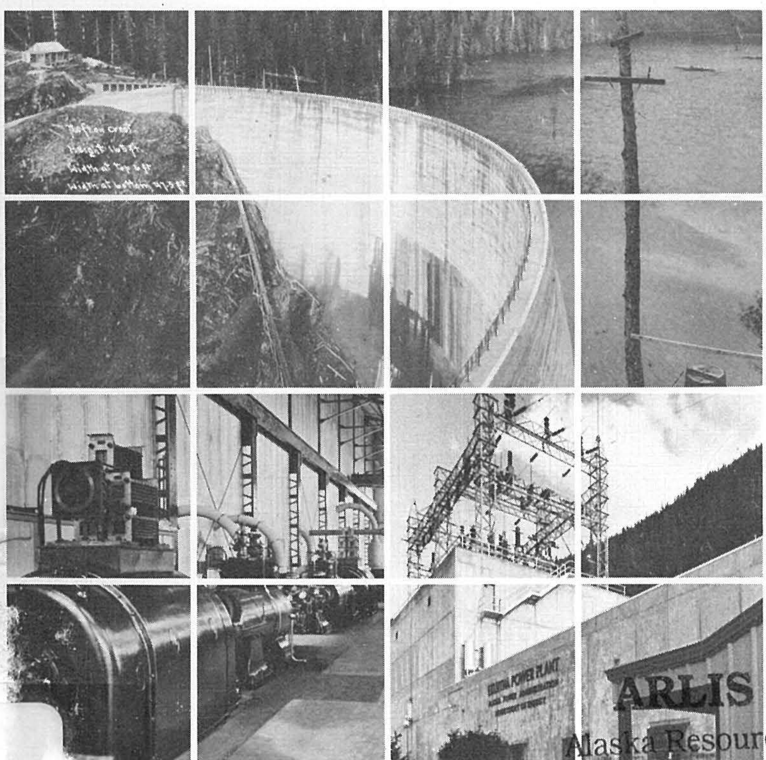
Hydroelectric Power In Twentieth Century Alaska:

Anchorage, Juneau, Ketchikan and Sitka



ohn Whitehead

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Acknowledgements

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In Sitka Fermin "Rocky" Gutierrez, City Manager, and Rick Anderson, Finance Director, provided valuable information on their city's bonding efforts over the years. Les Yaw, former President of the Sitka Public Utilities, recalled the origins of the public utility.

In Juneau William Corbus, Jr., General Manager of Alaska Electric Light and Power Company, gave me much background information on the older hydro plants in that city and took me by helicopter to the Salmon Creek facility. David Stone, local Juneau historian and archivist for AEL&P, shared with me his findings on Juneau's "golden age" and helped find many letters in the AEL&P archives on the original construction and engineering for Annex Creek. George Rogers, Juneau economist and author, shared his observations on the development of Snettisham and the prospects for the Juneau timber industry in the years after statehood.

In Anchorage Tom Kolasinski, acting General Manager of Chugach Electric Association, shared his experience with the operation of the Cooper Lake project. Eric Yould, Executive Director of the Alaska Power Authority, provided valuable information on the direction of state-financed hydro development. Dave Hutchens, Director of the Alaska Rural Electric Cooperative Association, offered his comments on the organization of electric utilities in Anchorage.

In Fairbanks, Renee Blahuta and Steve Jackson of the university archives found box after box of information on hydro development in the papers of Senators Ernest Gruening, Bob Bartlett, Mike Gravel and Representative Ralph Rivers.

My particular thanks go to Bob Cross, Administrator of the Alaska Power Administration in Juneau. He not only took many hours from his schedule to talk with me, but also offered detailed comments on drafts of this report and sent documents and statistics which would not have come my way otherwise. He really demonstrated how helpful a federal agency can be in facilitating research.

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Chapter 1
An Introduction to the Potential and the Reality of Hydropower

At the turn of the twentieth century, when Americans were actively exploiting Alaska's subsurface mineral riches and contemplating the timber wealth of its forests, many observers turned their eyes to another natural resource that they thought would be the key to the territory's future economic development—*water*. It took no high level of training or special instrumentation to contemplate the potential electric power that could be generated from the creeks, waterfalls, and rivers which continually caught the eyes. The availability of cheap hydroelectric power, many thought, would make mining, particularly lowgrade ore mining, and pulp production boom. This power would also provide "civilized" amenities for the cities and towns that this industry would bring. By 1908 southeastern Alaska alone could boast over 30 developed waterpower sites with a capacity of 15,319 horsepower (roughly equivalent to 11,500 KW). As Table 1.1 illustrates, these facilities were scattered from Ketchikan to Juneau to Skagway. The waterwheels in some of these installations provided mechanical power directly to machinery. In others the wheels drove generators producing electricity—in some cases with a capacity of 500-1,000 KW. Hydroelectric power had also reached a few locations in southcentral Alaska including Cordova, Valdez and Willow Creek in the first decade of the century.[1]

Agencies of the federal government, including the Department of the Interior, the Forest Service, the Federal Power Commission, and the U.S. Geological Survey quickly assumed the task of surveying the available waterpower sites and gaging the streamflow. From

Table 1.1. Developed Water Power in Southeastern Alaska, 1908[a].

Owner	Location of Plant	Number Wheels	Horse-power	Character of Industry
Porcupine Gold Mining Co.	Porcupine Creek	2	50	Placer mining
Columbia Canning Co.	Haines	3	70	Cannery
Nugget Creek Mining Co.	Haines	2	24	Mining
Columbia Canning Co.	Leonard Creek	3	25	Salmon cannery
Shakan Salmon Co.	Shakan Creek	4	150	Salmon cannery
Cahoon Creek Placer Co.	McKinley Creek	2	100	Placer mining
Union Iron Works	Gold Creek	1	8	Machine Shop
Hydraulic Pipe and Boiler Works	Juneau	1	8	Pipe and boiler works
Finn & Young	Shakan	1	25	
William Duncan	Metlakatla	2	53	Sawmill & salmon cannery
R.G. Ketchum	Kupreanof Island	1	50	Barrel factory
Alaska Industrial Co.	Jumbo Creek	1	150	
Alaska Industrial Co.	Sulzer	1	30	Mining
American Gold Mining Co.	Sheep Creek	3	80	Mining
Yukon Publishing Co.	Skagway	1	3	Newspaper
Home Power Co.	Lake Dewey	1	125	Light and power
New England Fish Co.	Lake Whitman & Coal Creek	2	1,100	Fish freezing and ice making
J.P. Jorgenson & Co.	Juneau	1	25	Lumber

Table 1.1 Developed Water Power in Southeastern Alaska, 1908[a] (Continued).

Owner	Location of Plant	Number Wheels	Horse-power	Character of Industry
Ebner Gold Mining Co.	Gold Creek	4	4,000	Quartz mining
Alaska Perseverance Mining	Silverbow Basin	8	880	Mining
Alaska-Juneau Gold Mining	Silverbow Basin	2	500	Mining
F.H. Partridge	Hoonah	2	15	Sawmill
Alaska Copper Co.	Lake Creek	4	300	Smelter and sawmill
A. Murray	Douglas	2	5	Wood turning, etc.
Juneau Iron Works	Juneau	1	6	General repairs
Treadwell group	Douglas Island	37	6,297	Gold mining
Citizen's Light, Power and Water Co.	Ketchikan Creek	2	240	Gold mining
Alaska Electric Light and Power Co.	Gold Creek	5	1,000	Gold mining
Chichagof Gold Mining Co.	Clay Bay	1	150	Gold mining
Total Capacity		99	15,319	

[a] Source: John C. Hoyt, *A Water Power Reconnaissance in Southeastern Alaska* in C.E. Ellsworth, and R.W. Davenport, *A Water-Power Reconnaissance in Southcentral Alaska* (Washington: Government Printing Office, 1915), p. 167.

1907 to the present day, federal reports on the potential of hydropower in Alaska have been forthcoming in an unending flow.[2] The tone of these reports, though occasionally cautious, has generally been euphoric. In 1924 J.C. Dort's *Water Powers of Southeastern Alaska* published by the Federal Power Commission proclaimed that the forests of Alaska would soon make the territory a "second Norway" as the production of paper and pulp reached the North. To power the new center of the wood pulp industry of North America, the report listed 47 major waterpower sites with 335,520 horsepower (250,000 KW) of primary capacity.

For the next two decades the development of hydropower, along with the rest of the economy of the territory, languished. Investors were never sure what the political status of a territory meant for development. Alaska's distance from the rest of the United States also made venture capital hesitant to come North. The Second World War renewed economic interest and activity in Alaska and once again focused federal attention on the territory's waterpower potential. In 1947 an update of Dort's 1924 report entitled *Water Powers Southeast Alaska* identified 200 potential sites in the Southeast with a primary capacity of 789,860 horsepower (590,000 KW). The search for potential hydropower gained force and pace every year after the war. The first territory-wide waterpower survey conducted by the Bureau of Reclamation in the late 1940s was issued in 1952. This report, entitled *Alaska: A Reconnaissance Report on the Potential Development of Water Resources in Alaska,* scaled down the number of sites to 72 "major" locations with a total primary capacity of 8.29 million KW. The report continued to talk in euphoric terms of Alaska's waterpower potential and announced that the territory could annually produce 47-50 billion kilowatt-hours of energy—1/5 of all electric utility sales in the United States at the time. The report concluded that development of Alaska's hydro potential was clearly needed and should be encouraged.

Statehood also encouraged the continued quest for Alaska's undeveloped water potential and revived the numbers game. The *Alaska Power Market Survey of 1960,* issued by the Federal Power Commission, found 223 undeveloped hydro sites statewide with 13 million KW of primary capacity. The most recent federal survey, *The National Hydropower Survey of 1980* issued by the U.S. Army Corps of Engineers, listed 695 potential hydro sites with a staggering 33 million KW of primary capacity. Realistically, the report found 59 "favorable" sites (10 of which had existing plants) with a total capacity of 3.5 million KW if developed fully.

The announced potential of hydropower in Alaska has clearly been great. But by 1981 the actual development of hydroelectric power was less than dramatic. *The National Hydropower Survey of 1980* noted only 40 hydroelectric developments in the state, some rated at only a few kilowatts. The report found only 14 plants making a significant contribution to the electric power needs of the state. These significant plants, which are listed in Table 1.2, had a capacity of 126,140 KW in 1979. Hydro projects scheduled for or under construction in 1981 would raise that capacity by another 100,000 KW after completion.[3] But even 250,000 KW of installed capacity is still a far cry from 3 million, much less 33 million KW.

While it may not be surprising that a state with only 400,000 people might have difficulty in absorbing this multimillion kilowatt capacity, it is nonetheless notable that hydropower's percentage of Alaska's installed electric capacity has been steadily falling as the potential has grown. In 1956 hydro accounted for 14.5% of total installed capacity. This percentage held over the next decade, but by 1970 the hydro share of total capacity dropped to 10%. The decline continued throughout the 1970s. In 1976 the share stood at roughly 8.5%. By 1979 hydropower accounted for only 7% of the state's estimated 1.87 million KW capacity.[4]

The decline in the share of capacity commanded by hydro is even more dramatic if the figure is divided into utility and nonutility components. For the last 50 years nearly all the hydropower in Alaska has been produced for utility purposes (consumer purchases) as opposed to industrial or military use. And in the last decade utility capacity has grown faster than the nonutility sector. In 1956 hydro's share of utility capacity was 50%. By 1965 the share had dropped to 34%. During the 1970s the share fell from 19% in 1970 to 13% in 1976, and finally to about 10.5% in 1979. These figures should make it obvious that there has been and still is

Table 1.2 Existing Hydroelectric Plants, June 1981[a].

Operating Authority	Plant Name	Location	Capacity (thousand KW)	Ownership	Year of Initial Oper.
SOUTHEAST REGION					
AK Elec. Light & Power	Gold Creek	Juneau	1.6	Private	1914[b]
AK Elec. Light & Power	Annex Creek	Juneau	3.5	Private	1916
AK Elec. Light & Power	Upper Salmon Creek	Juneau	2.8	Private	1913
AK Elec. Light & Power	Lower Salmon Creek	Juneau	2.8	Private	1914
AK Power & Telephone	Dewey Lakes	Skagway	0.5	Private	1902
Pelican Utility Co.	Pelican Creek	Pelican	0.5	Private	1943
Ketchikan Public Utilities	Ketchikan Lakes	Ketchikan	5.0	Public, Nonfederal	1947
Ketchikan Public Utilities	Silvis	Ketchikan	2.1	Public, Nonfederal	1968
Metlakatla Power & Light	Purple Lake	Metlakatla	3.0	Public, Nonfederal	1956
Petersburg Municipal Light & Power	Crystal Lake	Petersburg	2.0	Public, Nonfederal	1955
Sitka Public Utilities	Blue Lake	Sitka	6.0	Public, Nonfederal	1961
AK Power Administration	Snettisham	Speel River (Juneau)	47.2	Federal	1973

Table 1.2 Existing Hydroelectric Plants, June 1981[a] (Continued).

Operating Authority	Plant Name	Location	Capacity (thousand KW)	Ownership	Year of Initial Oper.
SOUTHCENTRAL REGION					
Chugach Electric Association, Inc.	Cooper Lake	Cooper Landing	15.0	Public, Nonfederal	1961
AK Power Administration	Eklutna	Eklutna	30.0	Federal	1955
Total Capacity			126.1		

[a] Source: U.S. Army Corps of Engineers, *National Hydropower Survey,* Vol. XXIV Alaska Region (Anchorage: U.S. Army Corps of Engineers, 1980).

[b] These plants were constructed and began production at earlier dates. They were rehabilitated in their present condition on the dates indicated.

a dramatic difference between the potential for hydroelectric development in Alaska and the utilization of that resource.

Why has this been the case? Have problems occurred which have made the development of hydropower less attractive as the years have gone on? Why hasn't this potential, which has been well documented for 60-70 years in some cases, been utilized? Such questions may be particularly important at the present moment. The State of Alaska is currently embarked on a major plan to develop the state's hydroelectric resources. The 1981 Legislature appropriated $460,000,000 for energy-related projects which included funds for the construction of seven hydroelectric projects as well as feasibility and reconnaissance studies of a dozen potential sites.[5] Will the state's recent infusion of money be the long sought for key to realize Alaska's decades old hydro potential? Or will it lead back to a repeat of mistakes already made? It may now be wise to reflect on the history of hydropower's past to see if there are any signals—red, yellow, or green—which should be heeded for the future.

To take such a look at the past, this report presents case histories of most of the major existing hydroelectric facilities in the state. It attempts to highlight a number of themes or problems which have emerged in the planning, construction and operation of these facilities over the years. Of the 14 major facilities listed in the *1980 National Hydropower Survey*, 10 have been given closer scrutiny along with two additional facilities either recently constructed or under construction. These 12 hydroelectric plants have been grouped in five separate chapters. First the four projects owned and operated by the Alaska Electric Light and Power Company of Juneau are examined as a group (Gold Creek, Annex Creek, Upper Salmon, and Lower Salmon). The next two chapters look at the municipal utility systems of Ketchikan and Sitka. In Ketchikan, the Ketchikan Lakes and the Silvis or Beaver Falls facilities as well as the new Swan Lake project are covered. In Sitka both the Blue Lake project and the new Green Lake project are analyzed. The fourth chapter concentrates on the Anchorage load area and examines both the Eklutna project operated by the Alaska Power Administration, a federal agency, and the Cooper Lake project operated by the Chugach Electric Association. Finally, Alaska's largest hydroelectric installation, the Snettisham project operated near Juneau by the Alaska Power Administration, is treated separately.

This selection covers plants built between the early 1900s and the present day, and ranging in capacity from 1,600 KW to 47, 160 KW. It includes an example of a facility run by each different kind of operating authority in the state: private utility company, federal agency, municipal utility system, and REA cooperative. It also includes plants in both southeast and southcentral Alaska—the only areas of the state with major hydroelectric facilities.

Because these facilities differ so greatly in age and ownership, the records and information available on each vary greatly. Plants operated by the federal government must provide published annual reports; their history is a matter of public record. Fortunately, extensive archives maintained by the Alaska Electric Light and Power Co. provide a rich history for many of the early hydro plants in Juneau. In other cases information varies from utility to utility. Interviews were conducted with each operating authority to augment the written record. Again, some utilities could provide more of this kind of personal history than others. As a result the picture which can be put together is not completely even. More questions can be answered in some locations than in others. The on-site research was conducted in the summer of 1981. Additional information was collected during the ensuing year. This study reflects the state of hydro development, particularly in terms of construction and state legislation, through mid-summer 1982.

In reconstructing this history I have tried to avoid making judgments which require technical, statistical or economic expertise beyond that of the general historian. This report tries to present a general narrative which will be useful in developing a sense of how Alaska has progressed in the development of hydroelectric power. It is not an investigation designed to give a final authoritative assessment or recommendation on the technical and economic details of hydropower. Despite these limitations, a number of conclusions seem clear and can, I believe, be confidently stated. These findings are listed at the end of each chapter.

