Unit control will be designed to:

- o Start a unit and synchronize it with the system,
- o Load the unit,
- o Stop a unit,
- o Operate a unit as spinning reserve (runner in air with water depressed in turbine and draft tube), and
- o Operate as a synchronous condenser (runner in air as above).

(c) Computer-Aided Control System (o)

The computer-aided control system at the Susitna Area Control Center at Watana will provide for the following:

- o Data acquisition and monitoring of units (MW, MVAR, speed, gate position, temperatures, etc.);
- o Data acquisition and monitoring of reservoir headwater and tailwater levels;
- o Data acquisition and monitoring of electrical system voltage and frequency;
- o Load-frequency control;
- o Unit start/stop control;
- o Unit loading;
- o Plant operation alarm and trip conditions (audible and visual alarm on control board, full alarm details on VDU on demand);
- o General visual plant operation status on VDU and on large wall mimic diagram;
- o Data logging, plant operation records;
- o Plant abnormal operation or disturbance automatic recording; and
- o Water management (reservoir control).

(d) Local Control and Relay Boards (o)

Local boards will be provided at the powerhouse floor equipped with local controls, alarms, and indications for all unit control functions. These boards will be located near each unit and will be utilized mainly during testing, commissioning, and maintenance of the turbines and generators. They will also be utilized as needed during emergencies if there is a total failure of the remote or computer- aided control systems.

(e) Load-Frequency Control (o)

The load-frequency system will provide remote control of the output of the generator at Watana and Devil Canyon from

the central dispatch control center through the supervisory and computer-aided control system at Watana. The basic method of load-frequency control will use the plant error (differential) signals from the load dispatch center and will allocate these errors to the power plant generators automatically through speed-level motors. Provision will be made in the control system for the more advanced scheme of a closed-loop control system with digital control of generator power.

The control system will be designed to take into account the digital nature of the controller-timed pulses as well as the inherent time delays caused by the speed-level motor runup and turbine-generator time constants.

4.2.7 - Station Service Auxiliary AC and DC Systems (**)

(a) Auxiliary AC System (**)

The station service system will be designed to achieve a reliable and economic distribution system for the power plant to satisfy the following requirements:

- Station service power at 480 volts will be obtained from two 2,000 kVA auxiliary transformers connected directly to the generator circuit breaker outgoing leads of Units 1 and 3;
- Surface auxiliary power at 34.5 kV will be supplied by two separate 7.5/10 MVA transformers connected to the generator leads of Units 1 and 3;
- Station service power will be maintained even when all units are shut down and the generator circuit breakers are open;
- 100 percent standby transformer capacity will be available;
- "Black start" capability will be provided for the power plant in the event of total failure of the auxiliary supply system, and 500 kW emergency diesel generators will be automatically started to supply the power plant with auxiliary power to the essential services to enable start-up of the generators.

The main ac auxiliary switchboard will be provided with two bus sections separated by bus-tie circuit breakers. Under normal operating conditions, the station-service load is divided and connected to each of the two-end incoming

transformers. In the event of failure of one end supply, the tie breakers will close automatically. If both end supplies fail, the emergency diesel generator will be automatically connected to the station service bus.

Each unit will be provided with a unit auxiliary board supplied by separate feeders from the two bus section feeder from the two bus section of the main switchboard interlocked to prevent parallel operation. Separate ac switchboards will furnish the auxiliary power to essential and general services in the power plant.

The unit auxiliary board will supply the auxiliaries necessary for starting, running, and stopping the generating unit. These supplies will include those to the governor and oil pressure system, bearing oil pumps, cooling pumps and fans, generator circuit breaker, excitation system, and miscellaneous pumps and devices connected with unit operation.

The 34.5 kV supply to the surface facilities will be distributed from a 34.5 kV switchboard located in the surface control and administration building. Power supplies to the power intake and spillway as well as the lighting systems for the access roads and tunnels will be obtained from the 34.5 kV switchboard.

The two 2000 kVA, 15,000-480 volt stations will have service transformers of the three-phase, dry-type, sealed gas-filled design. The two 7.5/10 MVA, 15-34.5 kV transformers will be of the three-phase oil-immersed OA/FA type.

Emergency diesel generators, each rated 500 kW, will separately supply the 480 volt and 34.5 kV auxiliary switchboards during emergencies. Both diesel generators will be located in the surface control building.

An uninterruptible high security power supply will be provided for the computer control system.

(b) DC Auxiliary Station Service System (*)

The dc auxiliary system will supply the protective relaying, supervisory, alarm, control, tripping and indication circuit in the power plant. The generator excitation system will be started with "flashing" power from the dc battery. The dc auxiliary system will also supply the emergency lighting system at critical plant locations.

4.2.8 - Grounding System (o)

The power plant grounding system will consist of one mat under the power plant, one mat under the transformer gallery, risers, and connecting ground wires. Grounding grids will also be included in each powerhouse floor.

4.2.9 - Lighting System (*)

The lighting system in the powerhouse will be supplied from 480-208/120 volt lighting transformers connected to the general ac auxiliary station service system. An emergency lighting system will be provided at the power plant and at the control room at all critical operating locations.

4.2.10 - Communications (o)

The power plant will be furnished with an internal communications system, including an automatic telephone switchboard system. A communication system will be provided at all powerhouse floors and galleries, transformer gallery, access tunnels and cable shafts, power intake structures, draft tube gate area, main spillway, dam, outlet facilities, and emergency release facilities.

4.3 - SF6 Gas-Insulated 345 kV Substation (GIS) (***)

The substation provides switching for the two transformer banks and two transmission lines. Four circuit breaker positions arranged in a ring bus switching scheme will be provided as shown in the single line diagram, Plate F31. This arrangement provides the desired switching flexibility and reliability of service required by the adopted system reliability criteria. Disconnecting and grounding switches as well as voltage transformers will be provided for each of the four circuits.

Since the conventional surge arresters do not have the reach to protect the GIS and transformers, metal-enclosed surge arresters will be provided at the end of the CGI buses.

The GIS will consist of two sections. One of the two sections contain three circuit breaker positions for two circuits (line/transformer) and one section contains one circuit breaker position for two circuits (line/transformer). Each of the sections will be installed in the area between the main transformer banks and connected to busses located on the downstream wall of the transformer gallery.

Provisions will be made for future extension and changing the ring bus to a breaker-and-a-half switching scheme.

5 - TRANSMISSION FACILITIES FOR WATANA STAGE I (**)

5.1 - Transmission Requirements (o)

The purpose of the project transmission facilities will be to deliver power from the Susitna River basin generating plants to the major load centers at Anchorage and Fairbanks. The transmission system is to deliver power to the load centers in an economical and reliable manner.

The facilities will consist of overhead transmission lines, under-water cables, switchyards, substations, a load dispatch center, and a communications system. Construction of the transmission facilities will be staged to provide reliable operations from each of the three stages of the development. The design will provide for delivery of power to one substation in Fairbanks, one substation at Willow, and two substations in Anchorage. As the power generated by the Watana Stage I hydroelectric station will be used to serve all the substations noted above, the associated transmission facilities will extend over the full length of the corridor. Later when Devil Canyon Stage II and Watana Stage III are developed, the facilities will be supplemented with additional components along some parts of the corridor.

5.2 - Description of Facilities (o)

5.2.1 - Corridor (o)

The corridor that the transmission lines will follow as they leave the generating plants is generally westward, following the Susitna River valley to Gold Creek near the Alaska Railroad route. At Gold Creek, the corridor divides to provide for lines north to Fairbanks and south to Anchorage; in both cases, the corridor generally follows the Railbelt. However, the lines to Anchorage will leave the Railbelt just outside Willow. At this point, the corridor continues in a southerly direction to reach the north shore of Knik Arm. Underwater cables will be installed to cross the Knik Arm. The corridor enters military reserved territory and is constrained to pass near the northern and eastern perimeter of Fort Richardson through the reservation, and finally loops south and west to the site of the existing University substation located some four miles southeast of the center of Anchorage.

The length of the corridor sections and the number of lines contained within them are shown in the following table:

CORRIDOR SECTION	Corridor Length Miles	NUMBER OF 345 kV CIRCUITS Stage I Watana	Stage II Devil Canyon	Stage III Watana	Development
1. Watana to Gold Creek	36	2	--	--	2
2. Gold Creek to Fairbanks	185	2	--	--	2
3. Gold Creek to Willow	79	2	--	1	3
4. Willow to Knik Arm (West)	43	2	--	1	3
5. Knik Arm Crossing	3	2	--	1	3
6. Knik Arm to Anchorage	19	2	--	--	2
7. D.C. to Gold Creek	8	--	2	--	2

The physical location of the corridor is shown in a regional context, on Plate No. F105, Exhibit F. A schematic diagram of the system is given on Plates No. F96, F97 and F98, of Exhibit F.

5.2.2 - Components (o)

At the Watana site, a SF6 gas-insulated 345kV substation (GIS) will be provided. The substation will be located in the transformer gallery. The switching arrangement will be a ring bus which will provide the necessary switching feasibility and reliability. Two sets of SF6 compressed gas-insulated busses will be carried from the GIS to the surface. Each set of busses consists of three single-phase busses sized to have sufficient capacity to carry the entire plant output. The busses will be terminated at the surface, where they will be connected to the two overhead transmission lines (refer to Plate F96, Exhibit E).

From Watana, two single-circuit 345 kV lines will be built westward to the Gold Creek switching station. From the Watana substation, both lines will continue in a northwest direction, a distance of approximately two miles crossing Tsusena Creek, then will turn west and share the same general corridor as the

proposed access road all the way to the Devil Canyon dam site. From Devil Canyon, the lines will head in a southwest direction, crossing the Susitna River at river mile 149.8, then will turn westward and follow the proposed railroad extension a distance of approximately six miles to the Gold Creek switching station. The Gold Creek switching station will be located in an area on the south bank terraces of the Susitna River at approximately river mile 142.

The Gold Creek switching station layout will be based on the breaker-and-a-half arrangement. At this station, switching will be provided so that the output of the Watana development can be transmitted partly north along the two lines to Fairbanks and partly to Anchorage along the two lines that run south. Power transmitted in either of these directions will be able to be switched to one line of the pair in the event of an outage on the other. Switching also will allow either of the lines from Watana to supply either Fairbanks or Anchorage, providing complete flexibility.

Access to the Gold Creek switching station site will be by an 8-mile long all-weather road from the railroad at Gold Creek (refer to Plate F 100, Exhibit F). The two 345 kV single-circuit lines to Fairbanks from Gold Creek will share the same right-of-way north, generally following the Railbelt past Chulitna, Cantwell, Denali Park and Healy, sited to the east of the railroad. About 1 mile north of Healy the lines will cross to the west side of the Nenana River and the railroad, continuing northwards for about 14 miles between the Parks Road on the west and the railroad on the east. At this point the lines will recross to the east side of the Nenana River and the railroad, continuing north to cross the Tanana River about 8 miles east of the town of Nenana, and then will continue northeastward to a point six miles west of Fairbanks at Ester substation, the northern terminal of the 345 kV system.

At Ester substation provision will be made to step down the voltage to 138 kV for delivery to the Golden Valley Electric Association. A total of four 150 MVA transformer banks can be installed at the substation site. Switching will be provided at 345 kV to enable the load to be supplied from both or either of the incoming lines. A breaker-and-a-half arrangement will be used. The Ester switchyard will also be provided with switchable 75 MVAR shunt reactors on each of the 345 kV lines for use during line energizing; switching will allow the reactor to be removed from the line if necessary during emergency heavy line loading if one line suffers an outage. For purposes of control of the system static VAR compensation will be required on the 138 kV busses at Ester and will consist of units with +200/-100 MVAR continuous, and +300/-100 MVAR short time ratings. The ratings

of the VAR control equipment will be confirmed and, if necessary, refined during final design (refer to Plate F99, Exhibit F). Access to the Ester Substation will be provided by an all-weather gravel road linked to the nearby Fairbanks Highway.

Two single-circuit 345 kV lines will exit from the Gold Creek switching station in a southwesternly direction following the east bank of the Susitna River past the village of Gold Creek. At this point while the river and the Alaska Railroad continue southwest, the line route will head south departing up to 10 miles to the east from the Railbelt. Approximately 50 miles south of Gold Creek the lines will rejoin the Railbelt near the Kashwitna River. From here the lines will run 6 miles parallel to the Railbelt on the east of the road to reach the Willow switching station. The Willow substation will be sited about 2 miles north of Willow.

The Willow switching station will serve a dual function; firstly, it will provide a facility to feed load in the locality at 138 kV. A total of three 75 MVA, three-phase transformers could be installed. Secondly, the station will provide complete line switching through a breaker-and-a-half arrangement. This switching will facilitate line energizing by limiting overvoltages. It will also allow flexibility to isolate a line section that might suffer an outage and to route load through the remaining lines (refer to Plate F101, Exhibit F). The Willow site access will be provided with an all-weather gravel road about 1 mile long across Willow Creek to the Willow Creek Road.

An Energy Management Center will also be located at the Willow substation site. The entire operation of the power generation and transmission system will be controlled from the Center. Remote control will be provided through communications via a microwave system. Existing microwave communications from Anchorage to Willow and from Fairbanks to Healy will be augmented and extended to provide a continuous link between Fairbanks and Anchorage with a spur into the power developments at Devil Canyon and Watana.

Two single-circuit 345 kV lines leaving Willow switching station will run due west for about 4 miles, then turn south and cross Willow Creek. The lines will continue in a generally southward direction to cross the Little Susitna River about 25 miles from Willow Creek. At this point the lines will bear in a south-easterly direction for about 15 miles to arrive at the west side of Knik Arm about five and a half miles north of Pt. MacKenzie, adjacent to the site of an existing 230 kV line.

Knik Arm will be crossed by submarine cables buried in the inlet bed. Two circuits will be provided, each consisting of three individual single-phase 345 kV submarine cables. A third cable will contain a spare phase. On each shore a cable termination station will contain disconnect switches, surge arrestors and ground connection devices required for operation of the cable facility. Another feature of the terminals will be an arrangement of an upper level bus which will allow for temporary connections to bring into contingency service a spare single phase cable. The spare cable can replace any cable which might suffer accidental damage.

In the bed of the inlet, the circuits will be physically separated into three back-filled trenches; two will contain three single-phase cables making up the two main circuits, the third will contain the spare phase. Each trench will be separated from the other by approximately 1/4 mile with a similar distance being maintained from the existing 230 kV crossing. The separation in the navigation area will be achieved by curving the trenches in plan on the foreshore of the inlet. This arrangement of separating the circuits will provide an added measure of protection against multiple circuit damage due to navigation in the inlet. Access to the east and west terminals will be by gravel road built along the transmission line right-of-way to the nearest public access about 3 miles distant on the east side and 12 miles on the west.

On the southeasterly side of Knik Arm the line route will pass through the Fort Richardson military reservation. The route will follow a path parallel to an existing 230 kV line. Beyond the Knik Arm substation it will consist of two 345 kV circuits. Because of the restricted width available for right-of-way there is a requirement to use compact line design techniques. Double-circuit steel pole structures will be designed with extra conservative safety factors to increase reliability against loss of both circuits due to structural failure. Separation of the circuit onto two separate single pole structures using post type insulators to prevent conductor swing will be adopted where right-of-way width permits. From the southeasterly shore of Knik Arm the route will run southeast to the intersection of Glenn and Davis Highways, where it will turn southwesterly following the Glenn Highway on the southeast side, and then pass east of Homesite Park and southwest to the vicinity of the existing University substation on Tudor Road.

The Knik Arm substation will be located in the general vicinity of the Glen and Davis Highway intersection near where the existing 230 kV and 115 kV lines share the same right-of-way. This facility will allow for a breaker-and-a-half layout with complete flexibility in switching at 345 kV between the incoming and outgoing pairs of lines to cope with possible outage situa-

tions. Each of the incoming lines from Willow will have a switchable 30 MVAR shunt reactor to assist with voltage control during energizing of the line. Also the facility will provide one 75 MVA, three-phase transformer to feed into the 115 kV existing system that passes nearby (refer to Plate F102, Exhibit F).

The University substation site will represent the southernmost terminal of the 345 kV transmission facility. The substation will serve as the major distribution point for power from Watana and Devil Canyon into the Anchorage area. Provision will be made for transformation to 230 kV and 115 kV to suit the existing utility systems in the area. At the 230 kV level up to four 250 MVA banks of single-phase transformers will be accommodated, and at 115 kV two 250 MVA bank of single-phase transformers can be installed. For transient stability, static VAR compensation will be provided on outgoing lines to Anchorage consisting of units with ratings on the 230 kV system of +150/-100 MVAR continuous and +200/-75 MVAR short time; on the 115 kV system rated at +200/-75 MVAR continuous, and +300/-75 MVAR short time. The ratings of the VAR control equipment will be confirmed and, if necessary, refined in final design (refer to Plate F103, Exhibit F). Access to the University substation will be by the existing gravel road directly off Tudor Road.

The Applicant has constructed an Anchorage-Fairbanks "Intertie" project (Commonwealth Associates, Inc. 1982). Approximately 170 miles of one of the 345 kV lines between Healy and Willow on the Fairbanks to Anchorage corridor has been constructed. This line is built to operate eventually at 345 kV, but is initially being operated at 138 kV. When it is integrated into the Watana transmission system it will operate at 345 kV.

5.2.3 - Right-of-Way (o)

The right-of-way for the transmission corridor will consist of a linear strip of land. The width will depend on the number of lines. North of the cable crossing of Knik Arm, the right-of-way will include that area necessary for the additions to the facilities planned in conjunction with the Devil Canyon Stage II and Watana III development. In the sections with two lines, the right-of-way width will be 300 feet; for three lines it will be 400 feet. Between Gold Creek and Devil Canyon, where ultimately four lines will be required, the width will be 510 feet.

In the Knik Arm underwater crossing area, the right-of-way will be widened to account for the fact that each circuit of the total development will be separated from the adjacent circuits by a distance of about 1/4 mile, The spare single phase cable will

also be 1/4 mile from the other cables. The width of the bed affected by the crossing will be approximately one mile.

Southeast of Knik Arm the right-of-way width will be restricted in the military reservation. In this section the right-of-way will be 300 feet from the centerline of an existing 230 kV line.

Approximate right-of-way areas to be occupied by the switching and substations are listed below.

	Area of Right-of-Way (acres)
Gold Creek Switchyard	16
Fairbanks (Ester) Substation	25
Willow Substation	25
Knik Arm Substation	15
Anchorage (University) Substation	45

Rights-of-way for permanent access to switchyard and substations will be required linking back to a public road or in some cases rail access. These rights-of-way will be 100 feet wide.