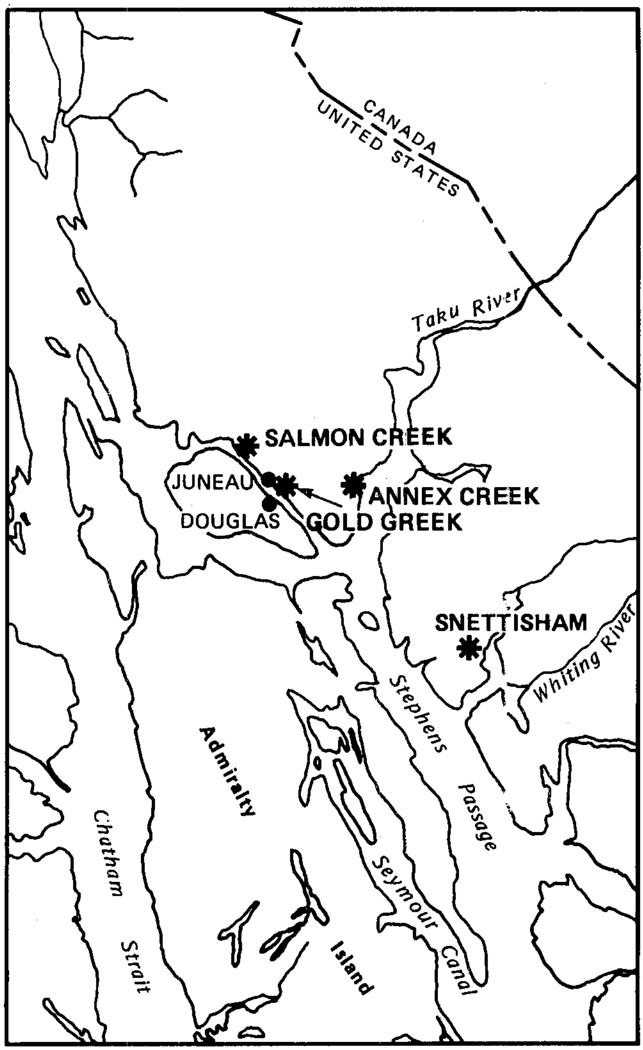

Figure 1. Approximate locations of hydroelectric facilities near Juneau.

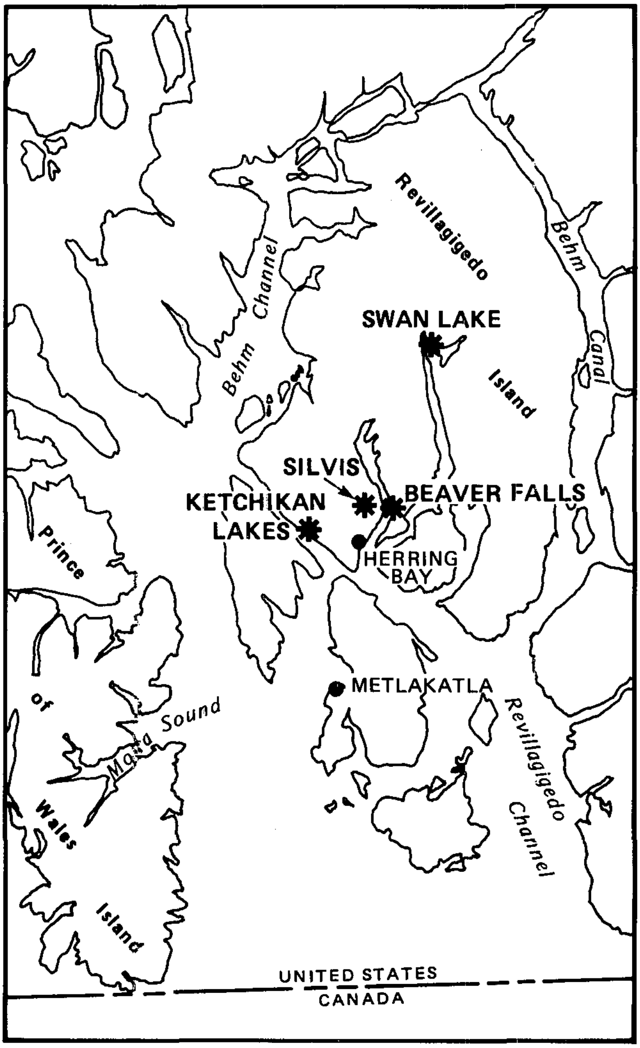

Figure 2. Approximate locations of hydroelectric facilities near Ketchikan.

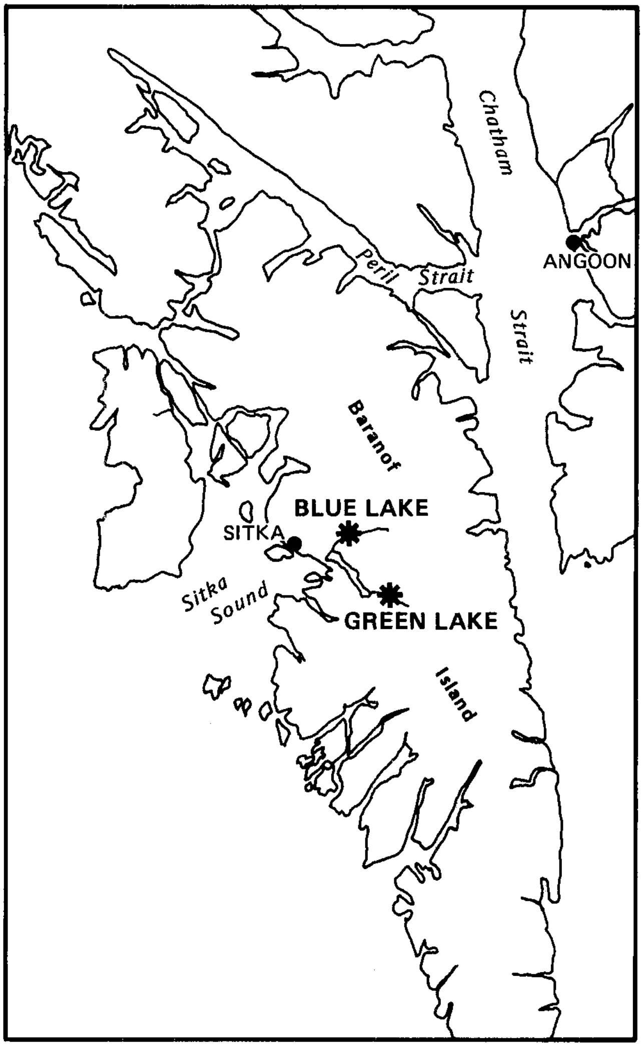

Figure 3. Approximate locations of hydroelectric facilities near Sitka.

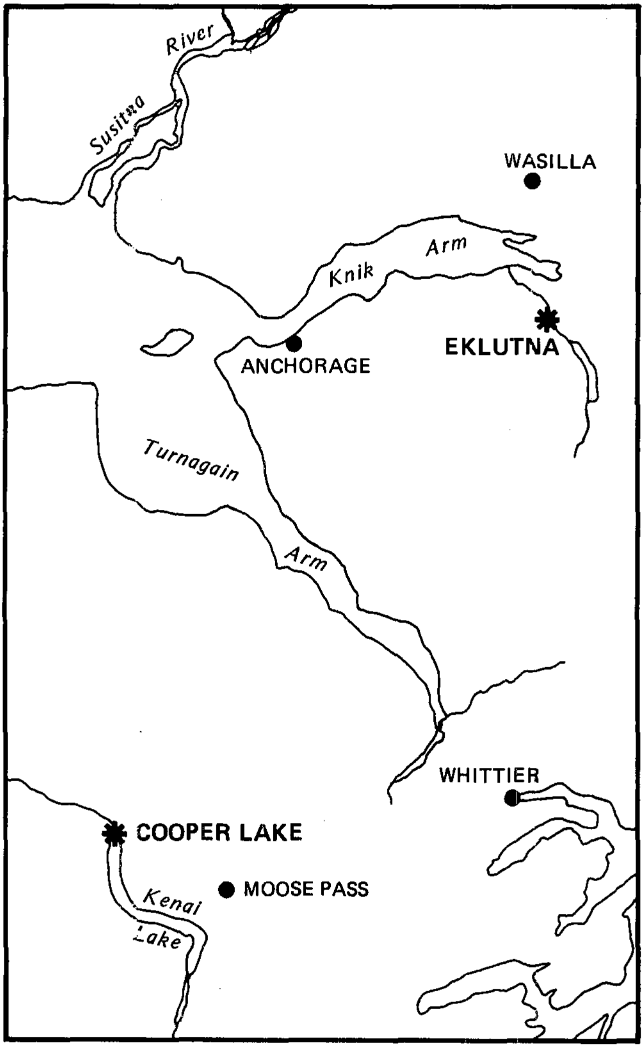

Figure 4. Approximate locations of hydroelectric facilities near Anchorage.

Footnotes

1. C.E. Ellsworth, *A Water Reconnaissance in Southcentral Alaska.* (Washington: Government Printing Office, 1915)
2. A bibliography of federal water power reports from 1907 to 1969 can be found in Henry Herfindahl, *Water Power in Alaska: A Bibliography.* (Juneau: Alaska Power Administration, 1969)
3. Plants currently under or scheduled for construction in 1981:

Solomon Gulch—Valdez	12,000 KW (on line Dec 1981)
Terror Lake—Kodiak	20,000 KW
Swan Lake—Ketchikan	22,000 KW
Tyee Lake—Petersburg/Wrangell	20-30,000 KW
Green Lake—Sitka	16,500 KW (on line Feb 1982)
Port Lions—Kodiak Island	180 KW
Total	100,680 KW

   Planned for construction in 1982:

Bradley Lake—Kenai Peninsula	70,000 KW

4. Computations on hydropower's share of installed electric capacity vary from report to report. My figures have been compiled from data listed in *Alaska Electric Power Statistics, 1970-76* (Juneau: Alaska Power Administration, 1977) and updated with Alaska Power Administration Figures in the *1980 National Hydropower Survey* (Anchorage: U.S. Army Corps of Engineers, 1980). In real terms hydro capacity increased from 50,005 KW in 1956 to approximately 126-130,000 KW in 1979. *Total* installed capacity increased from 347,300 KW in 1956 to 1,860,000 KW in 1979; *utility* capacity increased from 100,318 KW in 1956 to 1,220,163 KW in 1979. These values are for installed capacity, not for the amount of energy generated.
5. *Session Laws of Alaska 1981,* Chapter 90.

Chapter 2
The Golden Age of Hydro
c. 1900-1944

All too often the wilderness or frontier image of Alaska leads people to believe that the state of technology in such a land must be equally primitive or backward. And if such an image still holds in the present day, then how much more backward conditions must have been in the rugged days of the early 20th century. Such an image is totally at odds with the true picture of early hydroelectric development in Alaska. In the first two decades of the 20th century, it could easily be said that technology in Alaska reached a "state of the art" level for small hydro plants unsurpassed anywhere in the world. A number of plants built in this period have been operating continuously to the present day. And in many respects the engineering in those plants has not been improved upon in more recent installations. Where were these facilities and who built them?

As noted in the introduction, 30 waterpower sites had been developed in southeastern Alaska by 1908. That region's rain forest climate, which produced from 80 to 150 inches of precipitation a year in different locations, and its mountainous terrain gave streams and creeks a substantial head and force. Mountain lakes also provided natural reservoirs of power which could be tapped. Such potential energy did not go unnoticed by entrepreneurs who wanted to develop the region's mineral, timber, and fish resources. As a result the vast majority of those 30 plants were built by private investors to provide power for industrial operations, mainly for the gold mining works located in Juneau and on Douglas Island. Here lay the industrial heart of Alaska and one of the principal gold min-

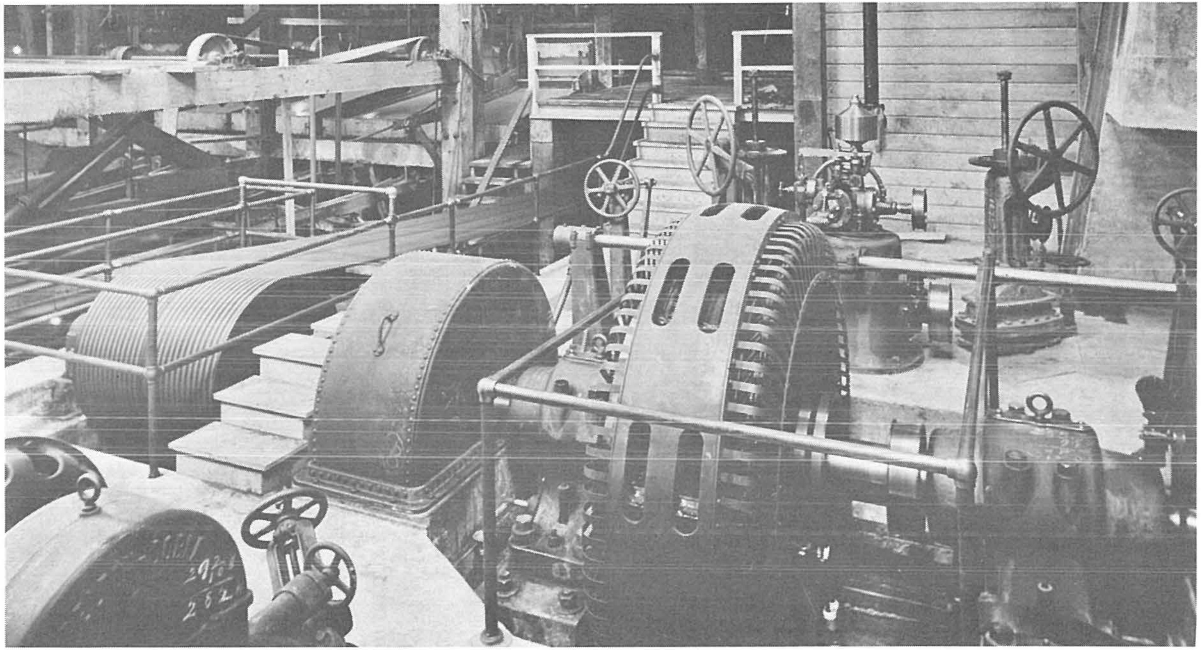

Figure 5. The Treadwell Co. built its first hydroelectric powerhouse in 1898 for its "240" stamp mill on Douglas Island. In this 1918 photograph, the stamp mill is to the left, and the powerhouse is to the right.

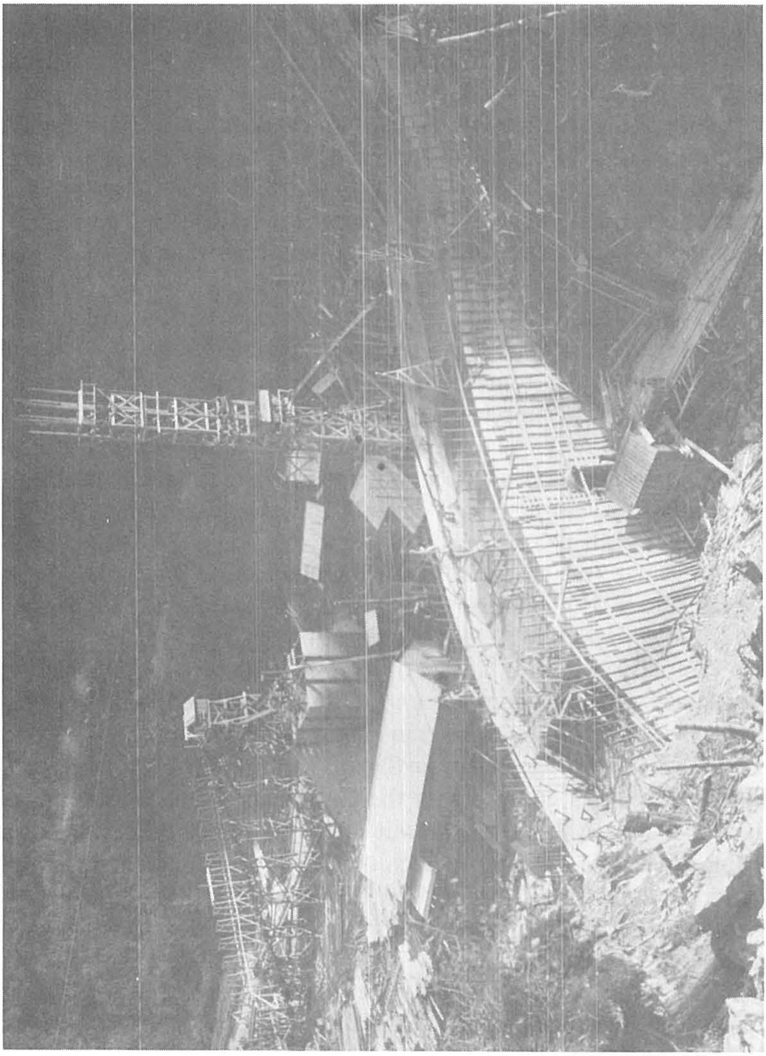

Figure 6. Salmon Creek Dam under construction in 1913.

ing centers of the world.