5.2.4 - Transmission Lines (o)

Access to the transmission line corridor will be via trails from existing access routes at intermittent points along the corridor. The exact location of these trails will be established in the final design phase. Within the transmission corridor itself an access strip 25 feet wide will run along the entire length of the corridor, except at areas such as major river crossings and deep ravines where an access strip would not be utilized for the movement of equipment and materials.

The conductor capacity for the lines will be in the range of 1,950 MCM; this can be provided in several ways. Typical of these is a phase bundle consisting of two 954 MCM "Rail" (45/7) Aluminum Conductor Steel Reinforced (ACSR) or a single 2,156 MCM "Bluebird" (84/17) ACSR conductor, both of which provide comparable levels of corona and radio noise within normally accepted limits. The single "Bluebird" conductor attracts less load under wind or ice loadings and avoids the need to provide the space damper devices required for a bundled phase. The single conductor is stiffer and heavier to handle during stringing operations, although this will tend to be balanced out due to the extra work involved in handling the twin bundle. Selection of the optimum conductor arrangement will be made in final design. The conductor will be specified to have a dull finish treatment to reduce its visibility at a distance. The

conductor capacity between Knik Arm and University will be 2,700 MCM per phase to handle the output of Devil Canyon without an additional circuit in this section of the route.

Two overhead ground wires will be provided the full length of the line. These will consist of 3/8-inch diameter galvanized steel stands. The arrangement will be based on a shielding angle of 15 degrees over the outer phases; this will provide protection against lightning strikes to the line. More refined studies of the lightning performance of the line will be made during final design to confirm the arrangement outlined above.

Vibration control devices will be required on both the conductors and the ground wire. Stockbridge-type dampers on single wires and spacer dampers with an elastometer damping element are expected to be most suitable.

Conductor suspension and dead-end assemblies will be detailed according to "corona free" design and prototype tested to check that corona and radio interference are below nuisance levels when operating at elevations of up to 3,500 feet. Insulators will be standard porcelain or glass disc type suspension units. A chain of 18 units is expected to be sufficient to provide acceptable flashover performance of the line. The configuration will be "M" type with vertical strings on the outside phases and a "V" string supporting the center phase.

The transmission structures and foundations that serve to support the conductors and ground wires will be designed for a region where foundation movement due to permafrost and annual freeze-thaw cycling is common. Of the structural solutions that have proved successful in similar conditions, all utilize an arrangement of guy cables to support the structure. All depend upon the basic flexibility inherent in guyed structures to resist effects of foundation movement. For tangent and small angle applications the guyed type of structure such as the guyed "V", guyed "Y", guyed delta and the guyed portal are the most common economical arrangements. The guyed "X" design has been selected for use on the 345 kV Intertie (1) and is therefore a prime candidate for consideration on the Watana lines. Experience gained during the Intertie project will be used in the final structure design (refer to Plate F104, Exhibit F).

Structures for larger angle and dead-end applications will be in the form of individual guyed masts, one for each phase. Individual guyed masts will also be used for lengths of line that are judged to be in unusually hazardous locations due to exposure terrain is extremely rugged. All structures will utilized a "weathering" steel which matures over several years to a dark

brown color which is considered to have a more aesthetically pleasing appearance than galvanized steel or aluminum (refer to Plate F 104, Exhibit F).

Foundations for structures will utilize driven steel piles in unstable soil conditions. In better soils steel grillage foundations will be used and set sufficiently deep to avoid the effects of the freeze-thaw cycle. Rock footings will employ grouted rock anchors with a minimum use of concrete to facilitate winter construction. Foundations for cantilever pole type structures will be large diameter cast-in-place concrete augered piles. Several types of guy anchor will be available for use; they include the screw-in helix type, the grouted bar earth anchor, driven piles and grouted rock anchors. Selection of the most economical solution in any given situation will depend on the site specific constraints including soil type, access problems and expected guy load. Foundation sites will be graded after installation to contour the disturbed surface to suit the existing grades. Tower grounding provisions will depend upon the results of soil electrical resistivity measurements both prior to and during construction. Continuous counterpoise may be required in sections where rock is at or close to the surface; it also may be required in other areas of high soil resistance. The counterpoise will take the form of two galvanized steel wires remaining at a shallow bury parallel to and under the lines. These will be connected to each tower and cross connected between lines in the right-of-way. Elsewhere, grounding will be installed in the form of ground rods driven into the soil adjacent to the towers.

5.2.5 - Switching and Stations (o)

The physical location of the stations and the system single line diagram is shown on Plate F105 and F96, 97, 98 respectively, of Exhibit F. The single line diagram and layout of the individual stations are contained on Plates F99 through F103 of Exhibit F.

The construction access to all sites will be over the route of the permanent access provided for each location. Any grading of the sites will be carried out on a balanced cut-and-fill basis wherever possible. Equipment will be supported on reinforced concrete pad-and-column type footings with sufficient depth-of-bury to avoid the active freeze-thaw layer. Backfill immediately around footing will be granular to avoid frost heave effects.

Light equipment may be placed on spread footings if movements are not a significant factor in operational performance.

The station equipment requirements are determined by the breaker-and-a-half arrangement adopted for reasons of reliability and security of operation. One and one-half breakers will be needed for each line or transformer circuit termination. The transformer capacities are determined by the load requirements at each substation. Control and metering provisions will cater to the plan for remote operation of all the facilities in normal circumstances. Protective relaying schemes for the 345 kV system will be in accordance with conventional practices, using the general philosophy of dual relaying and the local backup principle.

The station layouts are based on conventional outdoor design with a two-level bus which will result in a relatively low profile to the station. This will assist in limiting the visual impact of the stations and make the most of any available neutral buffers. Although they will be remotely controlled, all stations will be provided with a control building; in larger stations an additional relay building will be provided. A storage building will also be provided for maintenance purposes. Each station will have auxiliary power at 480 V; the normal 480 V ac power will be supplied from the tertiaries on the autotransformers or the local utility. The Willow station will include the Energy Management Center and the headquarters of the system maintenance group.

5.2.6 – Cable Crossing (o)

The cable crossing will consist of two 345 kV circuits each comprising three individual 2,000 MCM single-phase submarine cables; in addition a spare phase cable will be provided. Each circuit will be buried in the inlet bottom, the three cables of the circuit sharing the same trench. Beyond the foreshore area it is anticipated that cables can be buried by a combination of dredging and ploughing as the bed materials are reported to be soft. At each shore, gravel deposits are expected to be encountered so that conventional excavate-and-fill methods are more probable with work being performed from barges in the tidal zone.

The centerline of each circuit will be routed on the foreshore to obtain a physical separation of approximately 1/4 mile between circuits and the spare phase; a similar spacing will be maintained from the existing 230 kV circuit which runs adjacent to the crossing site.

On each side of the arm a terminal yard will be provided to contain the disconnect switches, surge arrestors, and grounding for the cables as well as the cable terminals. The yards will have bus arrangements which will permit the spare phase to be brought into service by installation of temporary bus connections.

5.2.7 - Dispatch Centers - Energy Management Centers and Communications (o)

The operation of the transmission facility and the dispatch of power to the load centers will be controlled from a central dispatch and Energy Management System (EMS) center. It has been proposed that the center be located at Willow since a suitable site could be developed at the Willow switching station site. The location of the center could alternatively be at one of the other key points along the line route. University substation could be considered in final design studies if close proximity to an existing major center of population is thought to be a major advantage in siting. The center will operate in conjunction with northern and southern area control systems in Fairbanks and Anchorage which would control generation in those two areas. The generation at the Susitna hydroelectric sites would be controlled at the Watana power facility. The Energy Management Center would orchestrate the overall operation of the system by request to the three local generation control centers for action and direct operation of the Gold Creek switching station and the four 345 kV switching and substations along the transmission system.

The system communications requirements will be provided by means of a microwave system. The system will be an enlargement of the facility being provided for the operation of the Intertie between Healy and Willow. Communications into the hydroelectric plants will be by a microwave extension from the Gold Creek switching station.

5.3 - Construction Staging (o)

Watana will require staged development of transmission facilities to Fairbanks and Anchorage. Stage I includes the following:

Substations	Line Section	Number of Circuits
Watana	Watana to Intertie switchyard near Gold Creek	2
Gold Creek (Southbound)	Switchyard to Willow	2[1/]
Willow	Willow to Knik Arm	2
Knik Arm	Knik Arm Crossing	2
University (Anchorage)	Knik Arm to University	2
Gold Creek (Northbound)	Gold Creek to Healy	2[1/]
Fairbanks	Healy to Fairbanks	2

1/ Circuit is the existing Anchorage-Fairbanks Intertie

The transmission will consist of two circuits from Watana to the load centers. The conductor for the sections from Watana to Knik Arm and Watana to Fairbanks will consist of bundled 2 x 954 kcmil, ACSR. The section between Knik Arm and University will employ bundled 2 x 1351 kcmil, ACSR. The submarine cable crossing will consist of two circuits. The cable will be single conductor, 345 kV self-contained oil-filled. For project purposes, the cable size will be 500 mm^2. A size of up to 1,500 mm^2 may be installed if duty requirements are increased. For reliability, a spare cable will be included on a standby basis.

The Matanuska Electric Association will be serviced from the Willow and Knik Arm substations via step-down transformers to suit the local voltage. Chugach Electric Association and Anchorage Municipal Light and Power will be serviced through the University substation in Anchorage. Golden Valley Electric Association will be serviced through the Ester substation at Fairbanks.

6 - PROJECT STRUCTURES - DEVIL CANYON STAGE II (**)

This section describes the various components of the Devil Canyon development, including diversion facilities, emergency release facilities, main dam, primary outlet facilities, reservoir, main spillway, saddle dam, power intake, penstocks, and the powerhouse complex, including turbines, generators, mechanical and electrical equipment, switchyard structures, and equipment and project lands. A summary of project parameters is presented in Table A.1.

A description of permanent and temporary access and support facilities is also included.

6.1 - General Arrangement (**)

The Devil Canyon reservoir and surrounding area are shown on Plate F39. the site layout in relation to main access facilities and camp facilities is shown on Plate F70. A more detailed arrangement of the various site structures is presented in Plate F40.

The Devil Canyon Dam will form a reservoir approximately 26 miles long with a surface area of 7,800 acres and a gross storage capacity of 1,100,000 acre-feet at el. 1,455, the normal maximum operating level. The operating level of the Devil Canyon reservoir is controlled by the tailwater level of the upstream Watana development. The maximum water surface elevation during flood conditions will be 1,466. The minimum operating level of the reservoir will be 1,405, providing a live storage during normal operation of 350,000 acre-feet.

The dam will be a thin arch concrete structure with a crest elevation of 1,463 (not including a 3.0-foot parapet) and maximum height of 646 feet. The dam will be supported by mass concrete thrust blocks on each abutment. On the south bank, the lower bedrock surface will require the construction of a substantial thrust block. Adjacent to this thrust block, an earth- and rockfill saddle dam will provide closure to the south bank. The saddle dam will be an earth and rockfill embankment generally similar in cross section to the Watana Dam. The dam will have a nominal crest elevation of 1,470 with an additional two feet of overbuild for potential settlement. The maximum height above foundation level of the dam is approximately 245 feet.

During construction, the river will be diverted by means of a single 35.5-foot diameter concrete-lined diversion tunnel on the south bank of the river.

A power intake on the north bank will consist of an approach channel excavated in rock leading to a reinforced concrete gate structure. From the intake structure four 20-foot diameter concrete-lined penstock tunnels will lead to an underground powerhouse complex housing four units with Francis turbines and synchronous generators.

Access to the powerhouse complex will be by means of an unlined access tunnel approximately 3,200 feet long as well as by a 950-foot deep vertical access shaft. The turbines will discharge to the river by means of a single 38-foot diameter tailrace tunnel leading from a surge chamber downstream from the powerhouse cavern. A separate transformer gallery just upstream from the powerhouse cavern will house twelve singlephase 15/345 kV transformers. The transformers will be connected by 345 kV single-phase, oil-filled cable through a cable shaft to the switchyard at the surface.

Outlet facilities consisting of seven individual outlet conduits will be located in the lower part of the main dam. These will be designed to discharge all flood flows of up to the estimated 50-year flood with Watana in place. Each outlet conduit will have a fixed-cone valve similar to those provided at Watana to dissipate energy and minimize undesirable nitrogen supersaturation in the flows downstream. The spillway will also be located on the north bank. As at Watana, this spillway will 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 309,000 cfs. This spillway, together with the outlet facilities, will be capable of discharging the PMF without overtopping the dam.

6.2 - Arch Dam (**)

The Devil Canyon Dam will be located at the Devil Canyon gorge, river-mile 152, approximately 32 river-miles downstream from Watana. The arch dam will be located at the upstream entrance of the canyon.

The dam will be a thin arch concrete structure 646 feet high, with a crest length-to-height ratio of approximately two, and designed to withstand dynamic loadings from intense seismic shaking. The proposed height of the dam is well within precedent.

6.2.1 - Foundations (**)

Bedrock is well exposed along the canyon walls, and the arch dam will be founded on sound bedrock. In local areas approximately 20 to 40 feet of weathered and/or loose rock will be removed beneath the dam foundation. All bedrock irregularities will be smoothed out beneath the foundation to eliminate high stress concentrations within the concrete. During excavation the rock will also be trimmed as far as is practical to increase the symmetry of the centerline profile and provide a comparatively uniform bearing stress distribution across the dam. Areas of deteriorated dikes and the local areas of poorer quality rock will be excavated and supplemented with dental concrete.

The foundation will be consolidation grouted over its entire area, and a double grout curtain up to 300 feet deep will run

beneath the dam and its adjacent structures as shown in Plate F47. Grouting will be done from a system of galleries which will run through the dam and into the rock. Within the rock these galleries will also serve as collectors for drainage holes which will be drilled just downstream of the grout curtain to intercept any seepage passing through the curtain.

6.2.2 - Arch Dam Geometry (*)

The canyon is V-shaped below el. 1,350. Sound bedrock does not exist above this level on the south abutment and an artificial abutment will be provided up to crest el. 1,463 in the form of a massive concrete thrust block designed to take the thrust from the upper arches of the dam. A corresponding block will be formed on the north abutment to provide as symmetrical a profile as possible bordering the dam and to give a symmetrical stress distribution across the faces of the horizontal arches.

Two slight ridges will be formed by the rock at both abutments. The arch dam will abut the upstream side of these such that the plane of the contact of the horizontal arches is generally normal to the faces of the dam. An exception will be in the lower portion of the dam where the rock in the upstream corners will be retained in order to decrease the amount of excavation.

The dam will bear directly on the rock foundation over the entire length of the contact surface. The bedrock at the foundation will be excavated to remove all weathered material and further trimmed to provide a smooth line to the foundation, thus avoiding abrupt changes in the dam profile and consequent stress concentrations.

The dam will be a double curvature structure with a cupola shape of the crown cantilever defined by vertical curves of approximately 1,352-foot and 893-foot radii. The horizontal arches are based on a two-center configuration with the arches prescribed by varying radii moving along two pairs of centerlines. The shorter radii of the intrados face cause a broadening of the arches at the abutment, thus reducing the contact stresses. The dam reference plane is approximately central to the floor of the canyon and the two-center configuration assigns longer radii to the arches on the wider north side of the valley, thus providing comparable contact areas and central angles on both sides of the arches at the concrete/rock interface. The longer radii will also allow the thrust from the arches to be directed more into the abutment rather than parallel to the river. The net effect of this two-center layout will be to improve the symmetry of the arch stresses across the dam.

The crown cantilever will be 643 feet high. It will be 20 feet thick at the crest and 90 feet at the base, a base width-to-height ratio of 0.140. The radii of the dam axis at crest level will be 699 feet and 777 feet for the south and north sides of the dam, respectively. The central angles vary between 53° at elevation 1,300 and 10° at the base for the south side of the arch, and 57° to 10° for the north side. The dam crest length is 1,260 feet and the ratio of crest length to height for the dam is 1.96 (thrust blocks not included). The volume of concrete in the dam is approximately 1.3×10^6 cubic yards.

6.2.3 - Thrust Blocks (*)

The thrust blocks are shown on Plate F46. The massive concrete block on the south abutment is 113 feet high and 200 feet long. It will be formed to take the thrust from the upper part of the dam above the existing sound rock level. It will also serve as a transition between the concrete dam and the adjacent rockfill saddle dam. The inclined end face of the block will abut and seal against the impervious saddle dam core and be enveloped by the supporting rock shell.

The 113-foot high, 125-foot long thrust block formed high on the north abutment at the end of the dam, adjacent to the spillway control structure, will transmit thrust from the dam through the intake control structure and into the rock.

6.3 - Saddle Dam (**)

The saddle dam at Devil Canyon, which is of similar configuration as the Watana Dam, will be of earth and rockfill construction and will consist of a compacted core protected by fine and coarse filters upstream and downstream. The outer shells will consist of rockfill material. A typical cross section is shown on Plate F49 and described below.

6.3.1 - Typical Cross Section (*)

The thickness of the impervious core at any section will be slightly more than 0.5 times the head of water at that section. Minimum core/foundation contact will be 50 feet, requiring flaring of the cross section at the abutments.

The upstream and downstream filter zones are sized to provide protection against possible piping through transverse cracks that could occur because of settlement or resulting from internal displacement during a seismic event.

Protection against wave and ice action on the upstream slope will consist of a layer of larger quarried rock accomplished by rock raking the outer 40 feet of the fill.

The estimated volumes of material needed to construct the saddle dam are:

o core material	140,000 cubic yards
o fine filter material	150,000 cubic yards
o coarse filter material	160,000 cubic yards
o rockfill material	1,500,000 cubic yards

The saturated sections of both shells will be constructed of compacted clean rockfill to minimize pore pressure generation and ensure rapid dissipation during and after a seismic event. The lower section of the downstream shell, due to a unique combination of bedrock and topographic elevations, may become saturated by natural runoff or dam seepage. During design the cost of a major drainage system to prevent this occurrence will be weighed against the added cost of processing the materials for the lower portion of the fill. Since pore pressures cannot develop in the unsaturated upper section of the downstream shell, the material in that zone will be unprocessed rockfill from surface or underground excavations.

6.3.2 - Crest Details and Freeboard (**)

A parapet 3.0 feet high will be constructed on the crest of the arch dam to provide a freeboard of 11.0 feet.

The highest reservoir level will be at el. 1,465.6 under PMF conditions. The normal maximum pool elevation will be at el. 1,455.

The typical crest detail for the saddle dam is shown in Plate F50.

A minimum saddle dam freeboard of four feet will be provided for the PMF; hence, the nominal crest of the saddle dam will be at el. 1,470. In addition, an allowance will be made for potential settlement of the rockfill shells. The constructed crest elevations of the saddle dam will be 1,470 at the abutments, rising in proportion to the total height of the dam to el. 1,472 at the maximum section. Under normal operating conditions, the freeboard will be 15 feet.

6.3.3 - Grouting and Pressure Relief System (**)

The rock foundation will be improved by consolidation grouting over the core contact area and by a grouted cutoff along the

centerline of the core. The cutoff at any location will extend to a depth in the range of 0.7 of the water head at that location, as shown on Plate F47.

A grouting and drainage tunnel will be excavated in bedrock beneath the dam along the centerline of the core and will connect with a similar tunnel beneath the adjacent concrete arch dam and thrust block. Pressure relief and drainage holes will be drilled from this tunnel, and seepage from the drainage system will be discharged through the arch dam drainage system to ultimately exit downstream below tailwater level.

6.3.4 - Instrumentation (*)

Observation devices will be installed within all parts of the dam to provide monitoring during construction as well as during operation. Instruments for measuring internal vertical and horizontal displacements, stresses and strains, and total and fluid pressures, as well as surface monuments and markers similar to those proposed for the Watana Dam, will be installed.

6.4 - Diversion (**)

6.4.1 - General (*)

Diversion of the river flow during construction will be through a single concrete-lined diversion tunnel on the south bank. The tunnel will have a horseshoe-shaped cross section with a major dimension of 35.5 feet. It will be 1,490 feet in length. The diversion tunnel plan and profile are shown on Plate F51.

The tunnel is designed to pass a flood with a return frequency of 1:25 years routed through the Watana reservoir. The peak flow that the tunnel will discharge will be approximately 43,000 cfs. The maximum water surface elevation upstream of the cofferdam will be el. 944.

6.4.2 - Cofferdams (**)

The upstream cofferdam will consist of a zoned earth and rockfill embankment (see Plate F52). The diversion dike will be constructed to elevation 915 based on a low water elevation of 910 and will consist of quarry-run rock fill. When the diversion dike is completed, a slurry wall cutoff will be constructed to minimize seepage into the main dam excavation. Final details of this cut-off will be determined following further investigations to define the type and properties of river alluvium. The abutment areas will be excavated to sound rock prior to placement of any cofferdam material.

The cofferdam, from elevation 915 to 947, will be a zoned embankment consisting of an impervious core, fine and coarse upstream and downstream filters, and rock shells with larger stone on the upstream face. The downstream cofferdam will be constructed from el. 860 to 898, with a slurry wall cutoff to bedrock.

The upstream cofferdam crest elevation will have a three-foot free-board allowance for settlement and wave runup. Under the proposed schedule, the Watana development will be operational when this cofferdam is constructed. In a cold winter, ice may form between RM 176 and the cofferdam. The diversion tunnel is designed to pass this ice without ponding, therefore a freeboard allowance for ice is not included in the cofferdam design.

6.4.3 - Tunnel Portals and Gates (*)

A gated concrete intake structure will be located at the upstream end of the tunnel (see Plate F53). The portal and gate will be designed for an external pressure (static) head of 250 feet.

Two 30-foot high by 15-foot wide water passages will will be formed in the intake structure, separated by a central concrete pier. Gate guides will be provided within the passages for the operation of 30-foot high by 15-foot wide fixed-wheel closure/control gates.

Each gate will be operated by a wire rope hoist in an enclosed housing, and will be designed to operate with a 75-foot operating head (el. 945).

Stoplog guides will be installed in the diversion tunnel to permit dewatering of the diversion tunnel for plugging operations. The stoplogs will be in sections to facilitate relatively easy handling, with a mobile crane using a follower beam.

6.4.4 - Final Closure and Reservoir Filling (*)

Upon completion of the Devil Canyon Dam to a height sufficient to allow ponding to a level above the outlet facilities, the intake gates will be partially closed, allowing for a discharge of minimum environmental flows while raising the upstream water level. Once the level rises above the lower level of discharge valves, the diversion gates will be permanently closed and discharge will be through the 90-inch diameter fixed-cone valves in the dam. The diversion tunnel will be plugged with concrete and curtain grouting performed around the plug. Construction will take approximately 1 year. During this time the reservoir will not be allowed to rise above el. 1,135 unless a flood

exceeding the outlet works capacity occurs. In this case the water level will be allowed to rise as needed to store the flood.

6.5 - Outlet Facilities (**)

The primary function of the outlet facilities is to provide for discharge in conjunction with the power facilities, of routed floods with up to 1:50 years recurrence period at the Devil Canyon Reservoir. This will require a total discharge capacity of 42,000 cfs. The use of fixed-cone valves will ensure that downstream erosion will be minimal and nitrogen supersaturation of the releases will be reduced to acceptable levels, as in the case of the Watana development. A further function of these releases is to provide an emergency drawdown for the reservoir, should maintenance be necessary on the main dam or low level submerged structures, and also to act as a diversion facility during the latter part of the construction period.

The outlet facilities will be located in the main dam, as shown on Plate F48, and will incorporate seven fixed-cone discharge valves set in the lower part of the arch dam.

6.5.1 - Outlet (*)

The fixed-cone type discharge valves will be located at two elevations: the upper group, consisting of four 102-inch diameter valves, will be set at el. 1,050, and the lower group of three 90-inch diameter valves will be set at elevation 930. The valves will be installed nearly radially (normal to the dam centerline) with the points of impact of the issuing jets staggered as shown in Plate F48.

The fixed-cone valves will be installed on individual conduits passing through the dam, set close to the downstream face, and protected by upstream ring follower gates located in separate chambers within the dam. Provisions will be made for maintenance and removal of the valves and gates. The gates and valves will be linked by a 20-foot high gallery running across the dam and into the left abutment, where access will be provided by means of a vertical shaft exiting through the thrust block. Although secondary access will be provided via a similar shaft from the north abutment, primary access and installation are both from the south side.

The valve and gate assemblies will be protected by individual trashracks installed on the upstream face. The racks will be removable along guides running on the upstream dam face. A travelling gantry crane will be used for raising the racks. Guides will be installed for the installation of bulkhead gates, if required, at the upstream face. The bulkhead gates will be handled by the travelling gantry crane.

6.5.2 - Fixed-Cone Valves (*)

The 102-inch diameter valves operating at a gross head of 405 feet and the 90-inch diameter valves operating at a head of 525 feet are within current precedent considering the valve size and the static head on the valve. The valves will be located in individually heated rooms and will be provided with electric jacket heaters installed around the cylindrical sleeve of each valve. The valves will be capable of year-round operation, although winter operation is not contemplated. Normally, when the valves are closed, the upstream ring follower gates will also be closed to minimize leakage and freezing of water through the valve seats.

The valves will be operated remotely by two hydraulic operators. Operation of the valves will be from either Watana or by local operation.

6.5.3 - Ring Follower Gates (*)

Ring follower gates will be installed upstream of each valve. The ring follower gates will have nominal diameters of 102 and 90 inches and will be of welded or cast steel construction. The gates will be designed to withstand the total static head under full reservoir.

The design and arrangement of the ring follower gates will be as for Watana.

6.5.4 - Trashracks (*)

A steel trashrack will be installed at the upstream entrance to each water passage to prevent debris from being drawn into the discharge valves. The bar spacing on the racks will be approximately six inches. Provision will be made for monitoring head loss across the racks.

6.5.5 - Bulkhead Gates (*)

The bulkhead gates will be installed only under balanced head conditions using the gantry crane. The gates will be 13 feet and 11 feet square for the upper and lower valves, respectively.

Each gate will be designed to withstand full differential head under maximum reservoir water level. One gate for each valve size has been assumed. The gates will be stored at the dam crest level.

A temporary cover will be placed in the bulkhead gate check at trashrack level to prevent debris from getting behind the trashracks.

The bulkhead gates and trashracks will be handled by an electric traveling gantry type crane located on the main dam crest at el. 1,463. The crane and lifting arrangement will have provision for lowering a gate around the curved face of the dam.

6.6 - Spillway (**)

The spillway at Devil Canyon will be located on the north side of the canyon (see Plate F54). The upstream control structure will be adjacent to the arch dam thrust block and will discharge down an inclined concrete-lined chute constructed on the steep face of the canyon wall. The chute will terminate in a flip bucket which will direct flows downstream and into the river.

The Devil Canyon spillway in combination with the outlet works is designed to pass the routed PMF from Watana during both Stages II and III. The maximum outflows from the spillway would be 351,000 cfs and 333,000 cfs in Stages II and III, respectively. The maximum water levels would be el. 1,465.6 and el. 1,463.1 in Stages II and III. These levels will be below the top of the parapet wall on the concrete arch section of the the dam (el. 1,466.0). The capacity of the spillway and outlet works is approximately 280,000 cfs at a water level of el. 1,456.0. This exceeds the 95 percent upper one sided confluence level for the 10,000 year flood inflow of 262,000. Thus the project can release the 10,000 year flood without the water level exceeding el. 1,456.0.

6.6.1 - Approach Channel and Control Structure (*)

The approach channel will be excavated to a depth varying between 100 feet and 176 feet in the bedrock with a width of just over 130 feet and an invert elevation of 1,375.

The control structure, as shown in Plate F55, will be a three-bay concrete structure set at the end of the channel. Each bay will incorporate a 61-foot high by 48-foot wide gate on an ogee-crested weir and, in conjunction with the other gates, will control the flows passing through the spillway. The gates will be radial type operated by individual hydraulic hoists.

A gallery will be provided within the mass concrete weir from which grouting can be carried out and drain holes can be drilled as a continuation of the grout curtain and drainage beneath the main dam. The main access route will cross the control structure deck upstream of the gate tower and bridge structure.

6.6.2 - Spillway Chute (**)

The spillway chute will be excavated in the steep north face of the canyon for a distance of approximately 900 feet, terminating at el. 1,000. The chute will taper uniformly over its length from 176 feet at the upstream end to 150 feet downstream. The chute will be concrete-lined with invert and wall slabs anchored to the rock.

The velocity at the lower end of the chute will be approximately 150 ft/sec. In order to prevent cavitation of the chute surfaces, air will be introduced into the discharges. As at Watana, air will be drawn in along the chute via an underlying aeration gallery and offshoot ducts extending to the downstream side of a raised step running transverse to the chute.

An extensive underdrainage system will be provided to ensure adequate underdrainage of the spillway chute and stability of the structure. This system is designed to prevent excessive uplift pressures due to reservoir seepage under the control structure and from groundwater and seepage through construction joints from the high velocity flows within the spillway itself.

The dam grout curtain and drainage system will be extended under the spillway control structure utilizing a gallery through the rollway. A system of box drains will be installed for the entire length of the spillway under the concrete slab. To avoid blockage of the system by freezing of the surface drains, a 30-foot deep drainage gallery will also be constructed along the entire length of the spillway. Drain holes from the surface drains will intersect the gallery. To ensure adequate foundation quality for anchorage, consolidation grouting will be undertaken to a depth of 20 feet. Drainage holes drilled into the base of the high rock cuts will ensure increased stability of the excavation.

6.6.3 - Flip Bucket (**)

The spillway chute will terminate in a mass concrete flip bucket founded on sound rock at el. 970, approximately 100 feet above the river. Detailed geometry of the curve of the flow surface of the bucket will be confirmed by means of hydraulic model tests. A grouting/drainage gallery will be provided within the bucket. The jet issuing from the bucket will be directed downstream and parallel to the river alignment.

6.6.4 - Plunge Pool (o)

The impact area of the issuing spillway discharge will be limited to the area of the river surface downstream to prevent

excessive erosion of the canyon walls. This will be done by appropriate shaping of the flow surface of the flip bucket on the basis of model studies. Over this impact area the alluvial material in the riverbed will be excavated down to sound rock to provide a plunge pool in which most of the inherent energy of the discharges will be dissipated, although some energy will already have been dissipated by friction in the chute and in dispersion and friction through the air.

6.7 - Emergency Spillway

(This section deleted)

6.8 - Power Facilities (*)

6.8.1 - Intake Structure (*)

The intake structure will be located on the north side of the canyon. Four sets of intake openings will be provided. The intake openings and power tunnels will be grouped in pairs so that each turbine may be supplied by water passing through two sets of intake openings. Each set of intake openings will consist of an upper and lower opening. The reservoir level will vary between elevations 1,455 (in the winter) and 1,405 in the summer of low flow years. In most years the reservoir water level is expected to stay above el. 1,435 all year. When the reservoir is at its maximum level the water will normally be withdrawn from the top opening in each set. As the reservoir is drawn down in August and September, the lower opening will be used. Each opening will be provided with a set of trashracks and a provision for placing sliding steel closure shutters downstream from the intake opening. The trash racks and shutters will be removed for maintenance.

The intake will be located at the end of an approximately 200-foot long unlined approach channel. The overburden in this area is estimated to be approximately ten feet deep. The excavation for the intake structure will require four tunnel portals on 60-foot centers. Rock pillars approximately 32 feet wide by 38 feet deep will separate the portals.

6.8.2 - Intake Gates (*)

Each of the four powerhouse intake tunnels will have a single fixed-wheel intake gate 20 feet wide by 24 feet high. The gates will have an upstream skinplate and seal and will be operated by hydraulic or wire rope hoists located in heated enclosures immediately below deck level. The gates, which will normally close under balanced head conditions to permit

dewatering of the penstock and turbine water passages for turbine inspection and maintenance, will also be capable of closing under their own weight with full flow conditions and maximum reservoir water level in the event of runaway of the turbines. A heated air vent will be provided at the intake deck to satisfy air demand requirements when the intake gate is closed with flowing water conditions.

6.8.3 - Intake Bulkhead Gates (*)

A bulkhead gate consisting of two sections will be provided for closing the intake openings. The gate will be used to permit inspection and maintenance of the intake gate and intake gate guides. The gates will be raised and lowered under balanced head conditions only.

6.8.4 - Intake Gantry Crane (*)

A 50-ton capacity electrical traveling gantry crane will be provided on the intake deck at elevation 1,466 for handling the trashracks, and intake bulkhead gates and for servicing the intake gate equipment.

6.9 - Penstocks (**)

The power plant will have four penstocks, one for each unit. The maximum static head on each penstock will be 638 feet, as measured from normal maximum operating level (el. 1,455) to centerline distributor level (el. 817). An allowance of 35 percent has been made for pressure rise in the penstock under transient conditions, giving a maximum head of 861 feet. Maximum extreme head (including transient loadings) corresponding to maximum reservoir flood level will be 876 feet.

The penstock tunnels are fully concrete-lined. In addition a 250-foot section upstream of the powerhouse which will be steel-lined. The inclined sections of the concrete-lined penstocks will be at 55° to the horizontal.

6.9.1 - Steel Liner (*)

The steel-lined penstock will be 15 feet in diameter. The first 50 feet of steel liner immediately upstream of the powerhouse will be designed to resist the full internal pressure. The remainder of the steel liner, extending another 200 feet upstream, will be designed to partially resist the internal pressure together with the rock. Beyond the steel liner, the hydraulic loads will be supported solely by the rock tunnel with a concrete liner.

The steel liner will be surrounded by a concrete infill with a minimum thickness of 24 inches. A tapered steel transition will be

provided at the junction between the steel liner and the concrete liner to increase the internal diameter from 15 feet to 20 feet.

6.9.2 - Concrete Liner (*)

The thickness of the concrete lining will vary with the design head, with the minimum thickness of lining being 12 inches. The internal diameter of the concrete liner will be 20 feet.

6.9.3 - Grouting and Pressure Relief System (**)

A comprehensive drainage system will be installed to protect the underground caverns against seepage from the high pressure penstocks and reservoirs. The system will consist of small diameter boreholes set out in an array to intercept the jointing in the rock. Grouting around the penstocks will also be undertaken.

6.10 - Powerhouse and Related Structures (**)

The underground powerhouse complex will be constructed in the north side of the canyon. This will require the excavation of three major caverns (powerhouse, transformer gallery and surge chamber), with interconnecting rock tunnels for the draft tubes and isolated phase bus ducts.

An unlined rock tunnel will be constructed for vehicular access to the three main rock caverns. A second unlined rock tunnel will provide access from the powerhouse to the foot of the arch dam.

Vertical shafts will be required for personnel access by elevator to the underground powerhouse, for oil-filled cable from the transformer gallery, and for surge chamber venting.

The draft tube gate gallery and cavern will be located in the surge chamber cavern, above maximum design surge level.

The general layout of the powerhouse complex is shown on Plates F63, F64 and F65. The transformer gallery will be located upstream of the powerhouse cavern and the surge chamber will be located downstream of the powerhouse cavern. The spacing between the underground caverns will be fixed so as to be at least 1.5 times the main span of the larger excavation.

6.10.1 - Access Tunnels and Shafts (**)

The 3,000-foot long main access tunnel will connect the powerhouse cavern at el. 858 with the canyon access road on the north bank. A secondary access tunnel will run from the main powerhouse access tunnel to the foot of the arch dam for routine

maintenance of the fixed-cone valves. Branch tunnels from the secondary access tunnel will provide construction access to the lower section of the penstocks at el. 820. Separate branch tunnels from the main access tunnel will give vehicle access to the transformer gallery at el. 896 and the draft tube gate gallery at el. 908. The maximum gradient on the permanent access tunnel will be eight percent; the maximum gradient on the secondary access tunnel will be nine percent.

The cross section of the access tunnels, which will be dictated by requirements for the construction plant, will be a modified horseshoe shape 35 feet wide by 28 feet high.

The main access shaft will be located at the north end of the powerhouse cavern, providing personnel access by elevator from the surface. Horizontal tunnels will be provided from this shaft for pedestrian access to the transformer gallery and the draft tube gate gallery. At a higher level, access will also be available to the fire protection head tank.

6.10.2 - Powerhouse Cavern (*)

The main powerhouse cavern is designed to accommodate four vertical-shaft Francis turbines, in line, with direct coupling to synchronous generators.

The unit spacing will be 60 feet with an additional 110-foot service bay at the south end of the powerhouse for routine maintenance and construction erection. The control room will be located at the north end of the main powerhouse floor. The width of the cavern will be sufficient for the physical size of the generator plus galleries for piping, air-conditioning ducts, electrical cables, and isolated phase bus. The overall size of the powerhouse cavern will be 74 feet wide, 360 feet long, and 126 feet high.