Since the early 1880s various mining companies had sought to extract the wealth locked in low-grade ore through the construction of stamp mills. A stamp was a mechanical device much like a giant hammer which fell rapidly—up to 100 times a minute—on ore bearing rock. Once the rock was pulverized, gold could be separated from the other minerals. Mills were usually rated by the number of stamps they contained. Alternatively, a mill's size might be stated by the number of tons of ore it could process.

By 1900 the Treadwell group of companies had emerged as the dominant mining concern in the area. Treadwell operated several mills containing a total of 880 stamps. As these mills required substantial power supplies, the Treadwell group pioneered the early use of hydropower. As early as 1882 Treadwell developed a waterpower site and installed a waterwheel which supplied direct mechanical power to one of its mills on Douglas Island. In 1898 Treadwell built a hydroelectric facility to power its large "240" stamp mill. By 1908 the group could boast 37 waterwheels generating 6,297 horsepower of energy—a mix of mechanical hydropower and hydroelectric generation.[1]

Initially each mill had its own separate power supply, but the Treadwell group soon expanded its plans to build central hydroelectric facilities with transmission lines to several mills. In 1910 Treadwell constructed the Sheep Creek power plant in Juneau with power lines going across the Gastineau Channel to Douglas Island. Between 1912 and 1914 it added a second facility with its Nugget Creek powerhouse. Both of these operations, which could generate in excess of 2,000 KW each, were seasonal facilities. In the winter months when water runoff was insufficient, electricity was generated by steam.

While the Treadwell group developed hydro facilities for its mills, four Treadwell employees built up Juneau's local utility, the Alaska Electric Light and Power Company (AEL&P). This company was originally founded in 1893 by Willis Thorp, a Juneau meat merchant, to supply electricity to the city. Thorp installed a small waterwheel and an electric generator on a bank of Gold Creek with power lines running into town. Though his operation was successful, he decided to sell the company in 1896 to the Treadwell men and devote his full attention to driving cattle north to Haines and then to the Yukon River. The new owners quickly relocated the power plant to another spot on Gold Creek, and installed new waterwheels and a larger generator. Since the Gold Creek plant was a seasonal facility, the utility built a steam plant to supply electricity during the winter months. AEL&P's Gold Creek plant still supplies seasonal power to Juneau today.

The efforts of Treadwell and AEL&P were soon overshadowed by the spectacular engineering feats of the Alaska Gastineau Mining Company—a conglomeration of several existing mills organized in 1911 by an aggressive young engineer named Bart Thane. Thane wanted to build a 6,000 ton mill south of Juneau at Sheep Creek. To be profitable the mill required an abundance of cheap year-round power. So, in 1912 Thane decided to build Juneau's first year-round hydroelectric facility at Salmon Creek, a site about 10 miles distant from the mill.

The Salmon Creek project consisted of a dam-reservoir and two powerhouses. Water from the reservoir flowed via a 40 inch pipe to an upper powerhouse (#2) about a mile from the dam. Water then exited that powerhouse via a 5 x 6 foot wooden flume for approximately two miles and finally descended through two 1,625 foot penstocks to a lower powerhouse (#1) at tidewater. Together both powerhouses had a capacity of 6,000 horsepower (about 4,600 KW).

The construction of the reservoir was a technological feat in itself. It required building a concrete variable arch dam 165 feet high with a stretch of 648 feet at its crest. When built, this was one of the largest dams of its kind in the world. Equally remarkable was the speed with which Salmon Creek was built and brought on line. Conceived by Thane in the summer of 1912, concrete was poured in the summer of 1913, and the dam was completed in 1914. Seasonal power was available from powerhouse #1 in late 1913, and by 1915 the entire facility was operational providing year-round power. What is even more remarkable is the fact that powerhouse #2 has provided power continuously to the present day with most of the originally installed equipment including two Joshua Hendy impulse

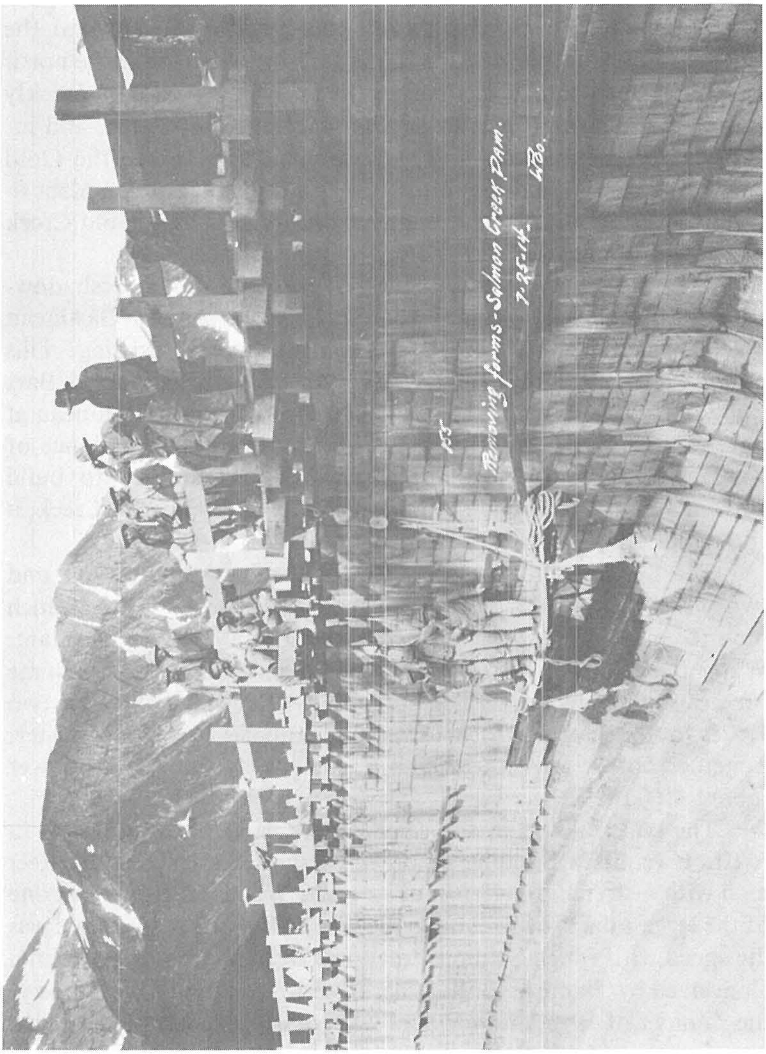

Figure 7. Salmon Creek Dam under construction in 1914.

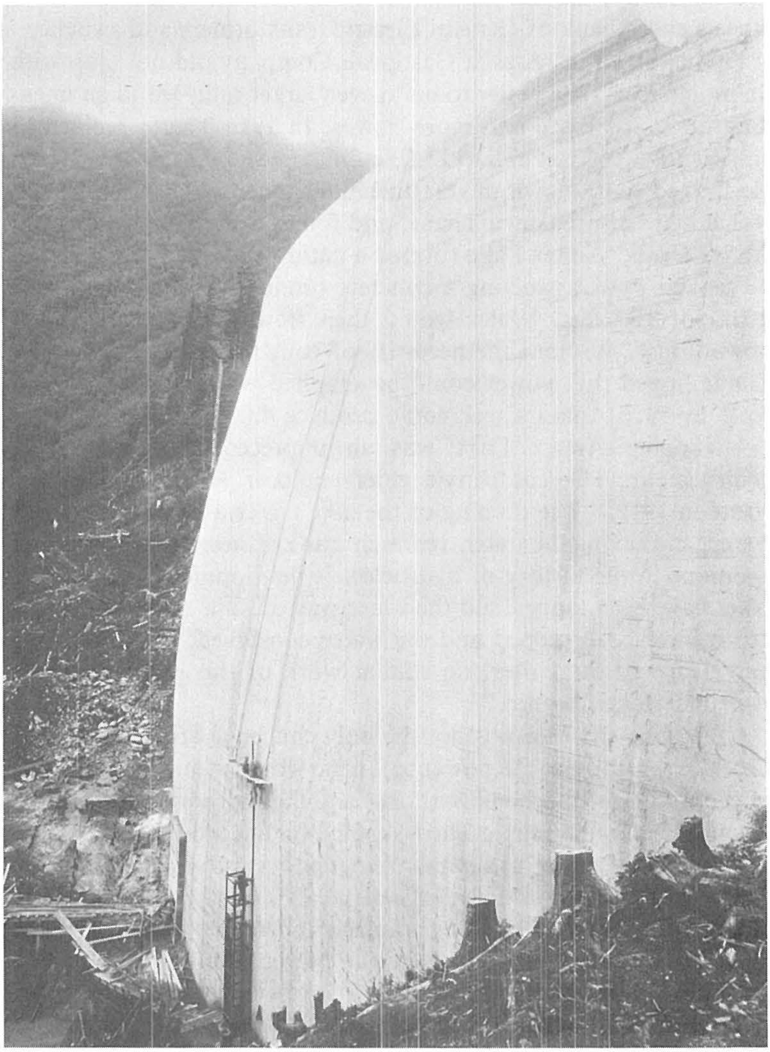

Figure 8. When constructed in 1913-14, the Salmon Creek Dam was one of the largest concrete variable arch dams in the world. Figures 6-8 show the dam in various stages of construction.

wheels and a bank of General Electric transformers and switches.[2]

Thane and his Alaska Gastineau Company did not stop with Salmon Creek. The desire to build even larger mills led to an unending quest for more and more power. In 1915 Thane decided to enlarge his 6,000 ton mill to 12,000 tons, if he could find the power. He looked south down the Gastineau Channel from Sheep Creek, which had been renamed Thane, and found a site 12 miles away at Annex Creek. Annex Lake formed a natural reservoir which could be tapped by constructing a concrete tunnel out of the lake at a depth of 150 feet. Water would then flow via the tunnel to a powerhouse. Without the necessity of constructing a major dam, Thane hoped that power could be supplied within a year—and it was! By 1916 Annex Creek could produce 4,000 horsepower.

Tapping Annex Lake was an unprecedented engineering achievement. The company's chief engineer H. L. Wollenberg wrote in 1915, "The tapping of the lake under a 150 foot head of water, and saving the water, represents an engineering problem that is unique in the history of hydroelectric development . . . . Other lakes have been tapped and the water wasted, and some of shallow depth have been tapped and the water conserved, but within the knowledge of the writer, no similar work of this magnitude was ever undertaken before."[3]

Tapping the lake was not the only challenge arising at Annex Creek. Transmitting the power to Thane would require a high level of engineering skill; the powerhouse and the mill were separated by a rugged mountain range. The transmission line would also have to endure conditions of high winds, icing, and possible avalanches. In fact, John C. Hoyt of the U.S. Geological Survey predicted in 1909 that the difficulty of building transmission lines "practically prohibits development at sites where the power cannot be utilized at the point of development." In an increasingly pessimistic tone, Hoyt went on to add, "In view of these difficulties the possibilities at the present time for large power development in southeastern Alaska are not great, and such projects should be closely scrutinized as to the feasibility both from an engineer's standpoint and from that of an investor."[4]

Six years later Hoyt's warning seemed outmoded to the engineers of the Alaska Gastineau Company. After all, the company had just built one of the largest concrete arch dams in the world and had tapped a full lake. Building a transmission line over mountains seemed more of a challenge than an obstacle. The Alaska Gastineau Company felt confident it had men and engineers to match the mountains.

In June of 1915 Chief Engineer Wollenberg wrote Thane that the challenge could be met. In a long letter Wollenberg described the route. He noted that the course had been carefully chosen "to eliminate all danger from snowslides" along much of the route and always to run "parallel with the prevailing winds." Descriptions of the towers, insulators, and wires gave every confidence that the line was well suited for the terrain. Wollenberg went on to note that trails to the lines were located so that weather conditions would seldom prevent repairs from being made easily. Thus, in winter he anticipated outages of no more than a few hours, and at most a day. So confident was Wollenberg in the excellence of his design that he told Thane, "...it does not seem justifiable to overdesign it to any great extent." He finished the letter stating, "...while higher test insulators and heavier towers might give some more insurance against interruptions, it is the opinion of the writer that the equipment outlined above is all that any known conditions require and if we try to design for unknown conditions of greater assumed severity, we would soon have an investment out of proportion to the results obtained."[5]

Those last lines were prophetic. They raised issues which have plagued hydroelectric development in Juneau to the present day. How can a line be designed to withstand unknown conditions? How much money should be invested in such a line—enough to make it as fail safe as possible or just enough to convince backers of the economic feasibility of the entire hydro system (dam, powerhouse, lines, etc.)? Sixty years later these problems would plague Juneau again. Before rushing too far into the future, let us see what happened once the Annex line was completed.

In 1916 Wollenberg may well have wondered about the confidence he expressed a year before. From November 1 to December 11, 1916, the Annex Creek line was out 100.5 hours. A combination

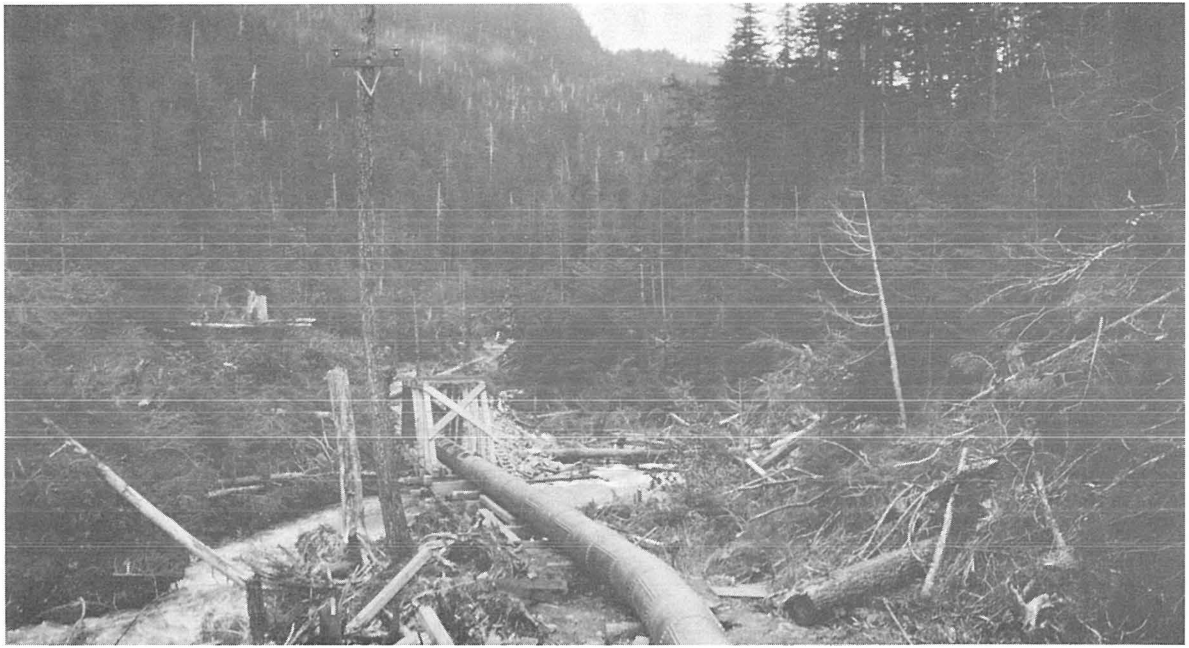

Figure 9. Construction of the pipe carrying water from the Salmon Creek reservoir began in the summer of 1913.

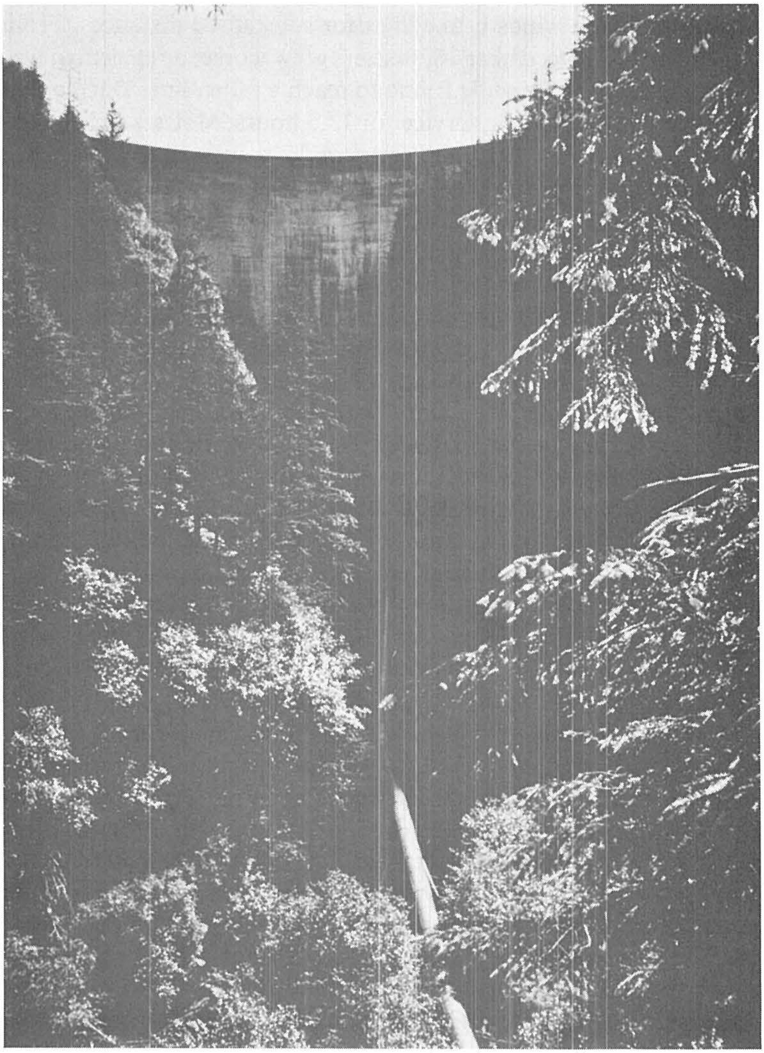

Figure 10. Water from the Salmon Creek reservoir near Juneau is carried to powerhouse number 2 by a pipe 4,477 feet long.

of sleet and high winds broke lines for substantial distances. From December 11 to December 18, matters grew worse; a repairman was killed by a snowslide while trying to reach a fallen line. During that week the line was only in service for 13.5 hours. Matters did not improve in January of 1917. On January 26, a snowslide demolished six steel towers. For the entire month Annex Creek produced power for only 10 days compared to 31 days for Salmon Creek.[6]

Despite these difficulties, the Annex Creek hydro facility remained in service—and has continued in service to the present day. But by 1917 two things were obvious to the Alaska Gastineau Company: 1) a considerable expense for line repair would have to be calculated into the overall cost of the facility; and 2) stand-by generation from other facilities would be necessary to keep the mills serviced by the Annex Creek station in continuous operation.

The completion of the Annex Creek facility marked the end of the installation of hydroelectric facilities in Juneau during the golden age. The construction of Nugget Creek, Sheep Creek, Salmon Creek, and Annex Creek constituted the major development of hydropower in Alaska until the 1950s. In fact, the Federal Power Commission noted in 1947 that 75% of all present hydropower in southeastern Alaska was installed between 1909 and 1916.[7] Why did the pace slacken after that year?

Though Juneau remained a gold mining center until the Second World War, the two companies which pioneered hydro development came upon hard times after 1917. Treadwell's principal mine on Douglas Island caved in that year. By 1921 the company had few productive mines left. A similar fate beset Alaska Gastineau. Though its mills and hydro facilities were superb, the company could not find an ore with sufficient grade for profitability. The low quality ore combined with a labor shortage in World War I pushed the company toward financial disaster by 1919; it ceased operations altogether in 1921. Prospects for continued gold mining would have been bleak had it not been for the strong emergence of another company in the 1920s—the Alaska Juneau Gold Mining Company.

Alaska Juneau had been organized in 1897, but it was not until 1916-17 that its major mill was constructed. To power that mill the company built an 8,000 KW steam electric plant—in part because it feared transmission interruption of hydropower. For the next decade the company showed little profitability and was not in a position to finance new power facilities. With the demise of the Treadwell group and Alaska Gastineau, Alaska Juneau found a ready source of power in the hydro facilities of these two companies. By 1928 Alaska Juneau was in a better financial condition and purchased the Treadwell group; in 1934 the company bought out Alaska Gastineau. With its newly purchased hydro facilities and its backup steam plant, Alaska Juneau had a superb power system which served the company well until its closure in 1944.[8]

While the plants built by Treadwell and Alaska Gastineau powered the Alaska Juneau Company, they also furnished enough power to supply the Alaska Electric Light and Power Company with electricity for private consumers in Juneau. Thus AEL&P did not need to install new plants. After 1944 and the closure of the Alaska Juneau mill, the mining company still continued to sell its hydroelectric power to AEL&P. This situation existed until 1972 when the private utility bought the facilities of A-J Industries, the successor company to the Alaska Juneau Gold Mining Company.

Though AEL&P continued to operate both Salmon Creek and Annex Creek along with its original Gold Creek installation, the importance of these early plants has been overlooked in most of the hydropower surveys of the last two decades. While this report has drawn attention to their advanced technology and continuous operation over 65-70 years, most other reports have paid only passing attention to what have sometimes been considered outmoded facilities. For example, the Federal Power Commission noted in 1976: "most of the early hydroelectric developments in Alaska were constructed to provide power for mining and other industrial uses, such as fish processing, and were often associated with hydromechanical installations. Over the years, many small hydroelectric installations were constructed in southeastern Alaska to serve local and seasonal needs. Some of these still remain in service today, although most small installations have been replaced by diesel generators."[9]

The U.S. Army Corps of Engineers echoed these thoughts in

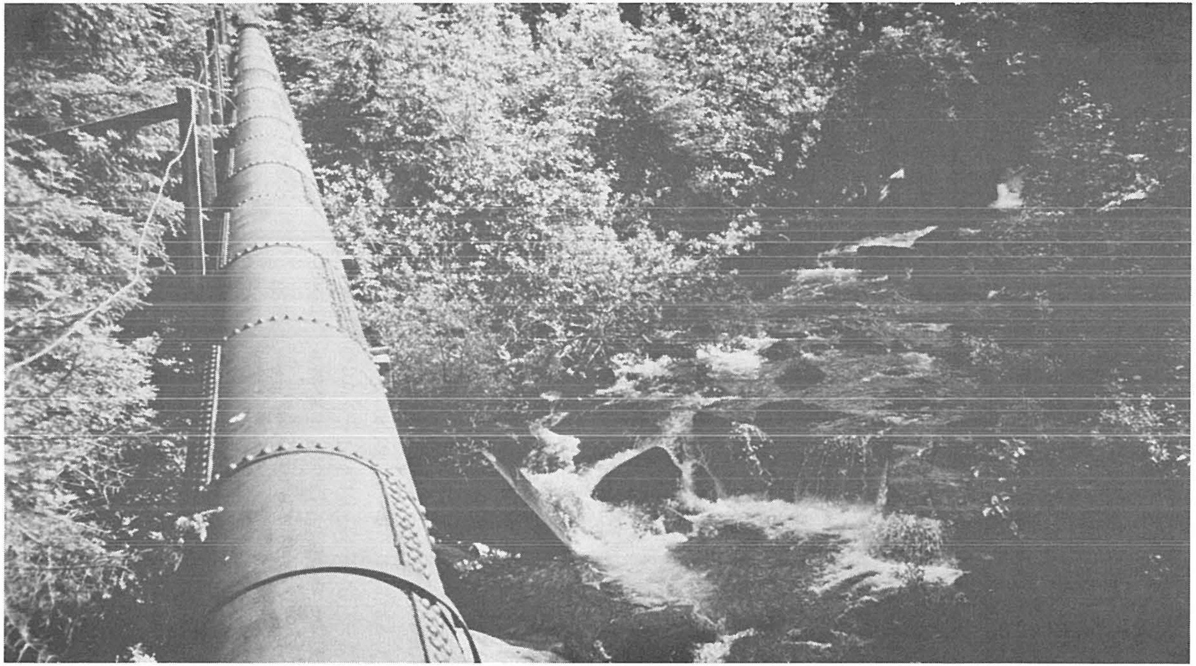

Figure 11. This pipe, which was installed in 1913 and photographed in 1981, still transports water from the Salmon Creek reservoir.

Figure 12. Powerhouse number 2 of the Salmon Creek project near Juneau has been supplying electricity from 1915 to the present day.

1981: "Juneau during the late 1950s and the 1960s was a rapidly growing community powered by a conglomerate of internal combustion diesel generators and small, generally outmoded, hydropower turbine generators."[10]

Such descriptions give little indication of the feats of Bart Thane. Is there a reason for this treatment of the older facilities? Or have I exaggerated their importance? There are, I believe, at least three reasons for the relatively poor light in which the older hydro facilities have been seen.

1. Surveys conducted by federal agencies were geared toward extolling Alaska's undeveloped hydro potential, not toward praising its past achievements.

2. When Alaska entered the union in 1959, hopes were high that a pulp industry would develop in Juneau. To power this industry Juneau looked forward to securing a federal appropriation for a new hydroelectric facility at Port Snettisham. Thus the eyes of the city were riveted on entering the union with a new modern facility worthy of the capital of a new state. No one wanted to think that facilities built in 1916 were adequate to propel the new capital into the future—even after the proposed pulp industry failed to materialize. Thus the political emotion and rhetoric of statehood tended to place the old hydro facilities back in a territorial past where they might be happily forgotten. (See Chapter 6 for a full discussion of the background of the Snettisham project.)

3. Probably the most important factor in tarnishing the image of the older facilities was the lack of care given them by A-J Industries after 1944 and the battle that company waged in the early 1960s with the local Alaska Electric Light and Power Company. Let us examine this factor more closely.

By 1960 both the Nugget Creek and the Sheep Creek facilities were inoperative and in disrepair. A-J Industries, a Los Angeles based company, continued to operate the Salmon Creek and Annex Creek plants. Through these two facilities, it supplied the majority of Juneau's electric power which it sold to AEL&P. That company held a 50 year franchise issued in 1908 by the city as the sole distributor of power in Juneau. When the franchise expired, the city did not immediately renew it.

In 1961 AEL&P sought a new franchise from the city. A-J Industries campaigned against this franchise and attempted to induce the city to buy its hydro facilities instead. An angry and bitter exchange between the two power companies filled the pages of Juneau's *Daily Alaska Empire* throughout the fall of 1961. AEL&P claimed that A-J Industries charged excessively high wholesale power prices—as much as 19.5 mills (1.95¢) per kwh. In fact, AEL&P contended that it had installed diesel generators between 1951 and 1954 to increase its own generating capacity and thus force A-J to lower its power price to 15 mills.

A-J responded that such claims were nonsense. It asserted that AEL&P had to spend 18 mills per kilowatt-hour on diesel fuel alone. The mining company went on to say that it was AEL&P which was charging excessively high retail prices of 5¢ (50 mills) per kilowatt-hour. An angry AEL&P replied that this was a fabrication; it maintained its average price per kilowatt-hour was 3¢.

The mining company further claimed that it had tried to sell its facilities to AEL&P but that the local utility did not have the financial ability to buy it. It further implied that AEL&P had no ability to finance a modernization of Juneau's power facilities. The utility responded that there was nothing wrong with its financial condition. AEL&P said it had not accepted A-J's offer because it felt the mining company was trying to dictate terms.

During this battle AEL&P consistently backed the proposed Snettisham project which it claimed would lower wholesale power rates to 7.5 mills. More importantly, Snettisham would free the utility from its dependence on A-J power. If Snettisham were built, AEL&P would buy its power from the federal government and then distribute it to local consumers.

After several months of debate, the citizens of Juneau sided with their hometown utility. The voters allowed AEL&P to continue its franchise for another 20 years, and the city decided not to buy A-J's facilities. By the end of 1961 the old complex of hydro facilities were not seen as Bart Thane's great engineering

Figure 13. Powerhouse number 2 of the Salmon Creek project looked much the same in 1981 as when it was built in 1914.

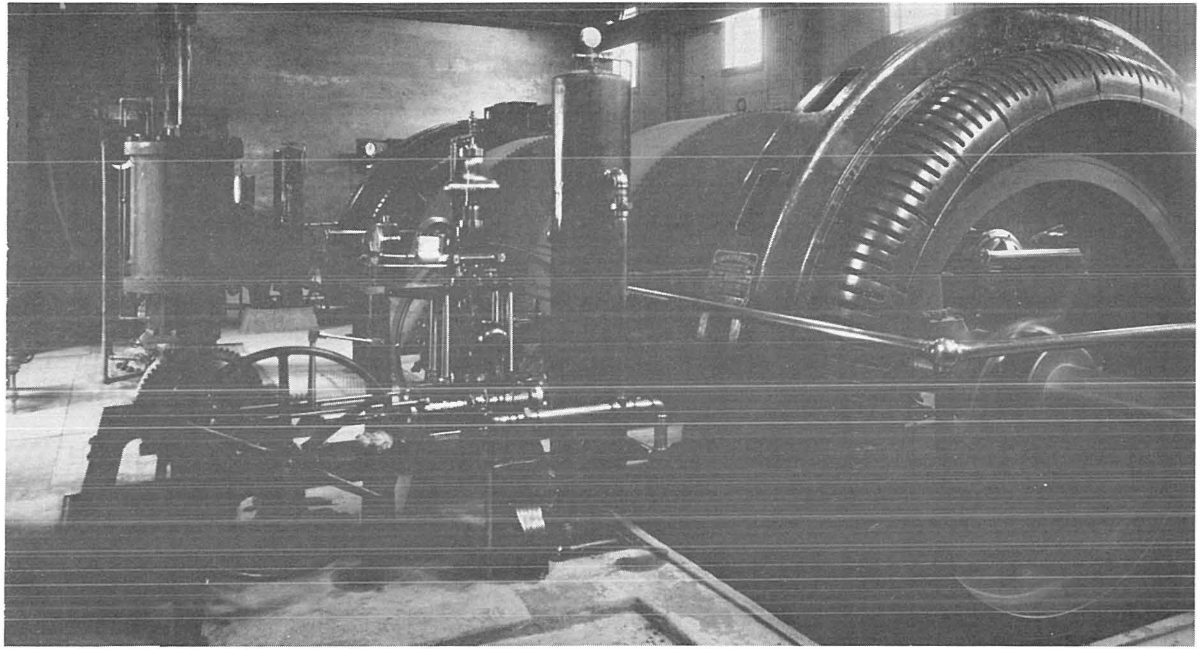

Figure 14. The waterwheels installed in Salmon Creek powerhouse number 2 in 1914-15 are still operational.

achievements, but as the somewhat run-down tools of a Californian company which was exploiting the electric consumers of Juneau and attempting to destroy a local utility which had been in the city since 1893.[11]

Thus matters stood until 1972 when the new Snettisham plant was nearing completion. In that year A-J Industries, seeing no future market for its power, sold its hydro facilities and mining claims to AEL&P. According to AEL&P Vice-President and General Manager William Corbus, Jr., the company bought the properties not so much for the generating facilities as for the transmission lines.[12] But no sooner did Snettisham go on line than it encountered transmission problems almost identical to those of Annex Creek in 1916. Constant outages on the Snettisham transmission line turned AEL&P's attention to the generating capacity of Annex Creek and Salmon Creek. Now that those facilities were locally owned, they gradually came to be seen in a better light as dependable sources of cheap power. Corbus stated in the summer of 1981 that the old facilities could produce power so cheaply that they were being run 365 days a year.[13]

The versatility and durability of those plants were again highlighted in the early 1980s when it became evident that the generating capacity of the Upper Salmon Creek Plant could be increased by rewinding its generators. The operating cost of that plant could also be lowered by installing an automatic switching system to replace the original 1916 equipment. The legislative appropriation of 1981 included a $3,000,000 loan to AEL&P via the Alaska Power Authority to make these improvements and raise Upper Salmon's installed capacity from 2,800 KW to 4,500 KW—one of the best investments per installed kilowatt for hydropower available in Alaska.[14]

By the summer of 1981 Bart Thane's pre-World War I hydro plants were regaining under local ownership some of the luster which they had lost over the years. The golden age of hydropower appeared to be making contributions to Alaska's future as well as to its past. At this point, it may be well to summarize both the significance which these plants have had in the past and the potential they hold for the future. Two factors seem particularly important.

1. The successful construction of these hydroelectric facilities by industrial developers provided a strong basis for the belief that hydroelectric power was the key to industrial growth in Alaska. If hydropower could make large-scale gold mining possible, why couldn't it lead to other industrial development? In fact, Bart Thane suggested that a pulp industry could be powered with his plants in 1919. It is thus no wonder that the Federal Power Commission optimistically boasted that the territory might become a "second Norway" in 1924.

From 1920 to the present day, the dream that hydropower and industry would come hand and hand has maintained a strong hold on the Alaskan mentality. The dream of a hydropowered pulp industry existed from the early 1920s to the mid-1960s. The dream of a hydropowered aluminum industry was prominent in the 1940s and 1950s. No significant industrial applications of hydropower have developed in the last half century. Still, the history of the connection between mining and hydropower has kept this dream alive. Hydropower did lead to large-scale mining in Juneau. Whether it can or will lead to future industrial development is yet to be seen. Why it has not—particularly in the pulp industry—will be discussed in future chapters.