Multiple stairway access points will be available from the powerhouse main floor to each gallery level. Access to the transformer gallery from the powerhouse will be by a tunnel from the access shaft or by a stairway through each of the four bus tunnels. Access will also be available to the draft tube gate gallery by a tunnel from the main access shaft.

A service elevator will be provided for access from the service bay area on the main floor to the machine shop, and the dewatering and drainage galleries on the lower floors. Hatches will be provided through all main floors for installation and routine maintenance of pumps, valves and other heavy equipment using the main powerhouse crane.

6.10.3 - Transformer Gallery (**)

The transformers will be located underground in a separate unlined rock cavern, 120 feet upstream of the powerhouse cavern, with four interconnecting tunnels for the isolated phase bus. There will be 12 single-phase transformers with one group of three transformers for each generating unit. For increased reliability, one spare transformer and one spare HV circuit will be provided. The station service transformers and the surface facilities transformers will be located in the bus tunnels. Generator excitation transformers will be located on the main powerhouse floor. The overall size of the transformer gallery will be 43 feet wide, 40 feet high, and 446 feet long; the bus tunnels will be 14 feet wide and 14 feet high.

High voltage cables will be taken to the surface in two 7.5-foot internal diameter cable shafts, and provision will be made for an inspection hoist in each shaft.

Vehicle access to the transformer gallery will be from the south end via the main powerhouse access tunnel. Personnel access will be from the main access shaft or through each of the four isolated phase bus tunnels.

6.10.4 - Surge Chamber (**)

A simple surge chamber will be constructed 120 feet downstream of the powerhouse to control pressure fluctuations in the turbine draft tubes and tailrace tunnel under transient load conditions, and on machine start-up. The chamber will be common to all four draft tubes. The overall size of the chamber will be 75 feet wide, 240 feet long, and 190 feet high.

The draft tube gate gallery and crane will be located in the same cavern, above the maximum anticipated surge level. Access to the draft tube gate gallery will be by a rock tunnel from the main access tunnel. The tunnel will be widened locally for storage of the draft tube gates.

The chamber will be an unlined rock excavation with localized rock support as necessary for stability of the roof arch and walls. The guide blocks for the draft tube gates will be of reinforced concrete anchored to the rock excavation by rock bolts.

6.10.5 - Draft Tube Tunnels (*)

The orientation of the draft tube tunnels will be 300°. The tunnels will be 19 feet in diameter and steel- and concrete-lined, with the concrete having a thickness of about two feet.

6.11 - Tailrace Tunnel (*)

The tailrace pressure tunnel will convey power plant discharge from the surge chamber to the river. The tunnel will have a modified horseshoe cross section with an internal dimension of 38 feet, and will be concrete-lined throughout with a minimum thickness of 12 inches. The length of the tunnel is 6,800 feet.

The tailrace portal site will be located at a prominent steep rock face on the north bank of the river. The portal outlet is rectangular in section, which reduces both the maximum outlet velocity (eight ft/sec) as well as the velocity head losses. Vertical stoplog guides will be provided for closure of the tunnel for tunnel inspection and/or maintenance.

6.12 - Access Plan (**)

6.12.1 - Description of Access Plan (*)

Access to the Devil Canyon development will consist primarily of a railroad extension from the existing Alaska Railroad at Gold Creek to a railhead and storage facility adjacent to the Devil Canyon camp area. From here materials and supplies will be distributed using a system of site roads.

To provide flexibility of access the railroad extension will be augmented by a road between the Devil Canyon and Watana damsites. The availability of both road and rail access will reduce the schedule and cost risks associated with limited access.

This road connection will also be required for travel between Watana and Devil Canyon by the post-construction operation and maintenance personnel who will be stationed at Watana.

6.12.2 - Rail Extension (*)

Except for a two-mile section where the route traverses steep terrain alongside the Susitna River, the railroad will climb steadily for 12.2 miles from Gold Creek to the railhead facility near the Devil Canyon camp.

Nearly all of the route traverses potentially frozen Basal till on side slopes varying from flat to moderately steep. Several streams are crossed, requiring the construction of large culverts. However, where the railroad crosses Jack Long Creek small bridges will be built to minimize impacts to the aquatic habitat. In view of the construction conditions it is estimated that it will take eighteen months to two years to complete the extension. Therefore construction should start two years prior to commencement of the main works at Devil Canyon.

The railroad extension will be designed in accordance with the parameters set out below:

Maximum grade	2.5%
Maximum curvature	10°
Design loading	E-72

These parameters are consistent with those presently being used by the Alaska Railroad.

6.12.3 - Connecting Road (**)

From the railhead facility at Devil Canyon a connecting road will be built to a high-level suspension bridge approximately one mile downstream of the damsite. The route then proceeds in a north- easterly direction, crosses Devil Creek and swings around past Swimming Bear Lake at an elevation of 3,500 feet before continuing in a southeasterly direction through a wide pass. After crossing Tsusena Creek, the road continues south to the Watana damsite. The overall length of the road is 37.0 miles.

In general the alignment crosses good soil types with bedrock at or near the surface. Erosion and thaw settlement problems should not be a problem since the terrain has gentle to moderate slopes which will allow roadbed construction without deep cuts.

The connecting road will be built to the same standards and in accordance with the design parameters used for the Watana access road.

6.12.4 - Construction Schedule (**)

The 1,790-foot long high-level suspension bridge crossing the Susitna River is the controlling item in the construction schedule, requiring three years for completion. Therefore, access for the start of the main works at the Devil Canyon damsite will utilize the Watana access road.

6.12.5 - Right-of-Way (**)

The road and railroad routes mainly traverse terrain with gentle to moderate side slopes, where a right-of-way width of 200 feet will be sufficient. Only in areas of major sidehill cutting and deep excavation will it be necessary to go beyond 200 feet.

6.13 - Site Facilities (*)

The construction of Devil Canyon will require various facilities to support the construction activities throughout the entire construction period. Following construction, the planned operation and maintenance

of Devil Canyon will be centered at Watana; therefore, a minimum of facilities at the site will be required to maintain the project during operation.

As described for Watana, a camp and construction village will be constructed and maintained at the project site. The camp/village will provide housing and living facilities for 1,900 people during construction. Other site facilities will include contractors' work areas, site power, services, and communications. Items such as power and communications and hospital services will also be required for construction operations independent of camp operations. Electric power will be provided from Watana.

6.13.1 - Temporary Camp and Village (**)

A tentative location for the camp/village is on the south bank of the Susitna River between the damsite and Portage Creek, approximately 2.5 miles southwest of the Devil Canyon Dam (see Plate F70). The south side of the Susitna was chosen because the main access road in this area will be from the south. South-facing slopes will be used for the camp/village location.

The camp will consist of woodframe dormitories with modular mess halls, recreational buildings, bank, post office, fire station, warehouses, hospital, offices, etc. The camp will accommodate approximately 1,400 workers.

The village, designed for approximately 150 families, will be grouped around a service core containing a school, gymnasium, stores, and recreation area.

The two areas will be separated to provide a buffer zone. The hospital will serve both the main camp and the village.

The camp location will be separated from the work areas by approximately one mile. Travel time to the work area will generally be less than 15 minutes.

The camp/village will be constructed in stages to accommodate the peak work force. The facilities will be designed for the peak work force plus ten percent for "turnover". The "turnover" will include provisions for overlap of workers and vacations. The conceptual layouts for the camp/village are presented in Plates F72 and F73.

Construction camp buildings will consist largely of factory-built modules assembled at site to provide the various facilities required. The modules will be fabricated with heating, lighting, and plumbing facilities, interior finishes, furnishings, and

equipment. Modules will be supported on timber cribbing or blocking approximately two feet above grade.

Larger structures such as the central utilities building, gym, and warehouses will be pre-engineered steel-framed structures with metal cladding.

The various buildings in the camp are identified on Plate F72.

6.13.2 - Site Power and Utilities (**)

(a) Power (**)

A 345 kV transmission line from Watana and a substation will be in service during the construction activities. Two transformers will be installed at the substation to reduce the line voltage to the desired voltage levels.

The peak demand during construction is estimated at 20 MW for the camp/village and four MW for construction requirements. The distribution system for the camp/village will be 4.16 kV.

(b) Water (**)

The water supply system will serve the entire camp/village and selected contractors' work areas. The water supply system will provide for potable water and fire protection. The estimated peak population to be served will be 1,940 (1,410 in the camp and 530 in the village).

The principal source of water will be the Susitna River. The water will be treated in accordance with the U.S. Environmental Protection Agency (EPA) primary and secondary requirements and with Drinking Water Standards of the State of Alaska Department of Environmental Conservation (ADEC).

(c) Wastewater (**)

One wastewater collection and treatment system will serve the camp/village. Gravity flow lines with lift stations will be used to collect the wastewater from all of the camp and village facilities. The "in-camp" and "in-village" collection systems will be run through the permawalks and utilidors so that the collection system will always be protected from the elements.

At the village, an aerated collection basin will be installed to collect the sewage. The sewage will be pumped

from this collection basin through a force main to the sewage treatment plant.

Chemical toilets located around the site will be serviced by sewage trucks which will discharge directly into the sewage treatment plant.

The sewage treatment system will be a biological system with lagoons. The system will be designed to meet Alaska ADEC and Federal EPA standards. The lagoons and system will be modular to allow for growth and contraction of the camp/village.

The location of the treatment plant is shown on Plate F70. The location was selected to avoid unnecessary odors in the camp.

The sewage plant will discharge its treated effluent to the Susitna River. All treated sludge will be disposed of in an approved solid waste sanitary landfill.

6.13.3 - Contractors' Area (**)

Contractors on the site will require offices, workshops, ware houses, storage areas, and fabrication shops. These will be located on the south side of the Susitna River near the dam site.

7 - DEVIL CANYON RESERVOIR STAGE II (*)

The Devil Canyon reservoir, at a normal operating level of 1,455 feet, will be approximately 26 miles long with a maximum width of approximately 1/2 mile. The total surface area at normal operating level will be 7,800 acres. Immediately upstream of the dam, the maximum water depth will be approximately 580 feet. The minimum reservoir level will be 1,405 feet during normal operation, resulting in a maximum drawdown of 50 feet. The reservoir will have a total capacity of 1,100,000 acre-feet of which 350,000 acre-feet will be live storage.

8 - TURBINES AND GENERATORS - DEVIL CANYON STAGE II (**)

8.1 - Unit Capacity (**)

The Devil Canyon powerhouse will have four generating units, each with a maximum output of 173 MW based on the full reservoir level at elevation 1,455 and a corresponding net head of 600 feet. The net head on the plant will vary from 545 feet to 600 feet. Unit characteristics including generator outputs are described in Table F.1.

The operating head for rating the unit will be the minimum net head of 545 feet. Rated unit output at this head is 150 MW.

The generator rating has been selected as 192 MVA with a 90 percent power factor to match the maximum in turbine output under maximum head. Generator output is assumed to be 98 percent of the turbine output at full load.

8.2 - Turbines (**)

The turbines will be of the vertical-shaft Francis type with steel spiral casing and a concrete lined elbow-type draft tube. The draft tube will have a single water passage with no piers.

Maximum and minimum net heads on the turbine will be 600 feet and 545 feet, respectively. The full-gate output of the turbines will be about 177 MW at maximum net head and 153 MW at minimum net head. For study purposes, the best efficiency (best-gate) output of the units has been assumed at 85 percent of the full-gate turbine output.

8.3 - Generators (o)

The four generators in the Devil Canyon powerhouse will be of the vertical-shaft, overhung synchronous directly connected to the vertical Francis turbines.

The generators will be similar in construction and design to the Watana generators. The general features described in Section 3.2 for the stator, rotor, excitation system, and other details also will apply for the Devil Canyon generators.

The rating and characteristics of the generators will be as follows:

Rated Capacity:	192 MVA, 0.9 power factor
Rated Power:	170 MW
Rated Voltage:	15 kV, 3 phase, 60 Hertz

Synchronous Speed:	225 rpm
Inertia Constant:	3.5 MW-Sec/MVA
Short Circuit Ratio:	1.1 (minimum)
Efficiency at Full Load:	98 percent (minimum)

8.4 - Governor System (o)

A governor system with electric hydraulic governor actuators will be provided for each of the Devil Canyon units. The system will be the same as for Watana (see Section 3.4).

9 - APPURTENANT EQUIPMENT - DEVIL CANYON - STAGE II

9.1 - Miscellaneous Mechanical Equipment (o)

9.1.1 - Powerhouse Cranes (o)

Two overhead type powerhouse cranes will be provided at Devil Canyon as at Watana. The crane capacity will be approximately 200 tons.

9.1.2 - Draft Tube Gates (o)

Draft tube gates will be provided to permit dewatering of the turbine water passages for inspection and maintenance of the turbines. The arrangement of the draft tube gates will be the same as for Watana, except that only two sets of gates will be provided, each set with two 21-foot wide by 10.5-foot high sections.

9.1.3 - Draft Tube Gate Crane (o)

A crane will be installed in the surge chamber for installation and removal of the draft tube gates. The crane will be either a monorail (or twin monorail) or a gantry crane with an approximate capacity of 30 tons. The crane will be pendant-operated and have a two point lift. A follower will be used with the crane for handling the gates. The crane runway will be located along the upstream side of the surge chamber and will extend over the intake for the compensation flow pumps as well as a gate unloading area at one end of the surge chamber.

9.1.4 - Miscellaneous Cranes and Hoists (o)

In addition to the powerhouse cranes and draft tube gate cranes, the following cranes and hoists will be provided in the power plant:

- o A 5-ton monorail hoist in the transformer gallery for transformer maintenance;
- o Small overhead, jib, or A-frame type hoists in the machine shop for handling material; and
- o A-frame or monorail hoists in other powerhouse areas for handling small equipment.

9.1.5 - Elevators (o)

Access and service elevators will be provided for the power plant as follows:

- o Access elevator from the control building to the powerhouse;
- o Service elevator in the powerhouse service bay; and
- o Inspection hoists in cable shafts.

9.1.6 - Power Plant Mechanical Service Systems (o)

The power plant mechanical service systems for Devil Canyon will be essentially the same as discussed in Section 5.1(f) for Watana, except for the following:

- o There will be no main generator breakers in the power plant; therefore, circuit breaker air will not be required. The high pressure air system will be used only for governor as well as instrument air. The operating pressure will be 600 to 1,000 psig depending on the governor system operating pressure.
- o An air-conditioning system will be installed in the powerhouse control room.
- o Heating and ventilating will be required for the entrance building to the access shaft in the south abutment.
- o For preliminary design purposes, only one drainage and one dewatering sump have been provided in the powerhouse. The dewatering system will also be used to dewater the intake.

9.1.7 - Surface Facilities Mechanical Service Systems (o)

The entrance building above the power plant will have only a heating and ventilation system. The mechanical services in the standby power building will include a heating and ventilation system, a fuel oil system, and a fire protection system, as at Watana.

9.1.8 - Machine Shop Facilities (o)

A machine shop and tool room will be located in the powerhouse service bay area to take care of maintenance work at the plant.

The facilities will not be as extensive as at Watana. Some of the larger components will be transported to Watana for necessary machinery work.

9.2 - Accessory Electrical Equipment (o)

9.2.1 - General (o)

The accessory electrical equipment described below includes the following:

- o Main generator step-up 15/345 kV transformers;
- o Isolated phase bus connecting the generator and transformers;
- o 345 kV oil-filled cables from the transformer terminals to the switchyard;
- o Control systems; and
- o Station service auxiliary ac and dc systems.

Other equipment and systems described include grounding, lighting system and communications.

The main equipment and connections in the power plant are shown in the single line diagram (Plate F68). The arrangement of equipment in the powerhouse, transformer gallery, and cable shafts is shown in Plates F63 to F65.

9.2.2 - Transformers and HV Connections (o)

Twelve single-phase transformers and one spare transformer will be located in the transformer gallery. Each bank of the three single-phase transformers will be connected to one generator by isolated phase bus located in bus tunnels. The HV terminals of the transformer will be connected to the 345 kV switchyard by 345 kV single-phase, oil-filled cables installed in 800-foot long vertical shafts. There will be two sets of three single-phase 345 kV oil-filled cables installed in each cable shaft. One additional set will be maintained as a spare three-phase cable circuit in the second cable shaft. These cable shafts will also contain the control and power cables between the powerhouse and the surface control room, as well as emergency power cables from the diesel generators at the surface to the underground facilities.

9.2.3 - Main Transformers (o)

The transformers will be of the single-phase, two-winding, oil-immersed, forced-oil water-cooled (FOW) type. A total of twelve single-phase transformers and one spare transformer will be provided, with rating and characteristics as follows:

Rated capacity:	70 MVA
High Voltage Winding:	345/1.73 kV, grounded Y
Basic Insulation Level (BIL) of HV Winding:	1300 kV
Low Voltage Winding:	15 kV, Delta
Transformer Impedance:	15 percent

9.2.4 - Generator Isolated Phase Bus (o)

Isolated phase bus connections will be located between the generator and the main transformer. The bus will be of the self-cooled, welded aluminum tubular type with design and construction details generally similar to the bus at the Watana power plant. The rating of the main bus will be as follows:

Rated current:	9000 amps
Short circuit current momentary:	240,000 amps
Short circuit current symmetrical:	150,000 amps
Basic Insulation Level (BIL):	150 kV

9.2.5 - 345 kV Oil-Filled Cable (o)

The cables will be rated for a continuous maximum current of 400 amps at 345 kV ±5 percent. The cables will be of single-core construction with oil flowing through a central oil duct within the copper conductor. The cables will be installed in the 800-foot cable shafts from the transformer gallery to the surface. No cable jointing will be necessary for this installation length.

9.2.6 - Control Systems (o)

The Devil Canyon power plant will be designed to be operated as an unattended plant. The plant will be normally controlled through supervisory control from the Susitna Area Control Center at Watana. The plant will, however, be provided with a control room with sufficient control, indication, and annunciation equipment to enable the plant to be operated during emergencies by one operator in the control room. In addition, for the purpose of testing and commissioning and maintenance of the plant, local control boards will be mounted on the powerhouse floor near each unit.

Automatic load-frequency control of the four units at Devil Canyon will be accomplished through the central computer-aided control system located at the Watana Area Control Center.

The power plant will be provided with "black start" capability similar to that provided at Watana to enable the start of one unit without any power in the powerhouse or at the switchyard, except that provided by one emergency diesel generator. After the start- up of one unit, auxiliary station service power will be established in the power plant and the switchyard; the remaining generators can then be started one after the other to bring the plant into full output within the hour.

As at the Watana power plant, the control system will be designed to permit local-manual or local-automatic starting, voltage adjusting, synchronizing, and loading of the unit from the powerhouse control room at Devil Canyon.