2. The continuous operation of Salmon Creek, Annex Creek, and Gold Creek over a period of 65 years demonstrates that hydroelectric facilities in Alaska have an extraordinarily long operational life—much longer than gas turbines or diesel generators. In fact, the operational life is considerably longer than the standard period in which the capital cost of a hydro project is amortized—usually 35-50 years. Operation and maintenance costs are low compared to these capital costs. Thus, the long operational life of a hydro project presents the intriguing possibility of decreasing power costs in the future. Until recently this aspect of hydropower was given little notice. The extraordinarily high initial capital costs of hydropower—which had to be met with rate increases—attracted more attention than any potential decreasing costs after 35-50 years.

Figure 15. Powerhouse number 1 of the Salmon Creek project was located at tidewater. A small railroad connected this facility to powerhouse number 2 which was located above it.

Figure 16. The Salmon Creek reservoir near Juneau provided the city's first year-round hydroelectric power.

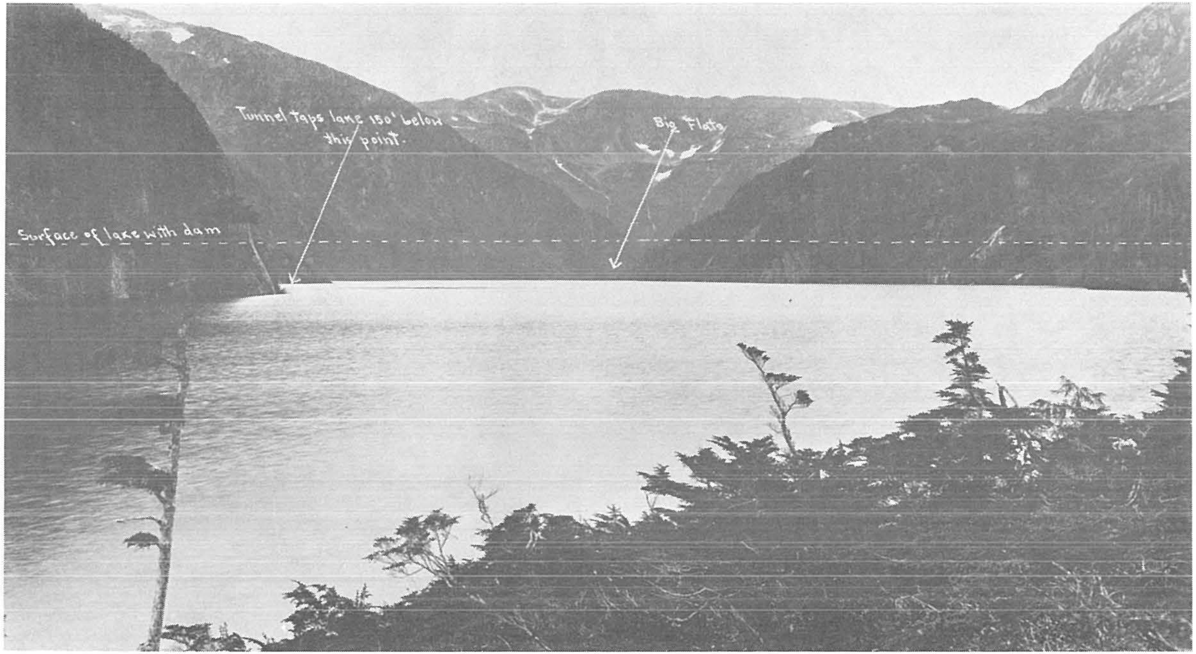

Figure 17. This 1916 photograph of Annex Lake shows the point at which engineer Wollenberg made his unprecedented 150 foot tap in 1915.

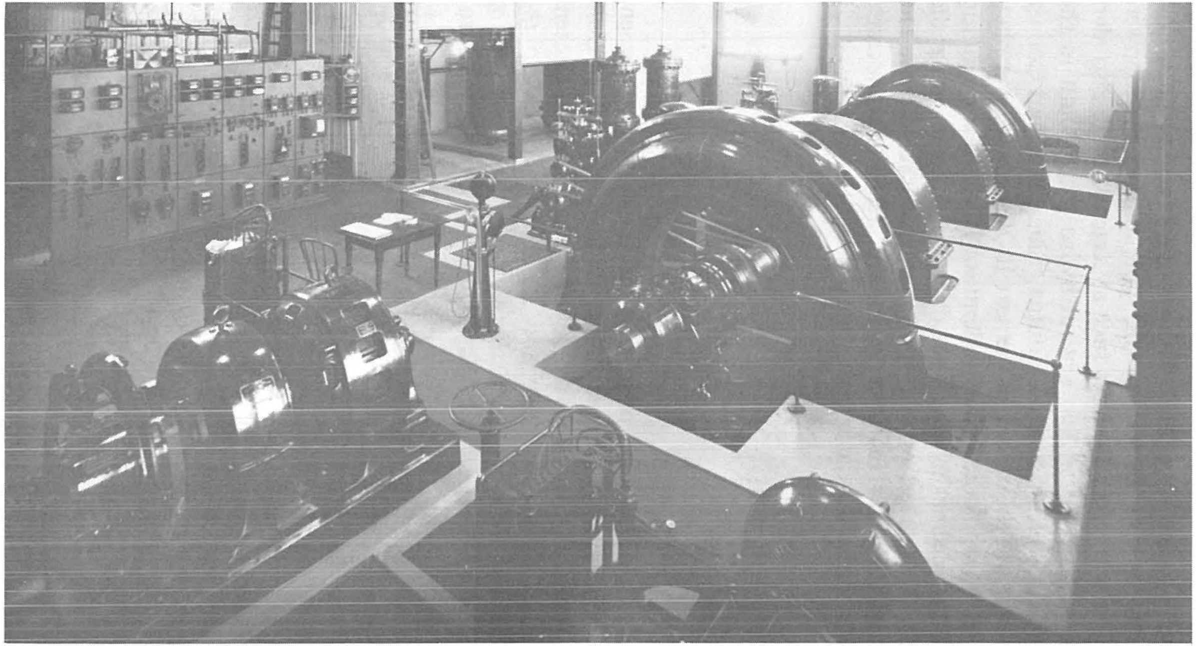

Figure 18. The Annex Creek powerhouse in 1915 was as modern as any in the world.

AEL&P's recent experience with its older facilities may now bring into focus this decreasing cost potential of hydropower. Other utilities with older facilities such as Ketchikan are also alert to such decreasing costs. And several hydro plants built in the mid-50s and early 1960s such as Eklutna, Blue Lake, and Cooper Lake may amortize themselves in the next 10-20 years. Power planners may well have to take into consideration 75-100 year operation spans and the decreasing cost phenomenon in computing the overall cost effectiveness of hydropower versus other means. The experience of the older facilities in Juneau clearly demonstrates that hydro facilities in Alaska have this potential.

Footnotes

1. Most of my discussion of mining and the early development of hydropower is based on David Stone, *Hard Rock Gold* (Juneau: City and Borough of Juneau, Juneau Centennial Committee, 1980) and J.C. Dort, *Report to the Federal Power Commission on the Water Powers of Southeastern Alaska* (Washington: Government Printing Office, 1924).
2. See Stone, pp. 39-41 for details of the construction of Salmon Creek.
3. Alaska Gold Mines Company *Annual Report*, 1915, cited in Stone, p. 47.
4. John C. Hoyt, *A Water-Power Reconnaissance in Southeastern Alaska,* in C.E. Ellsworth, *A Water-Power Reconnaissance in Southcentral Alaska* (Washington: Government Printing Office, 1915), p. 166.
5. Letter, H.L. Wollenberg to B.L. Thane, June 22, 1915, AEL&P archives, Juneau.
6. Letters, W.L. Pullen (Chief Electrician, Alaska Gastineau Mining Company) to G.T. Jackson (Asst. Manager), December 11, 1916; December 18, 1916; February 7, 1917. AEL&P archives, Juneau.

7. Fayette S. Warner, ed., *Water Powers of Southeast Alaska 1947* (Washington: Federal Power Commission, 1947), p. 39.
8. See Stone, pp. 57-75, for the history of the Alaska Juneau Mining Company.
9. U.S. Federal Power Commission, *The 1976 Alaska Power Survey,* Vol. 1, (Washington: U.S. Federal Power Commission, 1976), pp. 3-18.
10. U.S. Army Corps of Engineers, *Environmental Impact Statement Draft Supplement I, Snettisham Project, Alaska Crater Lake Phase Construction* (Anchorage: U.S. Army Corps of Engineers, 1981), p. 1.
11. For the debate between AEL&P and A-J Industries see Juneau *Daily Alaska Empire*, October 24, 1961—November 6, 1961.
12. Interview with William Corbus, Jr., Juneau, June 9, 1981.
13. Precise cost information on the older hydro facilities is difficult to obtain—particularly for individual projects. AEL&P reported in its 1981 Annual Report to the Federal Energy Regulatory Commission total operation and maintenance costs of $947,330 (1981) and $977,147 (1980) for all of its hydroelectric plants (Annex, Salmon, and Gold creeks). The three plants produced 47.2 million kwh in 1981 for an average cost of 2¢ per kwh. This cost per kwh is probably high. The 1981 figures were for manned operation. Expenses will drop with the automation of Salmon Creek. Production will also rise with the rewinding of the generators in Salmon Creek powerhouse #2 and the rehabilitation of powerhouse #1. (NOTE: A full wholesale power price would also include expenses for depreciation and company overhead.)
14. *Session Laws of Alaska 1981,* Chapter 90.

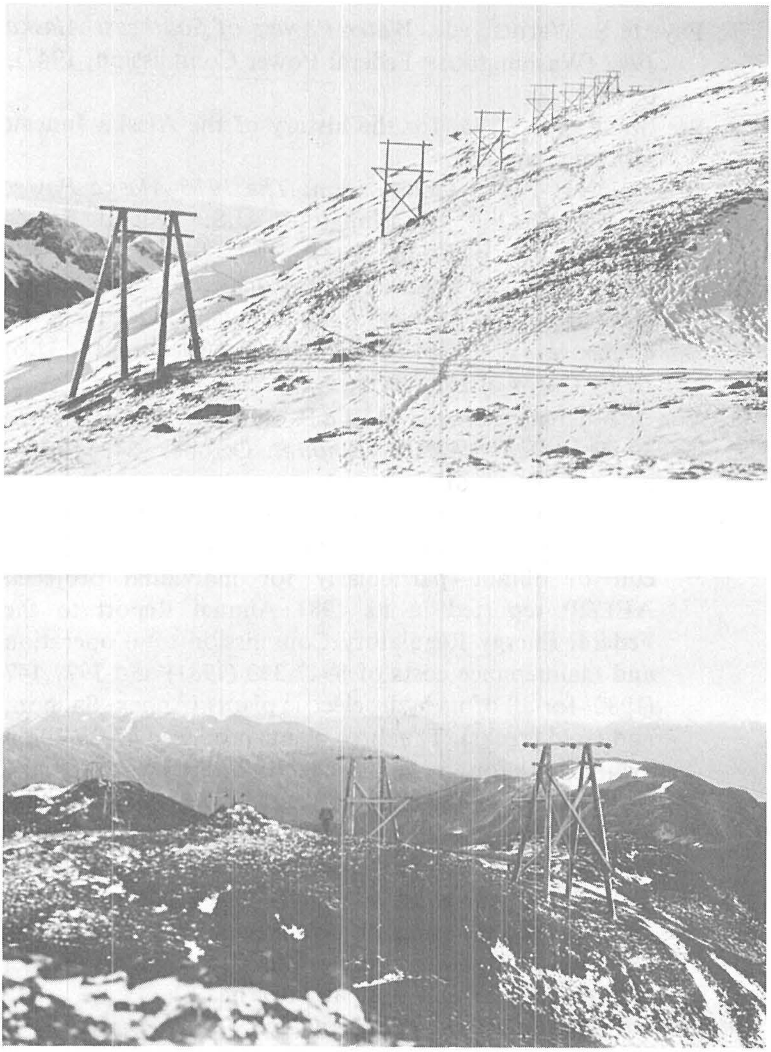

Figure 19. The Annex Creek transmission line near Juneau was often subject to outages due to the mountainous, avalanche-prone terrain it traversed. The line first supplied power in 1915. These photographs were taken in 1940.

Chapter 3
Ketchikan—Hydro City Gone Astray?

With an average annual rainfall of over 150 inches, it should not be surprising that hydroelectric power came early to Ketchikan. From 1903 to 1965 hydropower supplied nearly all of Ketchikan's electric needs. As a result Ketchikan very early on enjoyed the lowest electric rates in Alaska. In 1922 electric rates in the city were 10¢ per kwh for the first 24 kwh, 5¢ per kwh for the next 24 kwh, 3¢ per kwh for the next 100 kwh and an incredibly low 1¢ per kwh for the balance. In contrast, Juneau charged rates between 3¢ and 6¢ per kwh at the same time.[1] Thirty-five years later Ketchikan still held this lead position. In 1957, 500 kwh of power cost $9.88 compared to $10.81 in Juneau and $14.50 in Anchorage. With an average price per kilowatt-hour slightly under 2¢, Ketchikan's rates were even below the average United States price of approximately 2.5¢ per kwh. Such low prices made electric appliances and water heaters commonplace in Ketchikan while they were luxuries, if known at all, in other parts of Alaska. In 1957 the average electric customer in Ketchikan consumed 5,800 kwh of power annually compared to 3,780 kwh in Juneau and 3,759 kwh in Anchorage. Hydropower seemed to be the magic key for bringing a high standard of modern comforts to the North.[2]

By 1980-81 the scene had changed in Ketchikan. Only 11,300 KW of the city's 29,620 KW of installed capacity was hydropowered; 18,320 KW came from diesel generators. Statistics for generation also showed a shift toward diesel, though not as dramatic as the installed capacity might indicate. As Table 3.1 shows, 80% of the kilowatt-hours generated in Ketchikan in 1980 came from hydropower. The remainder was diesel generated. And

Table 3.1 Historical Statistics—Ketchikan Public Utilities[a].

Population	Year	Total Generation (thousand kwh)	Hydro Generation (thousand kwh)	Diesel Generation (thousand kwh)	Peak Demand (thousand KW)	System Capacity (thousand KW)
3,796 (Town)	1933	6,178	6,178	——	1.5	2.6
	1934	6,560	6,560	——	1.6	2.6
	1935	6,800	6,800	——	1.7	2.6
	1936	8,500	8,500	——	2.3	2.6
	1937	10,750	10,750	——	2.6	2.6
	1938	12,217	12,217	——	2.7	4.0
	1939	13,250	13,250	——	3.0	4.0
4,695 (Town)	1940	14,100	14,100	——	3.0	4.0
	1941	14,150	14,150	——	3.0	4.0
	1942	13,250	13,250	——	2.7	4.0
	1943	15,000	15,000	——	3.1	4.0
	1944	16,050	16,050	——	3.4	4.0
	1945	16,900	16,900	——	3.2	4.0
	1946	17,250	17,250	——	3.5	4.2[b]
	1947	18,337	18,337	——	3.7	6.2
	1948	19,150	19,103	46.9	4.0	6.2
	1949	20,726	20,726	0.0	4.5	6.2
5,305 (Town)	1950	22,387	22,331	56.4	4.7	6.2
	1951	23,975	23,931	43.6	5.3	6.9[c]
	1952	26,795	26,608	186.9	5.7	6.9

Table 3.1 Historical Statistics—Ketchikan Public Utilities (Continued).

Population	Year	Total Generation (thousand kwh)	Hydro Generation (thousand kwh)	Diesel Generation (thousand kwh)	Peak Demand (thousand KW)	System Capacity (thousand KW)
	1953	30,885	30,257	627.5	6.0	6.9
	1954	31,536	30,364	1,172.2	6.6	9.9
	1955	32,366	32,339	27.0	7.1	9.9
	1956	33,562	32,819	743.4	7.2	9.9
	1957	34,606	34,445	160.8	7.0	10.1[d]
	1958	35,900	35,900	0.3	7.5	10.1
	1959	37,377	37,344	32.6	7.5	10.1
6,483 (Town) 8,774 (Borough)	1960	37,908	37,907	0.6	7.8	10.1
	1961	39,723	39,696	26.8	8.0	10.1
	1962	42,326	42,302	23.4	8.3	10.1
	1963	44,521	44,485	36.1	9.2	10.1
	1964	47,158	46,900	258.0	10.1	10.1
	1965	48,328	46,900	1,428.0	10.1	12.1[e]
	1966	51,813	50,500	1,313.0	10.5	12.1
	1967	51,811	50,200	1,611.0	10.3	12.1
	1968	54,664	54,200	464.0	11.1	14.2[f]
	1969	56,164	52,000	4,164.0	10.7	14.2
6,994 (Town) 10,041 (Borough)	1970	61,823	57,600	4,223.0	11.8	12.1[g]
	1971	64,385	51,200	13,185.0	12.4	21.1[h]
	1972	67,514	47,668	19,846.0	12.5	21.1
	1973	70,227	56,082	14,145.0	12.4	21.1

Table 3.1 Historical Statistics—Ketchikan Public Utilities[a] (Continued).

Population	Year	Total Generation (thousand kwh)	Hydro Generation (thousand kwh)	Diesel Generation (thousand kwh)	Peak Demand (thousand KW)	System Capacity (thousand KW)
	1974	69,453	56,518	12,935.0	13.4	21.1
	1975	69,168	56,192	12,976.0	13.0	21.1
	1976	76,612	68,534	8,078.0	14.0	29.6[i]
	1977	75,331	67,430	7,901.0	16.3	29.6
	1978	80,538	57,732	22,806.0	15.0	29.6
	1979	80,814	57,739	23,075.0	16.1	29.6
	1980	86,002	68,249	17,753.0	17.7	29.6

[a] Source: Ketchikan Public Utilities, June 1981.

[b] 4,000 KW Hydro, 225 KW Diesel.

[c] 6,000 KW Hydro, 900 KW Diesel.

[d] 9,200 KW Hydro, 900 KW Diesel.

[e] 9,200 KW Hydro, 2,900 KW Diesel. Totem Bight on line.

[f] 11,300 KW Hydro, 2,900 KW Diesel. Silvis on line.

[g] 9,200 KW Hydro, 2,900 KW Diesel. Silvis out.

[h] 9,200 KW Hydro, 11,900 KW Diesel.

[i] 11,300 KW Hydro, 18,320 KW Diesel. Silvis back on line.

the city's electric rates were no longer Alaska's lowest. Ketchikan's average rate of 7¢ per kilowatt-hour was almost double that of Juneau and Anchorage.[3] Why had hydropower lost its hold on Ketchikan? And why had the prices gone up? Was the city disillusioned with its water resources? Were other power sources cheaper? Let us trace the story from the beginning.

Ketchikan stands at the very tip of the southeastern Alaskan panhandle and often refers to itself as the gateway to Alaska or its First City. The First City attracted its first settlers in the 1880s when opportunities in fish packing, mining and lumbering appeared promising. In 1900 Ketchikan incorporated as a city with a population of 459 people. The emerging city presented an opportunity for electric power consumption; the force of Ketchikan Creek which rushed directly through the town made the utilization of this resource almost irresistible. In 1902 the city council issued a franchise to a Juneau resident, Watson J. Hills, to operate a power plant to supply the city with electricity. Hills returned to Juneau and failed to do anything for Ketchikan. So the next year the city issued a franchise to the Citizens' Light, Power and Water Company, a private utility, for the same purpose. Citizens' began construction of a dam on Ketchikan Creek and installed a powerhouse with a 670 KW generator.[4]

Over the next two decades Ketchikan's population increased rapidly and the need for power continually grew. By 1920 Ketchikan claimed a citizenry of 2,458; it was second only to Juneau in size. During this period of growth, Citizens' Light and Power responded by building a dam at Ketchikan Lake and constructing a new powerhouse in 1912. The powerhouse was fitted the next year with two S. Morgan Smith turbines and two 600 KW General Electric generators for a total capacity of 1,200 KW. Between 1920 and 1923 the Ketchikan Lake reservoir and powerhouse were rehabilitated and the capacity was increased to 2,600 KW. The current Ketchikan Lake generating facility with 4,200 KW capacity is the product of these early efforts. The generators installed in 1913 were kept in service until 1957 when they were retired.

While the utility system developed, industrial uses for hydropower were also being found in Ketchikan. In 1908 the New

England Fish Company decided that power to run a cold storage plant for fish packing could best be provided by hydropower. The company built a dam at Lake Whitman and a powerhouse on Herring Bay, both about 5 miles from Ketchikan, with a total capacity of 1,200 KW. As in Juneau, both industrial and utility hydropower were being generated in the first decade of the 20th century. But industrial hydro development did not blossom in Ketchikan as it did in the mining city to the north. No substantial new industrial hydro facilities were built after this venture by the New England Fish Company. Thus, Ketchikan, unlike Juneau, had to continue developing its utility capacity on its own; it could not depend on industrial growth to provide its power requirements.

During the Depression a movement mounted in Ketchikan for the city to acquire the Citizens' Light and Power Company. That company was owned outside of Alaska, and many local residents thought that its profits were doing little to develop the economy of the city. Though the population had risen from 2,458 in 1920 to 3,796 in 1930, the company had installed no new generating facilities. In 1935 the Ketchikan Public Utilities Company, a municipally owned utility, was formed to buy out the private company for $760,000. KPU was now responsible for increasing the generating capacity of the system. It responded in 1938 by adding another generator to the Ketchikan Lake plant, upping its capacity to 4,000 KW.

Demand for electric power increased during the war years. As the Ketchikan Lake facility was approaching its hydraulic limit, KPU looked for a new site. It found an attractive location at Beaver Falls Creek, an easily accessible site about 12 miles from the city where a small canning plant had been operating for decades. The city issued $150,000 in bonds in 1945 to build this relatively inexpensive facility and installed two generators at 1,000 KW each in 1947. While KPU increased its hydro capacity after the war, it also added its first diesel generator as a standby supply of power. To meet demand before the Beaver Falls plant could be brought on line, the city purchased three 75 KW diesel generators in 1946. After a flood and fire temporarily knocked out the Ketchikan Lake plant in 1951, the utility added three 300 KW generators as standby power until the facility was operational a year later. These were the only diesel units required until 1965.

The consumption of electric power continued to rise in the early 1950s. By 1953 the utility had exceeded its hydro capacity, and the diesel generators had to be run continuously to meet demand. Also, some of the equipment installed in 1912 and 1913 was in need of rehabilitation and possible replacement. Fortunately both the Beaver Falls and Ketchikan Lake plants could be rehabilitated and their capacity increased. In 1954 and 1957 these plants were refurbished with approximately $3 million in funds coming from additional bond sales. After this work was completed, the system had a capacity of 10,100 KW, with all but 900 KW in hydroelectric facilities.[5]

The above recitation of the installation and rehabilitation of generators may sound tedious to some, but it has been done with a purpose. From 1903 to 1965 Ketchikan was peculiarly blessed, and possibly even spoiled, in the ease with which it continually expanded its hydroelectric system. The city had two easily accessible sites which required relatively small capital costs compared to many other hydro installations. And both sites proved capable of being enlarged and rehabilitated for convenient additional increments of power. Thus the city did not face the problem of having to look for new and possibly more expensive locations. As a result the price of electricity, which was cheap to begin with, actually fell in Ketchikan as the system grew. In 1922, 100 kwh of power cost $5.16; 500 kwh cost $10.12. In 1957 these figures were $4.00 for 100 kwh and $9.88 for 500 kwh. In short, Ketchikan had been lulled for several decades into believing that it could constantly increase its demand for electricity and meet it without a rate increase. What would happen when both Ketchikan Lake and Beaver Falls reached their limit?

Even before statehood in 1959, the potential power needs of Ketchikan had been noted by many observers, including the federal government. After World War II the outlook for the construction of a pulp mill in Ketchikan led the United States Bureau of Reclamation to investigate the feasibility of constructing a federally financed project at Swan Lake, a site 22 air miles northeast of

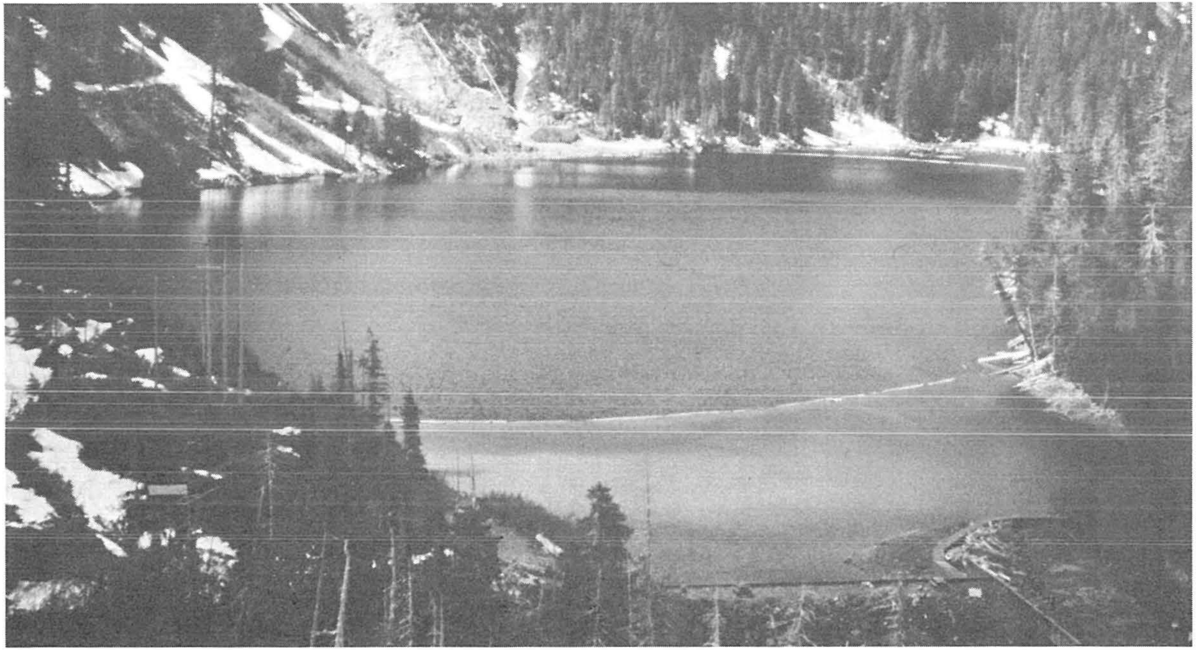

Figure 20. Lower Lake Silvis is one of two reservoirs that power the Silvis—Beaver Falls project near Ketchikan. The Silvis powerhouse can be seen in the background.

Ketchikan. This project would cost $13 million, have a capacity of 13,500 KW and be capable of generating 71 million kwh annually. According to the Bureau's economic projections, the opening of a pulp mill would raise the city's generating need to 73 million kwh by 1957. Though the Bureau noted that Swan Lake power would probably be more expensive than that coming from the older facilities, it nonetheless recommended in 1951 that the project be built.[6]

The projections about the growth of Ketchikan waned over the decade of the 1950s. The Ketchikan Pulp Mill did open in 1954, but it required no additional hydroelectric power. The mill was able to produce more than enough electricity for its own needs through an internal steam system using the plant's wood waste. General utility demand was slowed in the late 1950s when a number of fires in the central business district held back commercial growth. By 1959 Ketchikan's electric demand was only 37 million kwh—a far cry from the 73 million kwh which had been projected. As a result the Bureau recommended in that year that Swan Lake not be built.[7]

The Bureau's withdrawal from the Swan Lake project temporarily placed responsibility for increasing generating capacity back in the hands of the utility. From 1957 to 1963 KPU commissioned several engineering firms to prepare studies of Ketchikan's future generating needs. All of the firms suggested that the city build additional hydro facilities. The favored additions included yet another expansion of the Beaver Falls plant, a rehabilitation and expansion of the old New England Fish Company facility at Lake Whitman, and the construction of a new powerhouse between the Beaver Falls plant and its large reservoir at upper Lake Silvis.[8]

By 1962 plans were afoot to build the Lake Whitman facility with 4,000 KW of capacity. This facility would require a $1.5 million bond sale. The voters of Ketchikan, however, were reluctant to go into such a debt. According to former Ketchikan Public Utility manager Don Bowey, the city council kept hoping that some outside source would finance the city's power needs.[9] The Bureau of Reclamation's early interest in Swan Lake had turned Ketchikan's eyes toward the federal government. In the 1960s the city tried to convince itself that such funds would eventually materialize if it would wait long enough.

Figure 21. The Beaver Falls powerhouse has supplied power to Ketchikan since 1947.

Bowey noted that in the early 1960s Alaska's Senator Ernest Gruening advocated the construction of the giant Rampart hydro plant on the Yukon River. This enormous facility with a colossal *5.8 million* KW capacity would generate enough power for the entire state as well as for much of the Pacific Coast of the United States. If this plant were built, Ketchikan would not need to pay for additional facilities. According to Bowey, Ketchikan also hoped that the United States and Canada might build the proposed Yukon-Taiya power project. This enormous facility rated at 700,000 to 4 million KW had been advocated by federal power promoters since the late 1940s. A dam would be located on the Yukon River in Canada near Whitehorse. Water would then be diverted via a 17 mile tunnel across the international border to a power plant on the Taiya River near Skagway, Alaska. Electricity from the project would be used primarily to power electric smelters for a proposed aluminum plant near Skagway. Excess power from Yukon-Taiya, some hoped, could then be transmitted to southeastern Alaska. Though negotiations between Canada and the United States on this project had broken off in 1950, there was hope that talks might soon be reopened.

Even more federal possibilities loomed on the horizon. The city was able to convince the Bureau of Reclamation to reconsider its decision on Swan Lake. In 1962 the Bureau announced that the quickened economic pace which statehood was bringing might make Swan Lake a long-range possibility.[10] Though the Bureau committed itself to no timetable, Ketchikan hoped that if it could hold out long enough, Rampart, Yukon-Taiya or even Swan Lake might be built at federal expense. On a less grand scale, Ketchikan found in 1962 that it could apply for a special federal grant which might provide 50% of the financing for Lake Whitman. The city therefore applied for the loan and postponed the bond sale.

Ketchikan hesitated to go into debt. Possibly it feared that initial financing costs might raise its power rates above their longtime lows. Though the voters of Sitka had approved a $6,000,000 bond sale in 1956 and had a new 6,000 KW hydro plant on line in 1961, Ketchikan hoped it would not have to saddle itself with a similar burden (see Chapter 4 for the Sitka story). Unfortunately its hopes did not materialize. By 1964 no federal funds had come to Ketchikan's relief. The Rampart project encountered mounting criticism from environmental groups, and talks to reopen consideration of the Yukon-Taiya project had not begun.

In the spring of 1964, the utility once again proposed a bond issue to increase its hydro capacity. The $3.5 million bond package would add 4,000 KW to the existing Beaver Falls plant and provide for the construction of a new powerhouse between Beaver Falls and upper Lake Silvis with 2,100 KW capacity. To provide sufficient hydraulic capacity to power the new plant, the dam on upper Lake Silvis would be raised to increase its reservoir. Water would then flow through the Silvis power plant and out into another forebay reservoir at lower Lake Silvis. The same water would then flow to the Beaver Falls plant. The arrangement was similar to the Salmon Creek facility in Juneau. The same water would do double duty!

The package was still relatively inexpensive compared to Sitka's investment of $6 million for 6,000 KW a decade earlier. But the voters of Ketchikan turned it down, first in April of 1964 and then again in October. Opponents of the plan argued that it would double the utility's indebtedness and would fill Ketchikan's power needs for only five to seven years. The antihydro forces thought it would be better to generate additional diesel power which would cause no indebtedness until Ketchikan could convince the federal government to build Swan Lake. Some even suggested selling the utility back to the private company which had previously owned it. Though KPU provided the city with the lowest electric rates in Alaska, its opponents said the utility had promised in the 1930s to make Ketchikan a tax-free city by using its revenue surpluses to offset property taxes. To them the utility was not living up to its promise. Thus for a host of different reasons, the citizens of Ketchikan seemed to have a single determined purpose; they did not want to incur any financial obligations in providing for their own needs.[11]

With the defeat of the bond issue, KPU was left with only one choice: install additional diesel generating facilities. In 1965 it installed its first substantial diesel generating facility—the Totem Bight plant with 2,000 KW capacity. The amount of diesel generated power quickly jumped from 258,000 kwh in 1964 to 1,428,000 kwh in 1965.

Even with the added diesel power, the utility was in constant danger of reaching capacity, particularly in those times when the hydro plants faced their most severe hydraulic limitation. In January 1966, the utility announced that demand for that month exceeded its capacity. Once again it asked the voters to approve a bond issue for hydro construction. This time the package was only $1.6 million which provided for raising the reservoir at upper Lake Silvis and constructing the Silvis power plant—the additional capacity at Beaver Falls was excluded. In February 1966, the voters accepted this smaller package and construction was underway by June.

With the approval of the Silvis power plant, it appeared as if Ketchikan's half century of good luck in obtaining cheap hydroelectric power might be returning. In September 1968, the Silvis plant went on line and Ketchikan's dependence on diesel power declined substantially. In 1967 the utility generated 1,600,000 kwh of diesel power; in 1968 it generated only 464,000 kwh. But in 1969 the city, oddly enough, found itself generating more diesel power than ever before—over 4 million kwh. Had something gone wrong?