The protective relaying system is shown in the main single line diagram (Plate F68) and is generally similar to that provided for the Watana power plant.

9.2.7 - Station Service Auxiliary AC and DC Systems (o)

(a) AC Auxiliary System (o)

The auxiliary system will be similar to that in the Watana power plant except that the switchyard and surface facilities power will be obtained from a 4.16 kV system supplied by two 5/7.5 MVA, OA/FA, oil-immersed transformers connected to generators Nos. 1 and 4, respectively. The 4.16 kV double-ended switchgear will be located in the powerhouse. It will have a normally-open tie breaker which will prevent parallel operation of the two sections. The tie breaker will close on failure of one or the other of the incoming supplies. The 1400 hp compensation flow pumps will be supplied with power directly from the 4.16 kV system. Two 4.16 cables installed in the cable shafts will supply power to the surface facilities.

The 480 V station service system will consist of a main 480 V switchgear, separate auxiliary boards for each unit, essential auxiliaries board, and a general auxiliaries board. The main 480 V switchgear will be supplied by two 2,000 kVA, 15,000/480 V grounded wye sealed gas dry-type transformers. A third 2,000 kVA transformer will be maintained as a spare.

Two emergency diesel generators, each rated 500 kW, will be connected to the 480 V powerhouse main switchgear and 4.16

kV surface switchboard, respectively. Both diesel generators will be located at the surface.

An uninterruptible high-security power supply will be provided for the supervisory computer-aided plant control systems.

(b) DC Auxiliary Station Service System (o)

The dc auxiliary system will be similar to that provided at the Watana plant and will consist of two 125 V dc lead-acid batteries. Each battery system will be supplied by a double-rectifier charging system. A 48 V dc battery system will be provided for supplying the supervisory and communications systems.

9.2.8 - Other Accessory Electrical Systems (o)

The other accessory electrical systems including the grounding system, lighting system, and powerhouse communications system will be similar in general design and construction aspects to the system described in Section 5.2 for the Watana power plant.

9.3 - Switchyard Structures and Equipment (o)

9.3.1 - Single Line Diagram (o)

A breaker-and-a-half single line arrangement will be used at the switchyard. This arrangement was selected for reliability and security of the power system. Plate F69 shows the details of the switchyard single line diagram.

9.3.2 - Switchyard Structures and Layout (o)

The switchyard layout will be based on a conventional outdoor type design. The design adopted for this project will provide a two- level bus arrangement. This design is commonly known as a low station profile.

The two-level bus arrangement is desirable because it is less prone to extensive damage in case of an earthquake. Due to the lower heights, it is also easier to maintain.

10 - TRANSMISSION LINES - DEVIL CANYON STAGE II (**)

As part of the Stage II Devil Canyon development, the transmission system will be supplemented. Two single-circuit 345 kV transmission lines will be built between the Devil Canyon switchyard at the power development and the Gold Creek switching station.

From the Devil Canyon substation the lines will head directly west for a distance of approximately one mile where they will intersect the Watana to Gold Creek transmission corridor. From this point to the Gold Creek switching station the lines will share the same corridor as the Watana lines.

At Gold Creek, 345 kV breakers will be added in an new bay within the switching station. The new circuit breakers will provide switching and terminations for the incoming lines and accommodate a new line to Anchorage.

11 - PROJECT STRUCTURES - WATANA STAGE III (***)

This section describes the project features that will be altered or added during third stage construction of the Watana development. Stage III consists of increasing the plant capacity and energy generation by raising Watana Dam and the reservoir maximum normal operating level, and by adding two generating units.

11.1 - General Arrangement (***)

The raising of Watana Dam during Stage III will create a reservoir approximately 48 miles long with a surface area of 38,000 acres, and a gross storage capacity of 9,500,000 acre-feet at the normal maximum operating level of el. 2,185.

The maximum water surface elevation during flood conditions will be 2,199.3 The minimum operating level of the reservoir will be el. 2,065, providing a live storage during normal operation of 3,700,000 acre-feet.

The Stage I internal zoning will be maintained in raising the dam. The nominal crest elevation of the dam will be 2,205, with a maximum height of 885 feet above the foundation and a crest length of 4,100 feet. The embankment crest will initially be cambered to el. 2,210 to allow for potential settlement. The total volume of fill material placed in the dam during this will be 26,363,000 cubic yards, bringing the total volume of the dam to 58,470,000 cubic yards.

A new power intake will be constructed adjacent to the existing two intakes. The existing intake concrete superstructure will be raised to accommodate the higher reservoir level. Simultaneously, the concrete superstructure for the outlet facilities will also be raised. The approach channel constructed during Stage I will be adequate for the efficient flow of water to all intakes.

Additional power capacity will be achieved by the increased head on the Stage I generating units, which were designed for this reservoir raising, and the two additional generating units installed during this stage. This installation will require an extension of the powerhouse chamber to the south of the service bay. Similar extensions will be required to the south of the transformer gallery and surge chamber. The excavated cross sections of these chambers will be the same as the Stage I chambers.

A third power shaft and tunnel bifurcating into penstocks to supply water to the two generating units will be excavated and lined with concrete from the new intake structure. The power conduit will have an internal diameter of 24 feet.

The penstocks will be steel-lined for a distance of 200 feet upstream of the powerhouse. The steel-lined section will have a diameter of 15 feet. The remaining penstock reach to the bifurcation will be 18 feet in diameter.

The normal reservoir fluctuation for power generation will be 120 feet, from the normal maximum pool at el. 2,185 to the minimum normal pool at el. 2,065.

The surge chamber extension will be hydraulically joined to the powerhouse cavern by two draft tube tunnels. The turbine discharges will flow from the south end of the surge chamber by a second 34 foot diameter concrete-lined modified horseshoe tunnel. This tunnel will intersect the Number 2 diversion tunnel, which will be used to complete the tunnel tailrace system, and discharge to the river downstream of the dam. The transformer gallery extension will house a bank of three additional single-phase 15-345/ 1.73 kV transformers serving the two generators. The transformers will be connected by three 345 kV single-phase gas insulated SF_6 busses, and led through an existing shaft to the transmission yard at the surface.

There will be no change to the outlet facilities downstream of the intake structure.

The maximum outlet works discharge required to pass the 50-year flood at Watana without operating the spillway is approximately 24,000 cfs. In combination with a powerhouse flow of 7,000 cfs this will cause the Watana water level to be raised to el. 2,193. The average powerhouse flow during the passing of the 50-year flood may reach 9,900 cfs. This may result in Watana outflows of 33,900 cfs. The resulting inflow to Devil Canyon may reach approximately 43,000 cfs. The Devil Canyon outlet works has the capacity to pass 42,000 cfs without operating the spillway. A 1.0 foot surcharge has been provided at the Devil Canyon Dam to store flow in excess of the outlet works capacity. Therefore the raising of the reservoir will increase the discharge capacity of the outlet works for the maximum valve settings (80% gate stroke) from 24,000 cfs to 30,000 cfs. However, this extra capacity is not needed in Stage III to store and release the 50-year flood without operating the spillways. The project operating policy during floods is to transfer as much energy generation from the Devil Canyon powerhouse to the Watana powerhouse as necessary to pass the flood without raising the water level above el. 2,193 or opening the spillway. The Devil Canyon outlet works has the capacity to pass the outflow from Watana plus intervening flow without raising the Devil Canyon water level above el. 1,456.0 or requiring use of that spillway. Gas concentrations downstream of the dams are expected to be below naturally occurring levels.

The spillway control structure will require a substantial modification. The bridge will be removed, and the piers and abutment wall concrete

will be raised. This will be followed by raising the ogee section to a crest elevation of 2,135. The Stage I radial gates and hydraulic hoists will be re-installed. The ogee section will, in effect, be a gravity dam section with its downstream face forming the upper reach of the spillway chute prior to joining the lower reach which was constructed during Stage I. The spillway will still have the capacity to pass the Probable Maximum Flood (PMF) without overtopping the dam. The emergency release facilities constructed in diversion tunnel No. 1 will still be available for lowering of the reservoir over a period of time to permit emergency inspection or repair to the impoundment structures.

11.2 - Dam Embankment (***)

The Stage I Watana Dam has been designed with the intent of raising it during Watana Stage III development. In general, the outer slopes and internal zoning of the Stage I dam will be raised to the nominal final Stage III crest level of el. 2,205. Some excavation at the top of the Stage I dam will be necessary to ensure continuity of the zones between Stages I and III construction. The dam will be compacted earth and rockfill construction and will consist of an impervious core protected by fine and coarse filters upstream and downstream. The upstream and downstream outer shells will consist of rockfill. A typical cross section is shown on Plate F77 and is described below.

11.2.1 - Typical Cross Section (***)

The basic cross section of the Stage III dam is the same as the Stage I dam. Filter and impervious core thickness criteria are the same as for Stage I; core and filter thicknesses in the Stage I development take into account for the higher reservoir levels which will be present after Stage III.

The upstream and downstream filter zones provide protection against possible piping through transverse cracks that could occur because of settlement or resulting from internal displacement during a seismic event. The shells of the dam will consist of rockfill obtained from Quarry Site A. The rockfill will minimize pore pressure generation and ensure rapid dissipation of pore pressures should seismic shaking occur.

As in Stage I, protection against wave and ice action on the upstream slope will consist of a quarried-rock raked layer of large stone up to 36 inches in size.

The volume of material required to construct the Stage III Watana Dam is presently estimated as follows:

- Impervious material: 1,552,000 cubic yards
- Fine filter material: 753,000 cubic yards

- o Coarse filter material: 679,000 cubic yards
- o Rockfill material: 22,936,000 cubic yards

11.2.2 - Crest Details and Freeboard (***)

The typical crest detail is shown in Plate F77. Because of the narrowing at the dam crest, the filter zones are reduced in width but still protect the core material from damage by frost penetration and desiccation.

The nominal crest elevation of Watana Stage III will be 2,205.

The total settlement allowance considered results in a deformation of up to 0.5 percent of the height of the dam. During construction of the dam, additional allowances will be made for post-construction settlement of the dam under its own weight, for the effects of saturation on the upstream rock fill when the reservoir is first filled, and for possible settlement from seismic shaking. Provision will be made during construction for placement of additional fill at the crest should settlements exceed the estimated amounts. At each abutment the crest el. will be 2,205 while the central portion of the embankment would be to el. 2,210. Under normal operating conditions the minimum freeboard relative to the maximum operating pool elevation of 2,185 will be approximately 20 feet.

The PMF freeboard allowance of six feet is based on the crest level after all settlement has taken place. Less PMF level freeboard is necessary at Stage III than at Stage I because of the greater storage capabilities of the reservoir basin.

Ultimate security against overtopping of the dam will be provided by the spillway which is designed to pass the PMF without overtopping the dam.

11.2.3 - Grouting and Pressure Relief System (***)

The majority of the grouting and pressure relief system will have been constructed during Stage I. However, consolidation grouting along the abutments above el. 2,025 will be required in the core foundation during Stage III. In addition, grouting and drainage galleries, the grout curtain, and pressure relief drain holes, will be constructed above the existing Stage I to the final Stage III level.

The grout curtain and drilling for the pressure relief system will be largely carried out from galleries in the rock foundation in the abutments and beneath the dam. Details of the grouting, pressure relief, and galleries are shown on Plate F78.

11.2.4 - Instrumentation (***)

Instrumentation will have been installed during Stage I to provide monitoring of performance of the dam and foundation during construction as well as during operation. Instruments for measuring internal vertical and horizontal displacement, stresses and strains, and total fluid pressures, as well as surface monuments and markers, were installed. This instrumentation will also provide monitoring capabilities during and after Stage III construction. Some additional instrumentation will be required in the Stage III zone between elevations 2,025 and 2,205. Conservative quantity estimates for instrumentation have been made on the basis of currently available geotechnical data for the site.

(a) Piezometers (***)

- o Piezometers will be used to measure static fluid pressure in the pore space of soil, rockfill, and in the rock foundation.

(b) Internal Vertical Movement Devices (***)

- o Cross-arm settlement devices as developed by the USBR
- o Various versions of the taunt-wire devices which have been developed to measure internal settlement
- o Hydraulic-settlement devices of various kinds

(c) Internal Horizontal Movement Devices (***)

- o Taunt-wire arrangements
- o Cross-arm devices
- o Inclinometers
- o Strain meters

(d) Other Measuring Devices (***)

- o Stress meters
- o Surface monuments and alignment markers
- o Seismographic records and seismoscopes
- o Flow meters to record discharge from drainage and pressure relief system

11.3 - Diversion (***)

Passage of river flows during Stage III will be accomplished by in-place Stage I project features. Stage III diversion will involve reconstructing the downstream cofferdam over the in-place slurry trench cutoff, and dewatering the area between the Stage I dam and the cofferdam by pumping. Construction will involve approximately 10,000

cubic yards of impervious fill, and 16,000 cubic yards of rockfill and filter material. The foundation cutoff of this cofferdam will be sufficiently water tight that once the area downstream of the dam is dewatered, minimum pumping to tailwater will be required to maintain adequate drainage so that Stage III Watana foundation preparation and fill placement can occur. This care and handling of water will be required for one construction season.

11.4 - Emergency Release Facilities (***)

The emergency release facilities constructed during Stage I will not be subjected to any change during Stage III. The description of these facilities is presented in 1.4 - Emergency Release Facilities. The gated concrete plugs, and the bonnetted-type high pressure slide gates installed therein will have been designed for the hydraulic head imposed by the Stage III reservoir level. The emergency release facilities will not be operated under head conditions exceeding 600 feet. The upstream and downstream gates will be operated in unison maintaining equal gate openings in order to balance the hydraulic head drop across the gates. Energy dissipation at the diversion tunnel exit will be accomplished by the concrete flip bucket in the exit channel.

11.5 - Outlet Facilities (***)

The primary function of the outlet facilities remains the same as in Stage I, which is to discharge floods with recurrence frequencies of up to once in 50 years with minimum downstream erosion and minimum generation of dissolved nitrogen in the discharges. As before, the secondary function is the capability of drawing the reservoir down during an extreme emergency situation.

The descriptions (for the approach channel only) found in 1.5.1, Approach Channel and Intake, 1.5.2, Intake Gates and Trashracks, 1.5.3, shaft and Tunnel, 1.5.4, Discharge Structure, 1.5.5, Fixed Cone Valves, 1.5.6, Ring Follower Gates, and 1.5.7, Discharge Area, are still valid for the Stage III development. All structures and equipment constructed and installed in Stage I are designed for Stage III loadings.

The Stage III development of the outlet facilities will be limited to the raising of the intake superstructure. This work will entail raising the concrete exterior walls, central pier and placing a new deck at el. 2,207. The stop log and trashrack guides will be extended so that the stop logs and trashracks may be placed and removed from the new deck level. Access to the intake structure will be via an embankment which joins the crest of the dam. The Stage III Intake is shown on Plate F80.

11.6 - Spillway (***)

The function of the Stage III spillway is still to provide discharge capability for floods exceeding the capacity of the outlet facilities (50-year flood). The spillway and outlet facility will have a combined capacity to pass flood inflows to the reservoir with a frequency of occurrence of up to and including the Probable Maximum Flood (PMF).

Plate F79 shows the Stage III spillway, and indicates that the modification to the Stage I spillway is restricted to the control structure. The control structure will take on the appearance of a gravity dam spillway by raising the Stage I control structure between the approach channel and the chute channel. The overflow and chute sections will be hydraulically model tested to determine its configuration during the Stage I detailed design phase.

11.6.1 - Approach Channel and Control Structure (***)

The approach channel, as excavated in Stage I, will require no change for the Stage III development. The concrete control structure overflow section will be raised in phases once the crest of the dam has reached el. 2,050.

(a) Phase I (***)

At this point, concrete stop logs will be placed upstream of the control structure at a spillway end bay, bearing on the pier nose, and in a slot in the abutment wall. The water will be evacuated from the area between the stop logs and the radial gate prior to the removal of the gate for reuse when the concrete in the bay is at its final level. The remaining two bays, with increased reservoir surcharges, will provide sufficicent capacity to pass extreme flood events. Concrete will be placed in the initial bay to el. 2,014.

(b) Phase II (***)

A second bay will be closed when the dam crest is no less than el. 2,080 and the process indicated in (a) will be repeated. Concrete placement in the second bay will terminate upon reaching el. 2,014.

(c) Phase III(***)

The third and last bay will be closed when the dam crest elevation is no less than el. 2,100 and the initial process indicated in (a) will be repeated. Extreme flood events will be passed over the stop logs of the bay under

construction and incomplete crest at el. 2,014. Once concrete placement in the third bay reaches el. 2,014, concrete placement will begin in the other two bays.

(d) Phase IV (***)

During the final phase of concreting, placement will be in all bays allowing a more or less uniform raising of the concrete structure. The radial gates and bridge structure will be places once again in position on the raised structure.

11.6.2 - Spillway Gates and Stop Logs (***)

This equipment and arrangement is the same as that of Stage I which is described in 1.6.2.

11.6.3 - Spillway Chute (***)

The Stage III control structure will transition to the inclined Stage I chute which is described in 1.6.3.

11.6.4 - Flip Bucket (***)

There are no changes to the Stage I flip bucket described in 1.6.4.

11.6.5 - Access (***)

The deep cuts in rock required for access in Stage I will be filled with impervious material on the abutment side of the spillway and topped out with a roadway surface which follows the Stage I horizontal access road alignment. The south spillway abutment will be joined by the Stage III dam embankment.

11.7 - Power Intake (***)

11.7.1 - Intake Structures (***)

The Stage I intake structures Nos. 1 and 2 serving generating Units 1 to 4 will be raised and an intake structure adjacent to Intake No. 2 will be constructed (see Plate F83). The foundation for the new intake structure is at el. 2,002. Both the new intake and the Stage I intakes will be raised simultaneously while maintaining the Stage I generating requirements. The new intake will be provided with four pairs of openings in its upstream wall, all of which can be closed-off with sliding steel shutters. In the Stage I intakes, which are being raised, the

pattern and spacing of pairs of openings will be the same as in the new intake. All openings will be protected by trashracks upstream of the shutter openings . A heated boom will operate in guides upstream from the racks following the water surface, keeping the racks ice free.

The reservoir fluctuation in Stage III will be 120 feet from the reservoir el. 2,185. The upper level of the intake structures will be el. 2,201. Mechanical equipment will be housed at this level in a steel frame building. Part will have been removed from the Stage I deck, and the remainder will be a new extension for Intake No. 3.