In early 1969 the Ketchikan Lake and Beaver Falls plants produced much less energy than in previous years because of hydraulic limitations; there was not sufficient water in their reservoirs to produce maximum energy. That problem could solve itself only with increased rainfall. In November 1969, the rains came and deposited 42 inches of water. But this deluge did not solve Ketchikan's problem.

The rainfall was particularly heavy toward the end of the month. On November 27, 12.99 inches fell. The next day the mountain face below the upper Silvis reservoir collapsed and destroyed the Silvis powerhouse, covering it with 15-25 feet of mud, rock and debris. The mountain collapse occurred, according to Bowey, "because the spillway weir which was constructed as part of the upper Silvis Lake reservoir was not provided with a spillway channel which would have contained and carried water from the upper Silvis spillway weir. Lacking such a controlled method of conveying the water from upper Silvis Lake to lower Silvis Lake, which is some 327 feet below the upper lake, the water was free to seek its own paths over and through the native material below the spillway weir on its way to lower Silvis Lake. This caused saturation of the native material down to bedrock and undercutting of the . . . mountain slope . . . which created the condition for the massive land slide."[12]

Why was there no spillway channel to divert the water? According to Bowey, the problem lay with the expertise of the consulting engineers, Stearns-Roger Corp. of Denver, Colorado. Bowey claimed that Stearns-Roger, one of the largest engineering firms in the world, simply lacked expertise in Alaskan conditions and thus underestimated both the need for a spillway channel and the ability of the mountain face to absorb a water overflow. Ketchikan Public Utilities sued Stearns-Roger Corp. and eventually settled out of court with the firm's insurance carrier for approximately $800,000. KPU sued Stearns-Roger and settled out of court for approximately $800,000.

When asked about the Silvis collapse, W.T. Geiger of Stearns-Roger Corp. responded that his firm prefers to call the incident an "operational" failure rather than a fault of engineering. Geiger went on to say that Stearns-Roger believes "the engineering design of the project was adequate for the site and circumstances." He noted that in the opinion of the firm, "the rock flow which occurred was caused by excessive water discharge from the spillway channel. Major contributing factors to the failure," he said, "were the budgetary restraints, and actual operating procedures." Geiger pointed out that the disagreement over the Silvis collapse has never been resolved in or out of court. Stearns-Roger's insurance carrier chose to settle KPU's claim without pushing the engineering firm's case.[13]

I do not now intend to offer a final answer either. However, the existence of the disagreement to the present day highlights a problem facing a small utility. The utility must hire an outside engineering firm to design a new facility; it cannot support an in-house engineering department of this magnitude. How can a city council or local utility manager know how to trust a firm's estimates—particularly if the firm has a national and international reputation? Is a worldwide reputation proof of expertise in a particular setting in Alaska? Such questions need to be raised. Whether they can be satisfactorily answered is another matter.

While KPU awaited a settlement with Stearns-Roger, Ketchikan was thrown back on the need to generate additional diesel power. In 1971 the city added another 9,000 KW in diesel capacity. Diesel generation quickly soared from 4.2 million kwh in 1970 to 13.1 million in 1971 to 19.8 million in 1972. With the price of fuel oil constantly rising, Ketchikan's voters decided to accept a KPU bond proposal of $1.5 million in February 1974 to rebuild the Silvis plant. The reconstruction of Silvis began in July 1974; the plant came back on line in December 1975. Ketchikan's diesel generation dropped to 8 million kwh in 1976 and held at that level in 1977.

The increasing cost of diesel generation and the expense of rebuilding Silvis took its toll on Ketchikan's cheap power rates. The price of 500 kwh of power rose from $12.03 in 1968 to $14.85 in 1974 and then to $24.69 in 1976. While the 1976 figure was still less than Juneau's $25.10 for the same amount of power, it was substantially more than the Anchorage charge of $19.80.[14] And the renewed capacity of Silvis did not markedly improve matters. Soon after the plant went on line, hydraulic limitations again restricted the amount of water available for hydro generation in the KPU system. Hydro generation dropped from 67.4 million kwh in 1977 to 57.7 million in 1978. It remained at that low mark in 1979. The drop in hydro generation had to be made up with diesel power at ever-increasing fuel costs. In 1978 and 1979 Ketchikan generated about 23 million kwh in diesel power annually. Though diesel generation dropped to 17.8 million kwh in 1980, 500 kwh of power had risen in price to $35.80. Low-cost power seemed a vanishing goal in the First City.

Some recent statistics may highlight the dilemma of increasing diesel generation. In 1980 the operation and maintenance cost of hydropower in the Ketchikan system was 8.7 mills per kwh. For diesel power the figure was 84.7 mills of which fuel alone claimed 60 mills with labor and materials accounting for the remaining 24.7 mills. These figures did not include capital costs or the cost of transmitting the power. Still, one thing was clear. At KPU's 1980-81 average retail price of 7¢ (70 mills) per kwh, the operation and maintenance cost of the diesel power was not even covered.[15]

Hydropower provided a substantial subsidy per kwh for the diesel power. Thus if diesel generation increased, the price would rise even if fuel costs remained the same. The subsidy provided by a fixed—and in some years a decreasing—amount of hydropower would be diluted by more and more diesel power. Only an abundant rainfall could bring relief by raising hydro generation. In 1980-81 the cost of power in the First City was almost out of the hands of the utility and in the hands of nature. Could there be any way out of this dilemma?

The picture no longer appears so bleak. In the late 1970s the city revived its plan to investigate construction of a major new hydro facility. Attention once again turned to Swan Lake. Figures for that facility had risen since 1951. Its installed capacity was now rated at 22,000 KW with an annual generation of 85 million kwh. The estimated price of the project in the late 1970s was $80 million ($93.5 million in 1982). This sum seemed overwhelming. According to Don Bowey, the city council was again reluctant to approve such a massive bond sale—even if it could obtain financing. Even more problems beset Ketchikan's ability to go ahead with Swan Lake. There were several other potential hydro sites in the Ketchikan area, including Lake Grace and Mahoney Lake. Bowey noted that competing engineering firms tried to sell the virtues, and possible lower costs, of these different projects to the city council. This delayed a firm decision on any project. Would the city hesitate indefinitely?

Finally between 1978 and 1980, that long awaited outside aid came—not from the federal government, but from the State of Alaska. Through the Alaska Power Authority, the state agreed to lend Ketchikan $19.5 million at 5% interest to begin plans for Swan Lake. Ketchikan accepted this loan with the expectation that the legislature would be able to appropriate construction funds at 5% when the plans were completed. Based on state financing Ketchikan was able to show when it applied for a license from the Federal Energy Regulatory Commission that the construction of Swan Lake would be cheaper in its first year of operation than new diesel or gas turbine generation. Table 3.2 provides these figures.

Table 3.2 Comparative Costs of Swan Lake vs Diesel vs Gas Turbine[a].

	Swan Lake Hydroelectric	Diesel	Combustion Turbine
Installed Capacity (KW)	22,000 (2—11,000 KW units)	24,750 (9—2,750 KW units)	24,000 (8—3,000 KW units)
Dependable Capacity (KW)	18,000	18,000	18,000
Capital Cost ($)			
Total	80,924,000	17,047,000	12,355,440
Generating Plant	63,687,188	15,424,943	10,733,383
Substation	2,023,100	1,622,057	1,622,057
Transmission Line	15,213,712	——[b]	——[b]
Fixed Charge Rates (percent capital cost)			
Generating Plant	6.08	8.32	8.32
Substation	7.11	8.32	8.32
Transmission Line	6.81	——[b]	——[b]
Annual Cost Associated W/Capital Investment ($)	5,052,077	1,418,000	1,027,973

Table 3.2 Comparative Costs of Swan Lake vs Diesel vs Gas Turbine[a] (Continued).

	Swan Lake Hydroelectric	Diesel	Combustion Turbine
First Year O & M and A & G Cost ($)[c]			
Total	272,981	1,073,000	677,811
Generating Plant	218,953	1,073,000	677,811
Substation	21,893	——	——
Transmission Line	32,135	——	——
First Year Fuel Costs ($)[c,d]	——	4,047,600	5,667,144
Total Annual Cost First Year ($)[c]	5,325,058	6,538,910	7,372,928

a Source: U.S. Federal Energy Regulatory Commission, *Swan Lake Project No. 2911 Alaska Final Environmental Impact Statement* (Washington: FERC, 1980).

b Transmission cost negligible because diesel and combustion turbines would be located at load center.

c Assumes 1983 is first year.

d Assumes 85,400,000 kwh generation.

With state financing and a federal license granted, it appeared that Ketchikan's luck had finally returned. But in April 1981, the city's dependence on the generosity of the Alaska Legislature almost proved a disaster. Ketchikan was ready to sign a construction contract for Swan Lake. But political upheavals in the Alaska Legislature caused politicians to hold back on further appropriations for hydropower in the state. While the legislature battled, the Alaska Power Authority was able to arrange an interim three-year construction loan through a consortium of bankers. The city gambled that the legislature would eventually appropriate the funds.[16]

This was a tremendous gamble. According to KPU manager Bob Arnold, Ketchikan's 7¢ power rate could remain constant for one year under the terms of the loan. If the state failed to appropriate funds in one year, interest on the loan would force KPU to increase its rates such that they would double by the end of 1982. If no state appropriation came at the end of three years, the city might have to sell bonds in the open market. At interest rates of 14-17% the price of power might soar beyond 25¢ per kwh. Would people pay such rates? Would the utility, and ultimately the city, have to contemplate bankruptcy?[17]

Fortunately for the city this did not occur. In June 1981, the legislature designated the prior loans as grants and appropriated an additional $53 million for construction of Swan Lake.[18] A second Ketchikan hydro disaster, this time an economic one, was averted. The city's luck seems to have returned. When Swan Lake goes on line as scheduled in December 1983, the First City may once again reclaim its former role as hydro city.

Ketchikan's experience with hydropower from 1903 to 1981 is one of the longest in Alaska. What can we learn from it?

1. As in Juneau, the facilities in Ketchikan have demonstrated the extraordinarily long operational life of hydro equipment. With some modification the Ketchikan Lake plant has been in operation since 1912. Pelton turbines, manufactured in 1904, were installed and used in the Beaver Falls plant in 1947 and are, with some modification, still in

operation today. KPU is well aware of the decreasing cost of hydropower which can result from the low operational costs of a facility which outlasts its amortization period. Because Ketchikan's initial capital expenses were so low, the city actually experienced declining power costs between 1922 and 1960. The low cost of its hydropower today has been crucial in subsidizing its current diesel production.

2. The Ketchikan story indicates that hydropower can be *extraordinarily* cheap if the topography in a given area provides sites which require little capital investment to develop. The Ketchikan Lake and Beaver Falls sites also allowed Ketchikan to add relatively small additional increments of hydropower at a low cost per installed kilowatt—for example, the Silvis powerhouse. One might argue from the Ketchikan story that small installations are thus more economical to build than larger projects. This was indeed true in a few cases in Ketchikan. But the economy derived from the small project was based solely on the existence of a peculiarly good site, not on any inherent advantage in a small project.

On the other hand, one could also argue that Ketchikan's initial good fortune in adding small increments of power inhibited its ability to plan for a larger project. This planning dilemma may well have forced it into its current dependence on diesel generation.

3. The Ketchikan story provides evidence of the difficulty which a small utility with an isolated load center faces in building a major engineering project such as a hydroelectric facility. The disaster at the Silvis powerhouse and the utility's concern over the engineering firm which designed the project should be given careful thought. Can a small utility properly evaluate the advice it is given by an outside engineering firm? Should the city council of a small community be burdened with the responsibility of making a choice between firms? Or is there a need to develop some type of resident engineering expertise, say an engineering division within the Alaska

Power Authority, which could free a small utility from having to pick and choose between different outside firms?

4. The Ketchikan story also indicates the difficulty faced by a small utility or municipality when financing a large hydro project such as Swan Lake. On the one hand, a municipality may be reluctant to accept the initial debt burden which even the most economical installation presents. On the other hand, we may ask whether a city can be expected to take the kind of gamble which Ketchikan took in the final financing of Swan Lake. Once a municipality has feared economic disaster in the construction of a hydro project, it may be reluctant to consider any future projects.

5. Finally, the Ketchikan story is one of many examples in the state which shows that economic/industrial growth and hydroelectric growth do not necessarily go hand in hand. The Ketchikan Pulp Mill did not increase the need for hydropower. And the existence of hydropower was not crucial in attracting the mill. Thus one may deduce from the Ketchikan story that the building of additional hydro facilities will not, by itself, draw new industry for the simple reason that some industries do not need hydropower. Some can, in fact, satisfy their electric needs more advantageously in other ways.

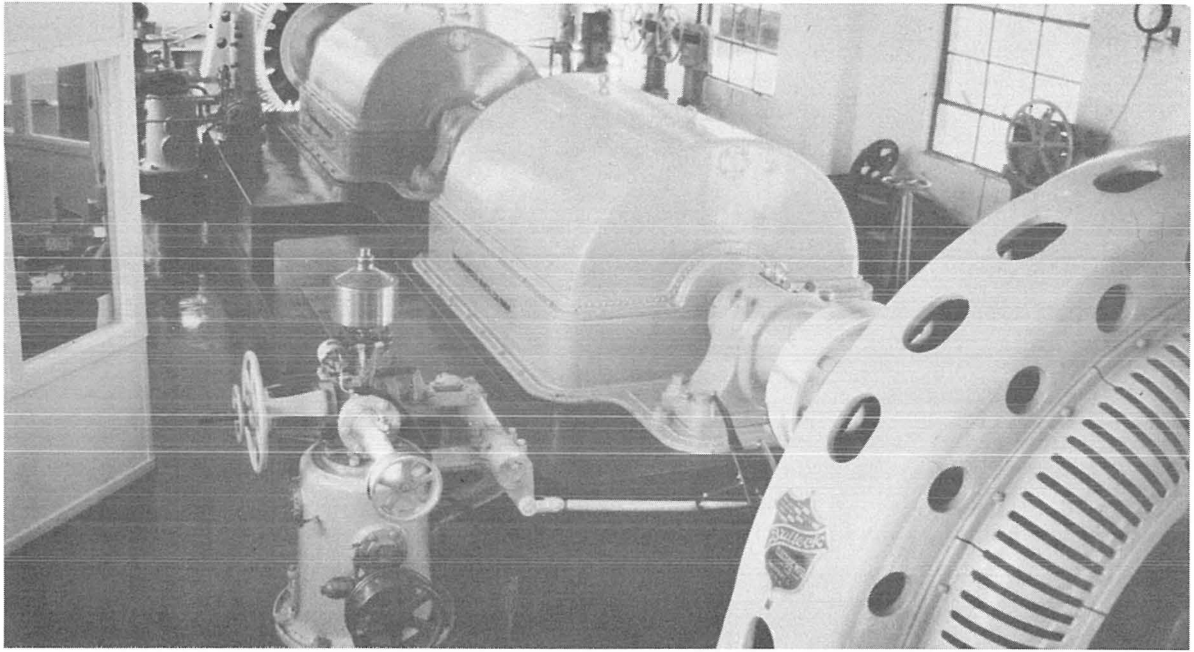

Figure 22. The waterwheels in the Beaver Falls powerhouse in Ketchikan were originally made in 1904. They were rehabilitated and brought to Ketchikan in 1947. Further rehabilitation took place in 1962.

Footnotes

1. 1922 rates taken from J.C. Dort, *Water Powers of Southeastern Alaska* (Washington: Government Printing Office, 1924), pp. 136-137.
2. 1957 rates taken from U.S. Federal Power Commission, *Alaska Power Market Survey 1960* (San Francisco: U.S. Federal Power Commission, 1960), p. 67.
3. 1980-81 prices and generation figures furnished by Ketchikan Public Utilities. June 1981 rates were: first 20 kwh, $7; remaining kwh at 4¢ per kwh plus 2¢ per kwh fuel surcharge.
4. For the early history of Citizens' Light, Water and Power Company see Dort, pp. 134-36. Additional information furnished by KPU.
5. Data on the increase in installed capacity furnished by KPU.
6. U.S. Bureau of Reclamation, *A Report on the Swan Lake Project, Alaska* (Juneau: U.S. Bureau of Reclamation, 1951).
7. See U.S. Bureau of Reclamation, *Swan Lake Project Re-Evaluation Study* (Juneau: U.S. Bureau of Reclamation, 1962), for details on the 1959 decision.
8. Information on the various engineering reports furnished by KPU.
9. Interview with Don Bowey (retired as KPU Manager, 1/1/80), June 15, 1981, Ketchikan. All further references to Bowey come from this interview, unless otherwise noted.
10. U.S. Bureau of Reclamation, *Swan Lake Project Re-Evaluation Study* (Juneau: U.S. Bureau of Reclamation, 1962).
11. For details on the opposition to the 1964 bonds see Ketchikan *Daily News* April 20-29, 1964, and October 1—October 7, 1964.