11.7.2 - Approach Channel (***)

There are no changes to the Stage I approach channel described in 1.8.2. Due to the substantially increased depth of flow in the approach channel, the velocities of flow during normal and extreme conditions will be less than that of Stage I for the same conditions.

11.7.3 - Mechanical Arrangement (***)

(a) Ice Boom (***)

A heated boom will be installed in the guides immediately upstream of the trashracks of intake No. 3. The heated booms of intakes No. 1 and 2 will rise in the structures guides as the reservoir is filled minimizing ice accumulation on the trashrack and intake shutters.

(b) Trashracks (***)

The intake structure No. 3 will have four sets of trashracks, each set will consist of a pair of trashracks divided in two sections to facilitate handling by the intake service crane. Each set of trashracks will cover two openings 24 feet wide by 25 feet high. The trashracks will have a bar spacing of 6 inches and will be designed for a maximum differential head of 20 feet.

For Intake Structures No. 1 and 2 the trashracks will be transferred from the lower level to the upper four openings of the Stage III addition. These trashracks will be designed in accordance with the criteria indicated above.

(c) Intake Shutters (***)

Three sets of intake shutters will be installed in each of the new intake No. 3 and the raised intakes Nos. 1 and 2

to prevent flow through the openings behind which the shutter will be installed. As the reservoir level changes, the sliding shutters will be removed or replaced as necessary using the intake service crane.

Each of the shutters will be designed for a differential head of 15 feet, and will incorporate a flap gate. This will prevent failure of the shutters in the event of an accidental blockage of all intake openings.

The shutter guides will be heated to facilitate removal in sub-freezing weather. In addition, a bubbler system will be provided in the intake behind the shutters to keep the intake structure water surface free of ice.

(d) Intake Service Crane (***)

The overhead traveling-bridge type intake service crane used in Stage I will be transferred to the Stage III deck where the crane runway will be extended to cover Intake No. 3. The crane will be used for:

- o Servicing the ice boom and ice boom hoist,
- o Handling and cleaning the trashracks,
- o Handling the intake shutters,
- o Handling the intake bulkhead gates, and
- o Servicing the intake gate and hoist.

The overhead crane will have a double point lift and followers for handling the trashrack shutters and bulkhead gates. The crane will be radio-controlled with a pendant or cab control for backup.

(e) Intake Bulkhead Gates (***)

The set of bulkhead gates provided to close the Stage I intakes will also be used for the Stage III Intake No. 3. The bulkhead gates will be used to permit inspection and maintenance of the intake gate and intake gate guides. The gates will be designed to withstand maximum differential pressure that will occur in No. 1 and 2 intakes.

(f) Intake Gates (***)

Intake gates will be provided to close the two No. 3 intake openings which are 12 feet wide by 24 feet high. The gates and operation thereof will be similar to the Stage I intake gates described in 1.8.3(f), although by virtue of the intakes vertical location the design head will be substantially reduced.

11.8 - Power Tunnel and Penstocks (***)

The general arrangement of the Stage III power tunnel and penstocks is shown on Plate F76. There are no changes to the Stage I arrangement. A single power tunnel from Intake No. 3 which bifurcates to penstocks is provided to convey water to each of the two new generating units. The power tunnel and penstocks will have a minimum concrete lining thickness of 18 inches and the penstock will be steel lined in the 200 foot reach immediately upstream of the powerhouse cavern.

11.8.1 - Steel Liner (***)

The description of criteria and parameters presented in 1.9.1 is also valid for Stage III.

11.8.2 - Concrete Lining (***)

The description presented in 1.9.2 is also valid for Stage III.

11.8.3 - Grouting and Pressure Relief System (***)

The comprehensive pressure relief system, established in Stage I, to protect the underground caverns against seepage from the high pressure penstock will be continued to provide protection for the extended caverns. This system comprised small diameter bore holes set out to intercept the jointing in the rock. A grouting and drainage gallery previously constructed in Stage I will provide the origin for this system.

11.9 - Powerhouse (***)

The existing Stage I powerhouse complex beneath the north abutment of the dam will be extended in Stage III towards the river to accommodate two additional generating units. This will require rock excavation in three caverns - the powerhouse, transformer gallery, and surge chamber - and interconnecting tunnels for the draft tubes, isolated phase bus ducts and tailrace.

The general layout of the powerhouse complex is shown in Plates F86 to F89.

11.9.1 - Access Tunnels and Shafts (***)

Except for a cross adit to be excavated from diversion tunnel No. 2 to the adjacent penstock construction adit, no additional access tunnels or shafts will need to be excavated in Stage III.

11.9.2 - Powerhouse Cavern (***)

The main powerhouse cavern extension will accommodate two additional vertical-shaft Francis turbines, with direct coupling to synchronous generators. Each unit will have a maximum output capability of 200 MW. The maximum output capabilities of the four Stage I turbines will also be increased to 200 MW due to the increased reservoir head.

The cavern extension will allow for the 60-foot long unit 5 and 6 monolith, and a 40-foot long laydown bay at the south end.

The two additional units will be separated form the existing units by a 69-foot long rock pillar, through which a drainage tunnel will have been excavated during Stage I construction. Multiple stairway access points will be available from the main generator floor to each gallery level. Additional access to the transformer gallery will be provided by stairway through a third isolated phase bus tunnel.

11.9.3 - Transformer Gallery (***)

The unit 5 and 6 transformers will be located underground in an extension of the transformer gallery, which is located 120 feet upstream from the powerhouse cavern. A third connecting tunnel will be added for the isolated phase bus. There will be three single-phase transformers rated at 15-345/1.73 kV, 150 MVA for the two generating units. Generator circuit breakers will be installed in the powerhouse on the generator floor level. The transformer gallery extension will be 45 feet wide, 20 feet high and 106 feet long; the bus tunnel will be 16 feet wide and 16 feet high.

A third station service auxiliary transformer (2 MVA) will be located in the isolated-phase bus tunnel.

Vehicle access to the transformers gallery will be by the existing main powerhouse access tunnel at the south end. Pedestrian access will be from the existing main access shaft or through each of the three isolated phase bus tunnels.

11.9.4 - Surge Chamber (***)

The surge chamber located 120 feet downstream form the powerhouse cavern, will be extended by the length of the powerhouse service bay, and by the two additional unit bays, for a total extension of 215 feet. The runway for the existing crane will be extended to allow access for placement of the stoplogs for a second trailrace tunnel.

11.9.5 - Grouting and Pressure Relief System (***)

Additional drain and grout holes will be drilled from the previously constructed adit, and from the cavern extension.

11.9.6 - SF_6 Gas Insulated Bus Shaft (***)

No additional SF_6 GIS will be required.

11.9.7 - Draft Tube Tunnels (***)

A 19-foot diameter tunnel will be constructed for each of the two additional generating units.

11.10 - Trailrace (***)

A second tailrace pressure tunnel will be provided to carry water from the surge chamber to the river. This second tunnel will also be a modified horseshoe cross section with a major internal dimension of 34 feet. It will connect the southern end of the surge chamber extension to the existing Division Tunnel No. 2, and will incorporate the cross adits between the penstock construction adit and the diversion tunnel which has to be provided for Stage III penstock construction. It will connect the surge chamber extension to the existing Diversion Tunnel No. 2.

11.11 - Access Plan (***)

Project access during Stage III will be the same as developed and used for Stage I. The primary objective of access is to provide a transportation system that will support construction activities and allow for the orderly development and maintenance of site facilities. The access plan is discussed in Section 1.12.

11.12 - Site Facilities (***)

Stage I site facilities will be used during Stage III, and are as described in Section 1.13.

11.13 - Relict Channel (***)

A relict channel exists on the north bank of the reservoir approximately 2,600 feet upstream from the dam. This channel runs from the Susitna River gorge to Tsusena Creek, a distance of about 1.5 miles. The surface elevation of the lowest saddle is approximately 2,205, and depths of up to 454 feet of glacial deposits have been identified.

To ensure the integrity of the rim of the Watana Reservoir and to control losses due to potential seepage, a number of conditions have

been evaluated. Study types include settlement of the reservoir rim, subsurface flows, permafrost and liquefaction during earthquakes.

11.13.1 - Surface Flows (***)

Based on information gained from past exploration programs, the relict channel soils are either dense or cohesive and as such are not deemed to be subject to settlement resulting for seismic shaking. Therefore, the low ground surface in the area will more than provide adequate freeboard as it is several feet above the Stage III dam crest which is at el. 2,205.

11.13.2 - Subsurface Flows (***)

The potential for progressive piping and erosion in the area of discharge into the Tsusena Creek will be controlled by continuous monitoring of the outlet area, undertaken for a lengthy period after Stage I reservoir filling, to ensure that a state of equilibrium has been established with respect to permafrost and seepage gradients in the buried channel area.

If seepage through the alluvium is found to be excessive during or following Stage I impoundment, or becomes excessive following Stage III impoundment, a "worst case" provision has been made to construct a slurry trench cutoff through the upstream alluvium at the narrow throat of the relict channel. A sufficient allowance has been made in the Watana construction cost for such cutoff construction and additional seepage pressure reduction measures.

11.13.3 - Permafrost (***)

The permafrost discussion in Section 1.14.3 for Stage I is applicable to Watana Stage III.

11.13.4 - Liquefaction (***)

Liquefaction was discussed in Section 1.14.4 for Stage I. No additional geotechnical investigations of the relict channel are foreseen during Stage III.

11.13.5 - Remedial Work Influence on Construction Schedules (***)

Relict channel remedial treatment construction work, if necessary, will have pratically no impact on the Watana Dam Stage III construction schedule. Because the relict channel work will be located near Borrow Site D, some coordination will be required between these two operations. Once this coordination has been accomplished, dam construction and the relict channel work can be concurrently accomplished.

11.13.6 - Relict Channel Treatment Summary (***)

Early concerns regarding the critical impact of the relict channel on the Watana project appear to be unfounded. Nevertheless, some uncertainties still exist and, therefore, costs ($57.1 million) for responding to the unknown concerns have been included in the Watana cost estimates for Stages I and III.

During design investigations, additional boreholes and inspection trenches will be employed to further delineate the relict channel foundation. The area will be studied during Borrow Site D excavation. The area will also be thoroughly monitored by observation devices during Stage I reservoir filling and operation, and Stage III reservoir filling to assess actual hydrological conditions in the relict channel.

Based on existing knowledge, the only remedial measures that may possibly be needed for the relict channel involve seepage control. To satisfy project feasibility until future exploration indicate that no seepage problems exist within the buried channels ("K" unit), costs ($51.0 million) have been included in Stage III for a positive seepage cutoff similar to an I.C.O.S. wall. The slurry trench would be in combination with a downstream toe drain. Should future design studies and investigations so indicate, a less conservative design will be considered.

12 - Reservoir Data - Watana Stage III (***)

The Watana Reservoir, at a normal operating level at el. 2,185 feet, will be approximately 48 miles long with a maximum width in the order of 5 miles. The total water surface area at normal operating level is 38,000 acres. The minimum reservoir level will be at el. 2,065 feet during normal operation, resulting in a maximum drawdown of 120 feet. The reservoir will have a total capacity of 9.5 million acre-feet, of which 3.7 million acre-feet will be live storage.

13 - Turbines and Generators - Watana - Stage III (***)

13.1 - Unit Capacity (***)

The Watana powerhouse will have six generating units: the four from Stage I and two additional units installed in Stage III. The maximum generator output of all six units will be 200 MW corresponding to the maximum normal reservoir level (el. 2,185), and a corresponding head of 719 feet. The net head on the plant will very from 600 feet to 719 feet. the turbine design net head of the two new units has been established at 680 feet.

The generator rating is the same as for the Stage I units (Section 3.1). Unit characteristics including generator outputs are described in Table F.1.

13.2 - Turbines (***)

The two additional turbines for Stage III will be of the vertical shaft Francis type, with steel spiral casing and a steel lined concrete elbow-type draft tube. The draft tube will comprise a single water passage without a center pier. These two turbines will be identical. These two turbines will also be identical to the Stage I turbines except for the design head selection. The design head is the head selected for optimum efficiency of operation. The narrower range of operating heads in Stage III will permit selection of a design head at the ultimate average operating head.

The rated output of each turbine will be approximately 174 MW at 645 feet rated net head. Maximum and minimum net operating heads on the units will be 719 feet and 600 feet, respectively. The full gate output of each turbine will be about 204 MW at 719 feet net head and 155 MW at 600 feet net head. Each turbine will be provided with a 12.5-foot diameter, straight flow-type butterfly valve. These guard valves will be located within the powerhouse just upstream of the turbines.

13.3 - Generators (***)

The generators for Stage III will be identical to the generators for Stage I. Type, rating, and excitation equipment are described in Section 3.3 - Generators.

13.4 - Governor System (***)

The governing systems for Stage III will be identical to the governing system for Stage I, as described in Seciton 3.4 - Governor System.

14 - Appurtenant Mechanical and Electrical Equipment - Watana Stage III (***)

14.1 - Miscellaneous Mechanical Equipment (***)

The mechanical service systems required for Stage III will be essentially the same as those installed under Stage I, described in Section 4.1.6 - Power Plant Mechanical Service Systems. On a unit basis, water will be provided for generator air coolers, turbine and generator bearing coolers transformers, and turbine shaft seals. The capacities of powerhouse systems common to all units will be increased as required, with piping and duct work extended to provide service to the new units.

14.2 - Accessory Electrical Equipment (***)

The accessory electrical equipment required for Stage III will be identical to those supplied for Stage I, described in Section 4.2 - Accessory Electrical Equipment.

15 - TRANSMISSION FACILITIES - WATANA STAGE III (***)

The raising of the Watana Dam during Stage III and, consequently, the upgrading of Watana generation, will require a third transmission line from the Gold Creek Switchyard to the Willow Substation and from Willow to the Knik Arm Substation.

The additional Stage III transmission line will use the existing corridor (refer to Plate F98, Exhibit F).

15.1 - Transmission Requirements (***)

Between Gold Creek and Knik Arm switching stations, a third 345 kV single-circuit line will be built parallel to the two Watana lines. The crossing of Knik Arm will be by cable with a similar arrangement to the original two circuits. At Willow switching station, four 345 kV breakers will be added, one in an existing bay, the rest in a new bay. These handle the new line and allow the installation of a third 75 MVA transformer for local supply, if required. Similarly, at Knik Arm switching station, a breaker will be installed in an existing bay to receive the incoming Watana line. Between the Knik Arm and University stations, the lines built for Watana were sized to accommodate the Devil Canyon need in order to limit right-of-way requirements. At University an additional transformer bank at each of 230 kV and 115 kV levels will be provided; this will involve the addition of two breakers in existing bays. At the Ester substation in Fairbanks, an additional 150 MVA transformer bank will be installed to serve the local load; this will require one new breaker in an existing bay.

15.2 - Switching and Substations (***)

The following substation additions will be required as part of Watana Stage III:

15.2.1 - Watana Switchyard (***)

The additional generating units at Watana require a determination in the switchyard. Circuit breakers will be added to provide this termination. The additional breakers will convert the ring bus arrangement, installed during Stage I construction, into a breaker-and-a-half substation.

15.2.2 - Gold Creek Switchyard (***)

Termination of the Stage III transmission line will be required. This termination will be achieved with the addition of necessary circuit breakers, and associated facilities.

15.2.3 - Ester Substation (***)

An additional 150 MVA transformer bank will be installed. The transformer will step-down voltage to 138 kV, and will include a circuit breaker for termination of the transformer. The added transformer will provide additional power at 138 kV for distribution by Golden Valley Electric Association. The transformer bank will have 13.8 kV tertiary windings for connection of static var compensation (SVC) equipment. The SVC equipment will allow control of 138 kV bus voltage.

The circuit breakers for connection of the SVC equipment and for the connection to local transmission lines are also included.

15.2.4 - Willow Substation (***)

Terminations at this substation are for the additional Stage III transmission lines from Gold Creek and Knik Arm, and for an additional 345/138 kV 75 MVA three-phase transformer. This transformer will provide power at 138 kV for local transmission and distribution. The circuit breaker arrangement is based on a breaker-and-a-half arrangement.

15.2.5 - Knik Arm Substation (***)

The termination of the third transmission line from Willow will require installation of additional circuit breaker, disconnect switches, and shunt reactor. Addition of the transmission line termination will make the whole substation arrangement a breaker-and-a-half.

15.2.6 - University Substation (***)

The Stage III development will require the addition of two 250 MVA single- phase transformer banks. The circuit breakers for termination of the transformers will be added to the existing substation, and form a complete breaker-and-a-half arrangement. One transformer bank will step-down the voltage to 230 kV and the other to 115 kV. The power factor from the 230 kV line will be for distribution by CEA, and from the 115 kV bus by AMPL. Both transformer banks will have 13.8 kV tertiary windings for SVC equipment connections. Circuit breakers for SVC equipment connections and local transmission lines are included.

16 - LANDS OF THE UNITED STATES (**)

The Susitna Hydroelectric Project will include numerous parcels of federal land within the project boundary as defined in Exhibit G of this application. Ownership was verified using the Bureau of Land Management (BLM) Alaska Automated Land Record System which has an approximate accuracy of 70 percent. Ownership was further verified from BLM individual case files bringing the accuracy to 95 to 98 percent. The following is a tabulation of those lands with ownership and acreage. Included in the list of federal lands are both those lands which have been selected, but not yet conveyed to non-federal owners and those lands which have been selected by and conveyed to non-federal owners.

DAMSITES, QUARRYSITES AND RESERVOIR AREAS
(Federal Ownership)

SEWARD MERIDIAN, ALASKA

TOWNSHIP/Section	OWNER[a/]	PLATE	U.S. ACREAGE*	U.S. ACREAGE SELECTED AND ALREADY CONVEYED*[b/]
T31N,R1W				
Section 1	BLM (1)	G6	640.0	0
Section 2	BLM (1)	G6	640.0	0
T32N,R1W				
Section 35	Knikatnu	G6	0	320.0
Section 36	CIRI	G6	0	28.5
T31N,R1E				
Section 1	CIRI	G7	0	235.5
Section 2	CIRI	G7	0	340.7
Section 3	CIRI	G7	0	376.5
Section 4	CIRI	G6&G7	0	188.2
Section 5	CIRI	G6	0	19.4
Section 6	BLM (1)	G6	607.4	0
Section 7	BLM (1)	G6	152.1	0
Section 8	BLM (1)	G6	160.0	0
Section 9	BLM (1)	G6	60.0	0
Section 10	BLM (1)	G7	00.6	0
Section 11	BLM (1)	G7	00.5	0

* Areas shown are true areas at elevation.

a/ Land Owner

(1) Selected by Cook Inlet Region Incorporated

(2) Partially selected by Cook Inlet Region Incorporated

(3) Selected by Ninilchik Native Association, Inc; Salamatoff Native Association, Inc.; Seldovia Native Association, Inc.; Tyonek Native Corporation; Knikatnu, Inc.; Alexander Creek, Inc.; and Chickaloon-Moose Creek Native Association, Inc.

(4) Selected by State of Alaska

b/ Lands selected by Cook Inlet Region Inc. are subjected to being conveyed at any time.

DAMSITES, QUARRYSITES AND RESERVOIR AREAS (Cont'd)

TOWNSHIP/Section	OWNER	PLATE	U.S. ACREAGE	U.S. ACREAGE SELECTED AND ALREADY CONVEYED*
T32N,R1E				
Section 31	CIRI	G6	0	264.4
Section 32	Knikatnu	G6	0	370.0
Section 33	CIRI	G6&G7	0	251.8
Section 34	BLM (1)	G7	22.9	0
T31N,R2E				
Section 1	Tyonek	G8	0	189.3
Section 4	BLM (1)	G7&G8	137.4	0
Section 5	CIRI	G7	0	200.2
Section 6	CIRI	G7	0	275.0
Section 7	BLM (1)	G7	57.9	0
Section 8	BLM (1)	G7	00.7	0
Section 12	Tyonek	G8	0	197.1
Section 13	CIRI	G8&G9	0	207.5
Section 24	BLM (1)	G9	07.4	0
T32N,R2E				
Section 22	BLM (1)	G8	00.2	0
Section 27	BLM (1)	G8	51.2	0
Section 31	BLM (3)	G7	01.1	0
Section 32	Knikatnu	G7	0	48.0
Section 33	Knikatnu	G7&G8	0	222.3
Section 34	Tyonek	G8	0	176.6
Section 35	Tyonek	G8	0	161.8
Section 36	Tyonek	G8	0	120.9
T31N,R3E				
Section 13	BLM (1)	G10	43.4	0
Section 14	BLM (1)	G10	97.8	0
Section 15	BLM (1)	G10	108.8	0
Section 16	BLM (1)	G10	17.2	0
Section 17	BLM (1)	G9&G10	59.9	0
Section 18	CIRI	G9	0	148.0
Section 19	CIRI	G9	0	157.9
Section 20	CIRI	G9&G10	0	149.3
Section 21	CIRI	G10	0	226.2

DAMSITES, QUARRYSITES AND RESERVOIR AREAS (Cont'd)

TOWNSHIP/Section	OWNER	PLATE	U.S. ACREAGE	U.S. ACREAGE SELECTED AND ALREADY CONVEYED*
T31N,R3E (Cont.)				
Section 22	Knikatnu	G10	0	148.0
Section 23	CIRI	G10	0	201.0
Section 24	Tyonek	G10	0	323.4
T31N,R4E				
Section 2	CIRI	G12	0	51.7
Section 3	CIRI	G11&G12	0	268.6
Section 9	BLM (1)	G11	38.3	0
Section 10	CIRI	G11	0	0
Section 15	CIRI	G11	0	300.0
Section 16	CIRI	G11	0	95.6
Section 18	BLM (1)	G10	00.2	0
Section 19	CIRI (3)	G10	0	374.4
Section 20	CIRI	G10&G11	0	445.7
Section 21	CIRI	G11	0	391.5
Section 29	BLM (1)	G10&G11	02.7	0
T32N,R4E				
Section 25	CIRI	G12	0	32.6
Section 26	BLM (3)	G12	225.0	0
Section 34	BLM (1)	G12	130.0	0
Section 35	Tyonek	G12	0	388.0
Section 36	Tyonek	G12	0	262.9
T31N,R5E				
Section 3	BLM (1)	G13&G15	420.0	0
Section 4	BLM (1)	G13	480.0	0
Section 5	BLM (1)	G13	360.0	0
T32N,R5E				
Section 13	BLM (3)	G16	60.0	0
Section 14	BLM (3)	G16	260.0	0
Section 15	BLM (3)	G14&G16	400.0	0
Section 16	BLM (3)	G14	330.0	0
Section 17	BLM (3)	G14	30.0	0
Section 19	BLM (3)	G13&G14	160.0	0
Section 20	BLM (3)	G13&G14	560.0	0
Section 21	BLM (3)	G13&G14	640.0	0

DAMSITES, QUARRYSITES AND RESERVOIR AREAS (Cont'd)

TOWNSHIP/Section	OWNER	PLATE	U.S. ACREAGE	U.S. ACREAGE SELECTED AND ALREADY CONVEYED*
T32N,R5E (Cont.)				
Section 22	BLM (3)	G13,14,15	640.0	0
Section 23	BLM (3)	G15&G16	631.1	0
Section 24	BLM (3)	G10&G11	75.2	0
Section 25	BLM (1)	G15	560.3	0
Section 26	Knikatnu	G15	0	372.2
Section 27	Knikatnu	G13&G15	0	238.3
Section 28	CIRI	G13	0	47.3
Section 29	BLM (3)	G13	640.0	0
Section 30	Tyonek	G13	0	38.1
Section 31	Tyonek	G13	0	127.7
Section 32	Tyonek	G13	0	196.5
Section 33	Tyonek	G13	0	204.3
Section 34	BLM (1)	G13&G15	598.4	0
Section 35	BLM (1)	G15	303.5	0
Section 36	BLM (1)	G15	329.3	0
T31N,R6E				
Section 1	BLM (1)	G17	233.8	0
Section 2	BLM (1)	G17	01.9	0
T32N,R6E				
Section 2	BLM (3)	G18	09.3	0
Section 3	BLM (3)	G18	01.0	0
Section 10	BLM (3)	G18	201.0	0
Section 11	BLM (3)	G18	70.6	0
Section 13	BLM (3)	G18	482.3	0
Section 14	BLM (3)	G18	243.2	0
Section 15	BLM (3)	G18	507.2	0
Section 16	BLM (3)	G18	00.7	0
Section 21	BLM (3)	G15,16,18	162.5	0
Section 22	BLM (3)	G17&G18	640.0	0
Section 23	BLM (3)	G17&G18	640.0	0
Section 24	BLM (3)	G17&G18	640.0	0
Section 25	BLM (1)	G17	640.0	0
Section 26	BLM (1)	G17	640.0	0
Section 27	BLM (1)	G17	640.0	0
Section 28	BLM (1)	G15&G17	630.2	0
Section 29	BLM (1)	G15	496.0	0
Section 30	BLM (3)	G15	382.2	0
Section 31	BLM (1)	G15	333.6	0

DAMSITES, QUARRYSITES AND RESERVOIR AREAS (Cont'd)

TOWNSHIP/Section	OWNER	PLATE	U.S. ACREAGE	U.S. ACREAGE SELECTED AND ALREADY CONVEYED*
T32N,R6E (Cont.)				
Section 32	BLM (1)	G15	256.1	0
Section 33	BLM (1)	G15&G16	184.9	0
Section 34	BLM (1)	G17	257.8	0
Section 35	BLM (1)	G17	396.5	0
Section 36	BLM (1)	G17	633.3	0
T31N,R7E				
Section 1	BLM (1)	G19	338.0	0
Section 2	BLM (1)	G19	634.4	0
Section 3	BLM (1)	G19	629.8	0
Section 4	BLM (2)	G17&G19	495.8	0
Section 5	BLM (1)	G17	332.4	0
Section 6	BLM (1)	G17	302.3	0
Section 10	BLM (3)	G19	88.1	0
Section 11	BLM (2)	G19	311.4	0
Section 12	BLM (2)	G19	621.8	0
Section 13	BLM (3)	G19	141.4	0
Section 14	BLM (3)	G19	01.1	0
T32N,R7E				
Section 3	BLM (3)	G20	246.4	0
Section 4	BLM (3)	G18&G20	160.7	0
Section 7	BLM (3)	G18	166.5	0
Section 8	BLM (3)	G18	331.0	0
Section 9	BLM (3)	G18&G20	517.5	0
Section 10	BLM (3)	G20	31.9	0
Section 16	BLM (3)	G18	141.8	0
Section 17	BLM (3)	G18	637.5	0
Section 18	BLM (3)	G18	563.9	0
Section 19	BLM (3)	G18	601.8	0
Section 20	BLM (3)	G17&G18	640.0	0
Section 21	BLM (3)	G17,G18&G20	391.6	0
Section 22	BLM (3)	G19&G20	60.7	0
Section 27	BLM (3)	G19	174.4	0
Section 28	BLM (3)	G17&G19	624.1	0

DAMSITES, QUARRYSITES AND RESERVOIR AREAS (Cont'd)

TOWNSHIP/Section	OWNER	PLATE	U.S. ACREAGE	U.S. ACREAGE SELECTED AND ALREADY CONVEYED*
T32N,R7E (Cont.)				
Section 29	BLM (3)	G17	640.0	0
Section 30	BLM (1)	G17	605.5	0
Section 31	BLM (1)	G17	640.5	0
Section 32	BLM (2)	G17	640.0	0
Section 33	BLM (3)	G17&G19	640.0	0
Section 34	BLM (3)	G19	423.5	0
Section 35	BLM (3)	G19	53.5	0
Section 36	BLM (3)	G19	11.0	0
T33N,R7E				
Section 27	BLM (4)	G21	80.2	0
Section 28	BLM (4)	G21	40.0	0
Section 33	BLM (4)	G20&G21	74.0	0
Section 34	BLM (4)	G20&G21	182.9	0
T30N,R8E				
Section 4	BLM (3)	G23	08.2	0
T31N,R8E				
Section 1	BLM (3)	G24	56.9	0
Section 7	BLM (3)	G19	386.4	0
Section 8	BLM (3)	G19&G24	535.0	0
Section 9	BLM (3)	G24	576.7	0
Section 10	BLM (3)	G24	372.9	0
Section 11	BLM (3)	G24	138.5	0
Section 12	BLM (3)	G24	287.9	0
Section 13	BLM (3)	G23&G24	598.6	0
Section 14	BLM (3)	G23&G24	612.2	0
Section 15	BLM (3)	G23&G24	640.0	0
Section 16	BLM (3)	G24&G23	280.3	0
Section 17	BLM (3)	G19,G22&G24	334.7	0
Section 18	BLM (3)	G19	353.1	0
Section 21	BLM (3)	G23	182.3	0
Section 22	BLM (3)	G23	248.9	0
Section 23	BLM (3)	G23	09.1	0
Section 24	BLM (3)	G23	55.1	0
Section 27	BLM (3)	G23	06.1	0
Section 28	BLM (3)	G23	245.8	0
Section 33	BLM (3)	G23	138.4	0

DAMSITES, QUARRYSITES AND RESERVOIR AREAS (Cont'd)

TOWNSHIP/Section	OWNER	PLATE	U.S. ACREAGE	U.S. ACREAGE SELECTED AND ALREADY CONVEYED*
T30N,R9E				
Section 1	BLM (3)	G26	143.0	0
Section 12	BLM (3)	G26	105.3	0
Section 13	BLM (3)	G26	05.8	0
T31N,R9E				
Section 6	BLM (3)	G24	49.2	0
Section 7	BLM (3)	G24	00.7	0
Section 17	BLM (3)	G24&G25	178.0	0
Section 18	BLM (3)	G23&G24	450.2	0
Section 19	BLM (3)	G23	175.3	0
Section 20	BLM (3)	G23&G24	432.8	0
Section 21	BLM (3)	G25	499.3	0
Section 22	BLM (3)	G25	267.1	0
Section 23	BLM (3)	G25	185.4	0
Section 25	BLM (3)	G25	280.1	0
Section 26	BLM (3)	G25	316.2	0
Section 27	BLM (3)	G25	309.3	0
Section 28	BLM (3)	G25	107.8	0
Section 36	BLM (3)	G25&G26	408.1	0
T30,R10E				
Section 6	BLM (3)	G26	216.0	0
Section 7	BLM (3)	G26&G27	389.3	0
Section 8	BLM (3)	G27	313.7	0
Section 9	BLM (3)	G27	170.8	0
Section 10	BLM (3)	G27	96.4	0
Section 11	BLM (3)	G27	312.9	0
Section 12	BLM (3)	G27	254.6	0
Section 13	BLM (3)	G27	120.2	0
Section 14	BLM (3)	G27	105.1	0
Section 15	BLM (3)	G27	251.1	0
Section 17	BLM (3)	G27	77.9	0
T31N,R10E				
Section 31	BLM (3)	G26&G27	143.2	0

DAMSITES, QUARRYSITES AND RESERVOIR AREAS (Cont'd)

TOWNSHIP/Section	OWNER	PLATE	U.S. ACREAGE	U.S. ACREAGE SELECTED AND ALREADY CONVEYED*
T29N,R11E				
Section 1	BLM (3)	G29	45.2	0
Section 2	BLM (3)	G29	199.2	0
Section 3	BLM (3)	G29	222.6	0
Section 4	BLM (3)	G29	68.2	0
Section 5	BLM (3)	G29	176.6	0
Section 6	BLM (3)	G29	135.3	0
Section 9	BLM (3)	G29	00.4	0
Section 10	BLM (3)	G29	204.5	0
T30N,R11E				
Section 7	BLM (3)	G27&28	293.8	0
Section 8	BLM (3)	G28	01.8	0
Section 17	BLM (3)	G28	241.0	0
Section 18	BLM (3)	G27&G28	280.4	0
Section 20	BLM (3)	G28	445.9	0
Section 21	BLM (3)	G28	00.9	0
Section 25	BLM (3)	G29	21.2	0
Section 28	BLM (3)	G28&G29	177.9	0
Section 29	BLM (3)	G28&29	480.0	0
Section 32	BLM (3)	G29	482.7	0
Section 33	BLM (3)	G29	437.3	0
Section 34	BLM (3)	G29	640.0	0
Section 35	BLM (3)	G29	471.8	0
Section 36	BLM (3)	G29	35.6	0
TOTAL			61,628.0±	7,430±

ELECTRICAL TRANSMISSION LINE CORRIDOR RIGHT-OF-WAY ACREAGES
(Federal Ownership)

SEWARD MERIDIAN, ALASKA

TOWNSHIP/Section	OWNER	PLATE	U.S. ACREAGE*	U.S. ACREAGE SELECTED AND ALREADY CONVEYED
T13N,R2W				
Section 4	U.S. Army	G30	10.21	0
Section 5	U.S. Army	G30	35.51	0
Section 7	U.S. Army	G30	37.20	0
Section 8	U.S. Army	G30	06.36	0
Section 18	U.S. Army	G30	30.68	0
Section 19	U.S. Army	G30	30.66	0
Section 30	U.S. Army	G30	30.31	0
Section 31	U.S. Army	G30	04.46	0
T14N,R2W				
Section 19	U.S. Army	G30	33.66	0
Section 20	U.S. Army	G30	31.36	0
Section 21	U.S. Army	G30	38.29	0
Section 22	U.S. Army	G30	03.06	0
Section 28	U.S. Army	G30	31.12	0
Section 33	U.S. Army	G30	36.52	0
T14N,3W				
Section 9	U.S. Army	G30	19.56	0
Section 10	U.S. Army	G30	33.29	0
Section 11	U.S. Army	G30	05.31	0
Section 13	U.S. Army	G30	14.15	0
Section 14	U.S. Army	G30	44.50	0
Section 24	U.S. Army	G30	24.64	0
T31N,1W				
Section 3	BLM (3)	G39	62.74	0
Section 4	BLM (3)	G39	54.77	0
Section 5	BLM (3)	G39	62.74	0
Section 6	BLM (3)	G39	61.36	0
T32N,R1E				
Section 13	BLM (3)	G39	11.77	0
Section 23	BLM (3)	G39	34.22	0
Section 24	BLM (3)	G39	33.23	0
Section 26	BLM (3)	G39	07.35	0

ELECTRICAL TRANSMISSION LINE CORRIDOR
RIGHT-OF-WAY ACREAGES (Cont'd)

TOWNSHIP/Section	OWNER	PLATE	U.S. ACREAGE*	U.S. ACREAGE SELECTED AND ALREADY CONVEYED
Section 27	BLM (3)	G39	38.03	0
Section 28	BLM (3)	G39	38.03	0
Section 29	BLM (3)	G39	37.95	0
Section 30	BLM (3)	G39	02.70	0
T32N,R2E				
Section 3	BLM (3)	G39	41.90	0
Section 4	BLM (3)	G39	20.02	0
Section 8	BLM (3)	G39	36.99	0
Section 9	BLM (3)	G39	24.88	0
Section 17	BLM (3)	G39	07.91	0
Section 18	BLM (3)	G39	42.13	0
T33N,R2E				
Section 25	BLM (4)	G40	34.20	0
Section 34	BLM (4)	G40	09.28	0
Section 35	BLM (4)	G40	44.90	0
Section 36	BLM (4)	G40	07.81	0
T32N,R3E				
Section 2	BLM (3)	G40	19.69	0
Section 3	BLM (3)	G40	37.52	0
Section 11	BLM (3)	G40	22.42	0
Section 12	BLM (3)	G40	40.01	0
T32N,R4E				
Section 7	BLM (3)	G40	34.69	0
Section 8	BLM (3)	G40	15.67	0
Section 13	BLM (3)	G40	37.10	0
Section 14	BLM (3)	G40	37.10	0
Section 15	BLM (3)	G40	35.22	0
Section 16	BLM (3)	G40	37.10	0
Section 17	BLM (3)	G40	21.43	0
T32N,R5E				
Section 18	BLM (3)	G40	16.45	0
Section 19	BLM (3)	G40	20.47	0
Section 20	BLM (3)	G40	07.68	0
SEWARD MERIDIAN SUB-TOTAL			1,598.31±	

ELECTRICAL TRANSMISSION LINE CORRIDOR
RIGHT-OF-WAY ACREAGES (Cont'd)

FAIRBANKS MERIDIAN, ALASKA

TOWNSHIP/Section	OWNER	PLATE	U.S. ACREAGE*	U.S. ACREAGE SELECTED AND ALREADY CONVEYED
T12S,R7W				
Section 7	AK R.R.	G46	0	43.77
Section 17	AK R.R.	G46	0	15.71
Section 18	AK R.R.	G46	0	14.52
T7S,R8W				
Section 24	USAF	G48	23.27	0
Section 25	USAF	G48	51.86	0
Section 26	USAF	G48	51.86	0
T7S,R7W				
Section 5	USAF	G48	48.93	0
Section 6	USAF	G48	02.76	0
Section 7	USAF	G48	51.36	0
Section 8	USAF	G48	00.50	0
Section 18	USAF	G48	51.86	0
Section 19	USAF	G48	28.59	0
T6S,R7W				
Section 4	BLM (4)	G49	49.43	0
Section 9	BLM (4)	G49	48.70	0
Section 16	BLM (4)	G49	48.25	0
Section 17	BLM (4)	G49	00.45	0
Section 20	BLM (4)	G49	34.86	0
Section 21	BLM (4)	G49	13.81	0
Section 29	BLM (4)	G49	49.63	0
Section 32	BLM (4)	G49	51.78	0
FAIRBANKS MERIDIAN SUB-TOTAL			681.90±	
TOTAL			2,280.21±	

ACCESS CORRIDOR RIGHT-OF-WAY ACREAGES
(Federal Ownership)

FAIRBANKS MERIDIAN, ALASKA

TOWNSHIP/Section	OWNER	PLATE	U.S. ACREAGE*	U.S. ACREAGE SELECTED AND ALREADY CONVEYED
T18S,R4W				
Section 16	BLM	G53	19.80	0
Section 21	BLM	G53	24.74	0
Section 22	BLM	G53	00.23	0
Section 27	BLM	G53	02.09	0
Section 28	BLM	G53	23.43	0
Section 33	BLM	G53	20.00	0
Section 34	BLM	G53	06.41	0
T19S,R4W				
Section 4	BLM	G53	29.59	0
Section 5	BLM	G53	06.41	0
Section 8	BLM	G53	29.94	0
Section 16	BLM	G53	20.70	0
Section 17	BLM	G53	08.41	0
Section 21	BLM	G53	23.57	0
Section 22	BLM	G53	04.95	0
Section 27	BLM	G53	25.35	0
Section 34	BLM	G53	25.61	0
T20S,R4W				
Section 3	BLM	G53	25.35	0
Section 10	BLM	G53	26.73	0
Section 14	BLM	G53	18.93	0
Section 15	BLM	G53	08.25	0
Section 23	BLM	G53	22.64	0
Section 24	BLM	G54	12.48	0
Section 25	BLM	G54	24.86	0
Section 36	BLM	G54	24.97	0
T21S,R4W				
Section 1	BLM	G54	28.28	0
Section 11	BLM	G54	34.94	0
Section 12	BLM	G54	03.36	0
Section 14	BLM	G54	24.63	0
Section 23	BLM	G54	24.38	0
Section 26	BLM	G54	24.38	0

ACCESS CORRIDOR RIGHT-OF-WAY ACREAGES (Cont'd)

TOWNSHIP/Section	OWNER	PLATE	U.S. ACREAGE*	U.S. ACREAGE SELECTED AND ALREADY CONVEYED
Section 27	BLM	G54	00.11	0
Section 34	BLM	G54	25.30	0
Section 35	BLM	G54	01.00	0
T22S,R4W				
Section 3	BLM	G54	24.39	0
Section 10	BLM	G54	24.53	0
Section 15	BLM	G54	26.96	0
Section 16	BLM	G54	08.55	0
FAIRBANKS MERIDIAN SUB-TOTAL			686.25+	
SEWARD MERIDIAN, ALASKA				
T31N,R1W				
Section 3**	BLM (1)	G59	26.20	0
Section 4**	BLM (1)	G59	27.92	0
Section 5**	BLM (1)	G59	12.92	0
Section 6**	BLM (1)	G59	21.80	0
T32N,R1E				
Section 23	BLM (3)	G58	14.19	0
Section 24	BLM (3)	G58	27.63	0
Section 26	BLM (3)	G58	12.91	0
Section 27	BLM (3)	G58	29.85	0
Section 28	BLM (3)	G58	24.33	0
Section 29	BLM (3)	G58	13.52	0
T32N,R2E				
Section 2	BLM (3)	G57	15.01	0
Section 3	BLM (3)	G57	28.29	0
Section 4	BLM (3)	G57	06.29	0
Section 8	BLM (3)	G58	07.92	0
Section 9	BLM (3)	G57&G58	31.71	0
Section 17	BLM (3)	G58	21.70	0
Section 18	BLM (3)	G58	13.94	0
Section 19	BLM (3)	G58	13.94	0

ACCESS CORRIDOR RIGHT-OF-WAY ACREAGES (Cont'd)

TOWNSHIP/Section	OWNER	PLATE	U.S. ACREAGE*	U.S. ACREAGE SELECTED AND ALREADY CONVEYED
T33N,R2E				
Section 35	BLM (4)	G57	19.42	0
Section 36	BLM (4)	G57	26.34	0
T32N,R3E				
Section 2	BLM (3)	G57	01.15	0
Section 3	BLM (3)	G57	37.09	0
Section 11	BLM (3)	G57	28.62	0
Section 12	BLM (3)	G57	20.09	0
Section 13	BLM (3)	G57	07.22	0
T32N,4E				
Section 11	BLM (3)	G56	22.96	0
Section 12	BLM (3)	G56	16.60	0
Section 13	BLM (3)	G56	21.23	0
Section 14	BLM (3)	G56	10.80	0
Section 15	BLM (3)	G56	26.86	0
Section 16	BLM (3)	G57	24.72	0
Section 17	BLM (3)	G57	24.75	0
Section 18	BLM (3)	G57	24.45	0
T32N,R5E				
Section 3	BLM (3)	G56	47.60	0
Section 4	BLM (3)	G56	26.86	0
Section 5	BLM (3)	G56	28.06	0
Section 8	BLM (3)	G56	26.46	0
Section 10	BLM (3)	G56	25.32	0
Section 15	BLM (3)	G56	09.51	0
Section 17	BLM (3)	G56	09.62	0
Section 18	BLM (3)	G56	23.69	0
SEWARD MERIDIAN SUB-TOTAL			863.59+	
TOTAL			1,549.84+	

17 - REFERENCES

Commonwealth Associates Inc. 1982. Anchorage-Fairbanks Transmission Intertie Route Selection Report. Prepared for Alaska Power Authority, Anchorage, Alaska.

Harza-Ebasco Susitna Joint Venture. 1983. Watana Development Winter 1983 Geotechnical Exploration Program. Prepared for Alaska Power Authority, Anchorage, Alaska.

TABLES

TABLE A.1: PERTINENT PROJECT DATA (Page 1 of 4)

Item	Stage I Watana	Stage II[1] Devil Canyon	Stage III[1] Watana	Stage III[1] Devil Canyon
Hydrology				
- Average River Flow (cfs)	8,050	9,160	----	----
- Peak Flood Inflows (cfs)				
. PMF	326,000	358,000 with Watana 362,000 without Watana	----	339,000 with Watana 362,000 without Watana
. 10,000-year	174,000	184,000 without Watana	----	----
. 50-year	89,500	46,000 with Watana 94,800 without Watana	----	44,600 with Watana (Yr 2008) 35,300 with Watana (Yr 2020) 94,800 without Watana
. 25-year	79,800	44,600 with Watana 84,500 without Watana	----	43,200 with Watana (Yr 2008) 31,600 with Watana (Yr 2020) 84,500 without Watana
- Peak Flood Flows through the Dam (cfs)				
. PMF	302,300	351,000 with Watana	283,600	333,000 with Watana
. 50-year	34,000	42,000 with Watana	33,900	42,000 with Watana
Reservoir Characteristics				
- Normal Maximum Operating Level [3]	2,000	1,455	2,185	----
- Maximum Level, PMF [3]	2,017.1	1465.6	2,199.3	1,463.1
- Minimum Operating Level [3]	1,850	1,405	2,065	----
- Area at NMOL (acres)	19,900	7,800	38,000	----
- Length at NMOL (miles)	39	26	48	----
- Total Storage (acre-feet)	4.3×10^6	1.1×10^6	9.5×10^6	----
- Live Storage (acre-feet)	2.4×10^6	0.35×10^6	3.7×10^6	----
- Maximum Allowable Surcharge Level for 50-year Flood [3]	2,014	1,456	2,193	----
- Average Tailwater [3]	1,455	850	1,455	----
Project Outputs				
- Dependable Plant Capability (December-January) (MW)	360	600	1,020	----
- Nominal Plant Capability (MW) [4]	440	680	1,110	----
- Annual Generation (GWh)				
. Firm	1,950	4,490[2]	5,720[2]	
. Average	2,400	4,750[2]	6,900[2]	

N.A. - Not Applicable

1/ Watana Stage I data as shown applies both before and after construction of Devil Canyon, except where indicated for Stage III. Devil Canyon Stage II data, as shown, applies both before and after construction of Watana Stage III except where indicated otherwise for Stage III.

2/ Total generation from Watana and Devil Canyon.

3/ Contour elevation (feet above mean sea level)

4/ At average operating head

TABLE A.1 (Page 2 of 4)

Item	Stage I	Stage II[1/]	Stage III[1/]	
	Watana	Devil Canyon	Watana	Devil Canyon
Dams				
- Type	Earth/Rockfill, Inclined Core	Concrete Arch (Earth/Rockfill Saddle)	Earth/Rockfill Central Core	----
- Crest Elevation [3/]	2,027	1,463 (1472)	2,210	----
- Crest Length (ft)	2,700	1,650 (950)	4,100	----
- Height Above Foundation [3/]	702	646 (245)	885	----
- Crest Width (ft)	35	20 (35)	35	----
- Upstream Slope (H:V)	2.4:1	N.A. (2.4:1)	2.4:1	----
- Downstream Slope (H:V)	2:1	N.A. (2:1)	2:1	----
- Allowance for Settlement (ft)	2	0 (2)	5	----
- Top of Parapet [3/]	N.A.	1,466.0	N.A.	----
Diversion				
- Recurrence Interval of Design Flood (yrs)	50	25	N.A.	N.A.
- Cofferdams				
. Type	Earth & Rockfill	Earth & Rockfill	----	N.A.
. Upstream Crest Elevation [3/]	1,550	947	N.A.	N.A.
. Downstream Crest Elevation [3/]	1,495	898	1,495	N.A.
. Maximum U/S Water Level for Design Flood [3/]	1,532	944	----	----
- Tunnels				
. Number/Type	2 - Circular, Concrete-Lined	1 - Horseshoe, Concrete-Lined	N.A.	N.A.
. Diameter (ft)	36	35.5	N.A.	N.A.
. Capacity for Design Flood (cfs)	77,000	43,300	N.A.	N.A.
Outlet Facilities				
- Control Structures	6-Fixed Cone Valves	7-Fixed Cone Valves	6-Fixed Cone Valves	----
- Diameter (in)	78	4-102, 3-90	78	----
- Water Passage Diameter (ft)	28	8.5/7.5	28	----
- Capacity (cfs)	24,000	42,000	30,000	----

N.A. - Not Applicable

[1/] See first page of this Table.
[3/] See first page of this Table.

TABLE A.1 (Page 3 of 4)

Item	Stage I Watana	Stage II[1] Devil Canyon	Stage III[1] Watana	Stage III[1] Devil Canyon
Spillway				
- Capacity at 50-yr flood surcharge (cfs)	258,000	240,000	220,000	----
- Capacity at PMF surcharge (cfs)	278,400	309,000	259,600	291,000
- Control Structure				
. Type	Gated Ogee	Gated Ogee	Gated Ogee	----
. Crest Elevation [3]	1,950	1,398	2,135	----
. Gates				
Number	3	3	3	----
Dimensions (HxW, ft)	64 x 44	58 x 48	64 x 44	----
Top of Gate Level [3]	2,014	1,456	2,199	----
- Chute Width (ft)	164 x 120	176 x 150	164 x 120	----
- Energy Dissipation	Flip bucket	Flip bucket	Flip bucket	----
Power Intakes				
- Intake Structures	Multi-level, Gated	Multi-level, Gated	Multi-level, Gated	----
. Number of Levels	5	2	4	----
. Number of Shutters per Level	4	4	6	----
. Dimensions of Shutters (HxW, ft)	25 x 24	20 x 34±	25 x 24	----
- Control Gates				
. Number	4	+ 4	6	
. Dimensions (HxW, ft)	24 x 12	24 x 20	24 x 12	
- Invert Elevation [3]	1,800	1,365	1,800 & 2012	----
Power Tunnels				
- Number	2	See Penstocks	3	----
- Type	Inclined/Horizontal	See Penstocks	Inclined/Horizonal	----
- Concrete-Lined Diameter (ft)	24	See Penstocks	24	----
Penstocks				
- Number	4	4	6	----
- Type	Horizontal	Inclined/Horizontal	Horizontal	
- Diameter (ft)				----
. Concrete-lined	18	20	18	----
. Steel-lined	15	15	15	----

[1] See first page of this Table.
[3] See first page of this Table.

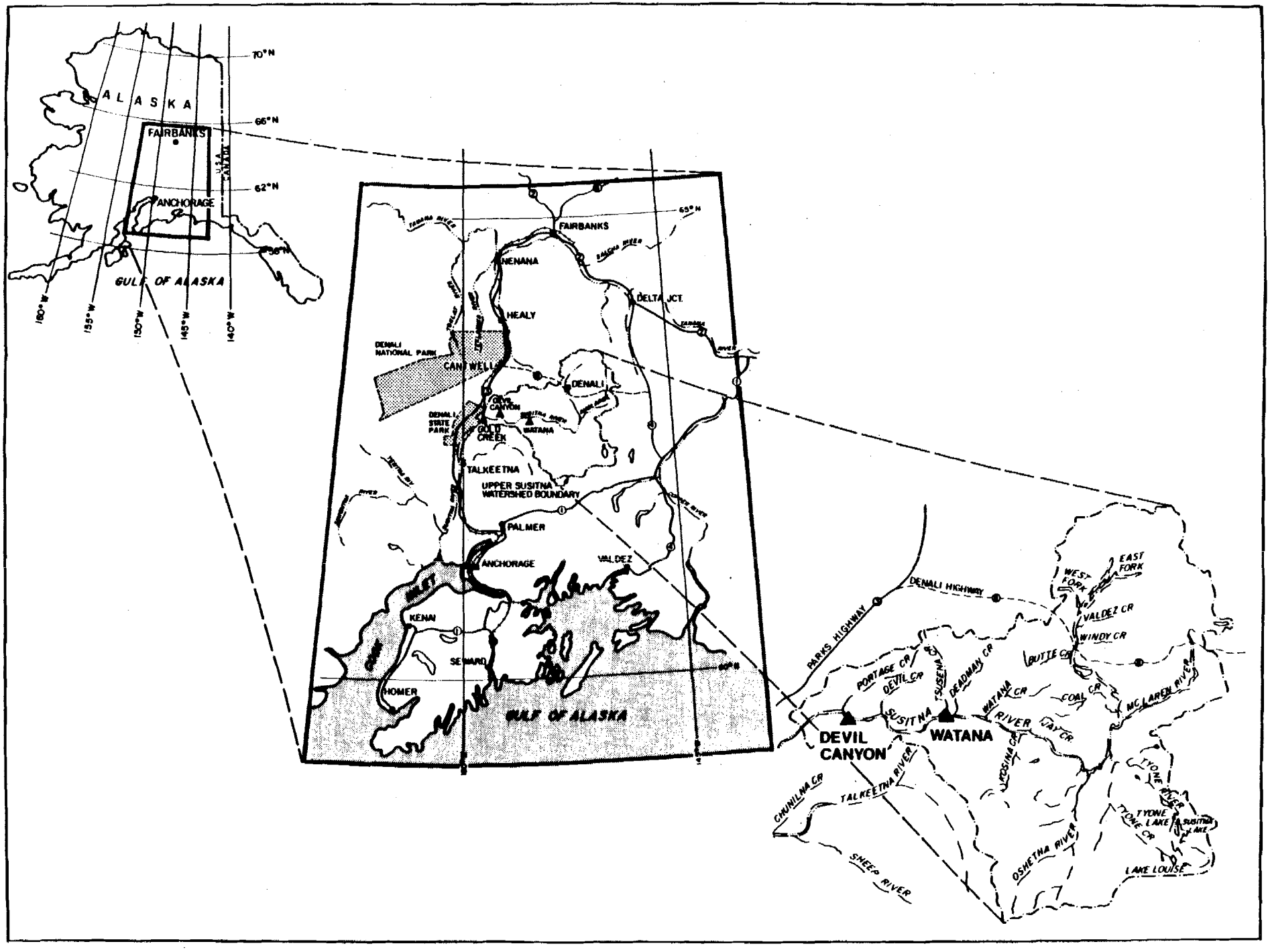
TABLE A.1 (Page 4 of 4)

Item	Stage I Watana	Stage II[1/] Devil Canyon	Stage III[1/] Watana	Stage III[1/] Devil Canyon
Powerhouses				
- Type	Underground	Underground	Underground	----
- Cavern Size (L x W x H, ft)	365 x 78 x 136	360 x 74 x 126	520 x 78 x 136	
- Turbine (No. and Type)	4 Vertical Francis	4 Vertical Francis	6 Vertical Francis	----
- Speed (rpm)	257	225	257	----
- Nominal Unit Capability at Average Operating Head (MW)	110	170	185	----
- Maximum Unit Capability				
. Net Head (ft)	537	600	719	----
. Flow (cfs)	3,080	3,790	3,800	----
. Output (MW)	125	173	200	----
- Minimum Unit Capability				
. Net Head (ft)	384	545	600	----
. Flow (cfs)	2,310	3,615	3,310	----
. Output (MW)	65	150	150	----
- Generators				
. Type	Vertical Synchronous	Vertical Synchronous	Vertical Synchronous	----
. Rated Capacity (MVA)	223 Air Cooled	192 Air Cooled	223 Air Cooled	----
. Power Factor	0.9	0.9	0.9	----
. Voltage (kV)	15	15	15	----
. Frequency (Hz)	60	60	60	----
. Speed, rpm	257	225	257	----
- Transformers				
. Location	Upstream Gallery	Upstream Gallery	Upstream Gallery	----
. Cavern Size (L x W x H, ft)	308 x 45 x 40	446 x 43 x 40	414 x 45 x 40	
. Number	6	12	9	----
. Rating (MVA)	150	70	150	----
. Voltage (kV)	15-345/1.73 Single Phase	15-345/1.73 Single Phase	15-345/1.73 Single Phase	----
Tailrace Tunnels				
- Number/Type	1 - Horseshoe, Concrete-Lined	1 - Horseshoe Concrete-Lined	2 - Horseshoe Concrete-Lined	----
- Diameter (ft)	34	38	34	----
- Surge Chamber Size (L x W x H, ft)	250 x 50 x 150	240 x 75 x 190	445 x 50 x 150	----

N.A. - Not Applicable

1/ See first page of this Table.

FIGURES



PROPOSED PROJECT LOCATION