12. Letter, Don Bowey to author November 27, 1982. Also see Ketchikan *Daily News*, November 28, 1969—February 4, 1970, for details of the Silvis disaster.
13. Letter, Willard T. Geiger to the author, November 13, 1981. (There may be a problem of terminology in the quotes. Geiger indicates the existence of a spillway *channel*. Bowey says there was a spillway or spillway *weir* but no spillway *channel*. A spillway *weir* is part of the dam; a spillway *channel* leads water away from the weir.)
14. 1968 rates are from U.S. Federal Power Commission, *Alaska Power Survey 1969* (San Francisco: U.S. Federal Power Commission, 1969), p. 30. 1974-76 rates are from Alaska Power Administration, *Alaska Electric Power Statistics 1960-76* (Juneau: Alaska Power Administration, 1977), p. 37.
15. Operating expenses for hydro and diesel furnished by KPU.
16. See Ketchikan *Daily News* April—May, 1981, for a day-by-day description of the problems connected with the financing of Swan Lake.
17. Interview with Bob Arnold, Ketchikan, June 15, 1981.
18. *Session Laws of Alaska 1981,* Chapter 90, Chapter 91. NOTE: All state appropriations for Swan Lake are made through the Alaska Power Authority.

Chapter 4
Sitka - Big Bonds in a Small Town

The visitor to Sitka today will find a city which in many ways appears to be a model of community planning. The city is located on Baranof Island in the southeastern Alaskan panhandle. It abounds with all aspects of Alaska's heritage. St. Michael's Russian Orthodox Church stands as a reminder that Sitka was once Alaska's Russian capital. The neat campus of Sheldon Jackson College with its English Tudor buildings brings back memories of early missionary activity. The totem-filled Sitka National Historical Park, run by the National Park Service, provides one of the most beautiful displays of native culture in the state. First-class hotels offer more than adequate comfort in what one might initially think is only a tourist town.

This is not, however, the full picture. Sheltered in a cove about four miles from the city is the Alaska Lumber and Pulp Mill, opened in 1959 and owned by a Japanese corporation. Also neatly tucked into this island setting are two hydroelectric facilities—Blue Lake, which has been operating since 1961, and Green Lake, which went on line in 1982. Blue Lake lies in a picture postcard setting a few miles east of Sitka. The dam, which was built to increase the lake's reservoir capacity, has a "ski-jump" type spillway which creates a waterfall effect when the lake reaches its crest. The Green Lake powerhouse nestles on the shores of Silver Bay about 12 miles from the city and lies next to a rushing stream. The combination of the powerhouse and the stream create a picture of an almost perfect blend of nature and technology. This picture of harmony on the island might quickly lead the visitor to conclude that Sitka must always have been this way. Sitka, like Ketchikan and Juneau, must surely have a record of progress with hydropower stretching back to the turn of the century.

Such is not completely the case. Though waterpower sites on Baranof Island were well recognized by the turn of the century, the harmony and order in Sitka are of relatively recent vintage. Twenty to thirty years ago Sitka possessed a fairly primitive electric system. While industrial development in Juneau and utility development in Ketchikan brought cheap electricity to those communities by the 1920s, Sitka lagged behind. As late as 1957 the average annual consumption of electricity per customer was only 1,750 kwh compared to 5,800 kwh in Ketchikan. In Sitka 500 kwh of power cost $26.50 compared to $9.88 in Ketchikan. Two decades later, however, the tables had turned and power was less expensive in Sitka than in its neighboring city to the south. In 1976 a Sitka customer paid $20.90 for 500 kwh of power compared to $24.69 in Ketchikan. Why did Sitka, which was a much older community than Ketchikan, lag so far behind? And how did it catch up so rapidly?[1] Let us trace the story from the beginning.

Sitka was founded as a Russian trading settlement in the late 18th century. In 1804 the Russians made it the permanent center of their North American empire. After the United States and Russia signed the Alaska Purchase Treaty in 1867, American troops took possession of the new land. Sitka was the capital of Alaska from 1867 to 1906. In 1900 Sitka's population stood at 1,396, but the transfer of the capital to Juneau in 1906 set the population of the city back to 1,039 by 1910. By 1920 Sitka had grown marginally to include 1,175 souls. Though Sitka's population did not grow like that of Juneau or Ketchikan in the early 20th century, a community of 1,000 still provided a market for electric power. And like most communities in southeast Alaska, Sitka possessed a number of potential waterpower sites—the most promising of which was located near Blue Lake and the Medvetcha River about six miles from the city.

As early as 1910 some men had envisioned building a small dam near Blue Lake with a tunnel to carry water to a powerhouse near tidewater. Unfortunately, the development of Blue Lake required greater resources than these men could command, and the plan was abandoned. In 1912 and 1913 the Sitka Wharf and Power Co., a private, locally owned utility, built a small dam and powerhouse on Sawmill Creek, as the Medvetcha River was called locally, about two miles below Blue Lake. The powerhouse had a capacity of only 160 KW to provide power not only for a cold storage plant but for general utility purposes in Sitka.[2]

Ten years after this installation, the Blue Lake site still lay undeveloped. In 1924 J.C. Dort of the Federal Power Commission noted that Blue Lake could well be utilized to increase the capacity of Sitka Wharf and Power's facility. According to Dort, "No storage has been developed, but there is an excellent reservoir site at Blue Lake. . . . The lake outlet is through a narrow rocky gorge where a dam up to 150 feet could be built at reasonable cost."[3]

Almost two decades after Dort's report, Sitka Wharf and Power Co. had done little to increase the capacity of the 1913 system, though it did add another 160 KW generator in the existing powerhouse. In 1941 Sitka's population was 1,987, stimulated by the installation of a U.S. Navy air station on nearby Japonski Island. But the city had a hydroelectric generating capacity of only 320 KW compared to 4,000 KW in Ketchikan. Alaska's Territorial Governor Ernest Gruening was embarrassed that the Navy should find such a state of affairs. And he was particularly outraged because the utility was owned by a local resident who seemed to have no more interest in developing the town than the outside company which had owned Citizens' Light and Power in Ketchikan. With Gruening's urging, the Sitka city council decided to purchase the Sitka Wharf and Power Co. and establish a municipal utility. In 1941 the city paid $115,000 for the facility—quite a high price compared to the $760,000 Ketchikan paid for its 2,600 KW system in 1935. Gruening was again outraged thinking that the local owner, Mr. Walter Mills, had exploited his fellow townspeople once again.[4]

Sitka Public Utilities immediately took on the responsibility for developing the Blue Lake site. However, little had come of this by the end of World War II. In fact, floods on the Medvetcha River damaged the existing system in 1943 and destroyed it beyond repair

Figure 23. Blue Lake reservoir provides the water source for one of Sitka's hydroelectric plants.

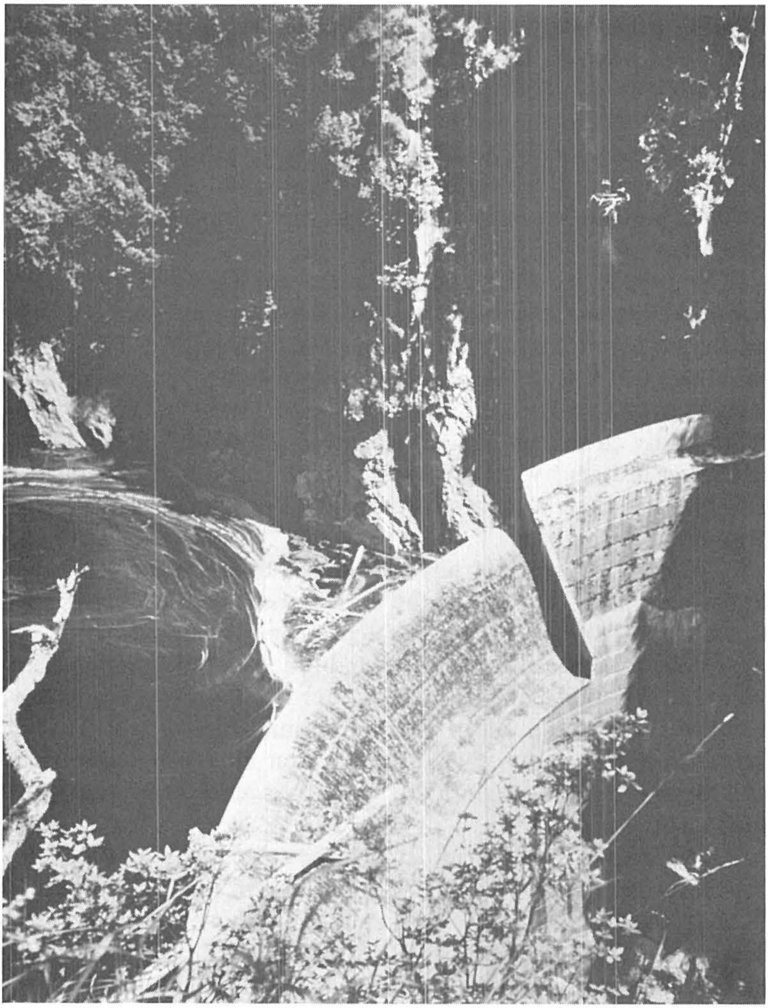

Figure 24. Sitka's Blue Lake Dam has a "ski-jump" spillway which creates a waterfall effect when the reservoir overflows.

in 1947. Fortunately the U.S. Navy had constructed a 3,000 KW steam electric plant for its facility on Japonski Island with a submarine cable connecting the system to Sitka. After the war the Navy turned the plant over to the Alaska Native Service for its Mt. Edgecumbe school and hospital. As the navy facility could generate more than enough power for Mt. Edgecumbe, the Sitka Public Utilities purchased nearly all of its electricity from the Native Service after 1947.[5]

In 1950 Sitka still possessed a pathetic electric system. The hydro facility was destroyed, and the city owned only one 240 KW diesel generator. Though the steam plant on Japonski Island was rated at 3,000 KW, it had a peak capacity of only 1,900 KW in the winter. With a power price of 7-8¢ per kilowatt-hour, only 100 Sitka utility customers had electric ranges, and only two had electric water heaters.[6] What a contrast to the state of electric comfort enjoyed less than 175 miles south in Ketchikan. The two cities seemed worlds apart.

Despite—or possibly in reaction to—this gloomy scene, the utility continued to plan for the development of Blue Lake. Like Ketchikan, Sitka hoped the federal government would finance this hydro plant. According to a utility publication, "All through these years the feasibility of the Blue Lake project was constantly pursued with the Rural Electrification Administration, the Federal Works Administration, the Reconstruction Finance Corporation, and the Navy all being considered possible agencies through which funds could be obtained . . . ."[7]

The federal government did provide some planning funds immediately after World War II. The future looked bright indeed in 1952-53 when the Bureau of Reclamation paid for and conducted a complete feasibility study of Blue Lake. The Bureau felt that Sitka's future power needs called for a new facility, particularly since Sitka, like Ketchikan, hoped to attract a pulp mill. Such an industrial installation, the Bureau thought, could well justify the Blue Lake project. However, in its 1954 report the Bureau recommended only that further planning of Blue Lake be considered. It also said that assurance of the pulp mill development must come before any future steps were taken. This recommendation was quite different from the Bureau's 1951 statement that Congress immediately authorize construction of the Swan Lake project in Ketchikan. The federal government had hardly given Sitka the green light.[8]

Possibly the Bureau's lukewarm support nudged the city into realizing that it would have to accept primary responsibility for financing the project. The city may also have feared that it might lose the proposed pulp mill if it showed no initiative in developing its power system. Whatever the prod, in June 1956, the voters of Sitka approved the sale of $5 million in bonds for Blue Lake with a vote of 241 to 6. Later they increased the amount to $6 million.

Though Sitka had been willing to take this step, the move was almost for nought. Authorizing the bond sale was one thing, selling the bonds was another. With a population of a little over 2,000 Sitka found that no financial house would look at its bond prospectus. Affairs looked dim until 1957 when the Alaska Lumber and Pulp Co. announced that it would definitely locate its plant in Sitka. Like the pulp mill in Ketchikan, AL&P would need no hydroelectric power; it could produce all of its electrical needs through its own internal steam plant. But it did need a water supply and Blue Lake could provide it. In September 1957 the city and AL&P signed a mutually advantageous pact called the Water Plan whereby the company agreed to purchase $2.2 million in Sitka bonds. These funds would be used to construct a portion of the Blue Lake dam and a tunnel to convey water to the mill. AL&P also agreed to help construct a portion of that tunnel. To complete Blue Lake for hydroelectric production, the city would have to raise the dam, extend the tunnel, build a powerhouse and equip it with turbines and generators. Even more importantly, it would have to sell the remaining $3.8 million in bonds. This was by far the harder task. According to the utility, "It seemed that prospective buyers had a deep rooted fear of construction estimates in Alaska and the inability of an Alaskan city to meet its commitments. Sitting in their offices in the "lower 48" they seemed to prefer to do business with cities they knew, rather than with unknown cities which they imagined to be bleak, rugged, slightly unconventional country somewhere north of the Arctic Circle."[9]

Sitka did not despair and once again sought aid from the federal government, this time from the Housing and Home Finance Agency. The city hoped the agency would lend it the funds to complete the Blue Lake project. Fortunately the city's application went to that agency in 1959—just as Alaska entered the union. The new state now had a full congressional delegation and Alaska's E.L. "Bob" Bartlett, long a voteless delegate, was now a U.S. Senator. Bartlett was able to conclude an arrangement for financing through the H&HFA based on the potential purchase of power from Blue Lake by the U.S. Public Health Service for its Native hospital at Mt. Edgecumbe. Technically the agency could not fund a potential or unbuilt project, but it agreed to purchase Sitka's bonds at 5% once Blue Lake was completed. With such a guarantee, interim construction financing was arranged through a consortium of banks.

With financing finally obtained the city awarded a construction contract in September 1959; 20 months later Blue Lake went on line with an initial capacity of 6,000 KW. Once the project was completed, Sitka found it did not have to rely on the federal loan guarantee. A private financial house, Foster and Marshall, purchased the $3.8 million in bonds for 4%—one percentage point lower than the H&HFA offer.

In 1961 Sitka finally had a modern hydroelectric facility after a 50-year struggle. Furthermore, Sitka obtained a modern municipal financial base and a credit rating through its bond sale. By overcoming the rebuff dealt it by the initial rejection of financial houses, Sitka was in many ways fortified with a spirit of civic pride that it could do things on its own. This spirit—along with the credit rating—would be called upon two decades later to construct the Green Lake project. In some ways the feat of financing Blue Lake was as extraordinary a part of Alaska's hydro heritage as Bart Thane's engineering achievements in Juneau almost a half century earlier.

Sitka was justly rewarded for building Blue Lake. Hydropower brought those comforts to Sitka which had eluded it before. Five hundred kwh of power which cost $26.50 in 1957 dropped to $19 by 1968. The number of residential customers rose from 770 in 1957 to 1,333 in 1969. Even more astounding was the rise in usage from 1,750 kwh annually per customer in 1957 to 6,516 kwh annually in 1969. Sitka's hydropower was slightly more expensive than in Ketchikan where 500 kwh cost only $12.30 in 1968. But Sitka's price, of course, included the cost of financing Blue Lake.[10]

Blue Lake clearly succeeded in bringing Sitka the electric power its citizens desired. Success, however, soon took its toll. By 1969 Blue Lake was beginning to reach its installed capacity. Peak demand in that year was 5,300 KW. Blue Lake's maximum capacity with a full reservoir was 8,050 KW, but its minimum capacity was 6,000-6,500 KW. In addition to the hydro facility, the city had 1,100 KW in diesel units which it had purchased a few years before Blue Lake went on line. In 1969 it purchased an additional 2,000 KW diesel unit. Would Sitka go the way of Ketchikan?

Several good water years staved off the need to generate large quantities of diesel power. For example, in 1969 Sitka generated 148,000 kwh in diesel power compared to 26 million kwh in hydropower. In 1974 it generated only 36,000 kwh in diesel compared to 28.5 million in hydro. And in the extraordinary water year of 1976-77, the city generated 54,000 kwh in diesel compared to 40.8 million kwh in hydro. Nonetheless by 1974 its peak demand was 5,950 KW. This meant that the system stood right at its minimum hydro capacity. As demand grew, Sitka's power supply and its prices would be subject to the whims of nature and annual waterflow. In good water years it could generate cheap hydropower at an operating cost between 4 and 5 mills. But low water years would force it to run its diesel generators at an operating cost between 60 and 135 mills. Could Sitka—and would Sitka—expand its hydroelectric capacity?[11]

To increase its hydro system Sitka could not contemplate an incremental addition to Blue Lake. Though the original Blue Lake plan specified that an additional 3,000 KW generator could be added at small additional cost, the water commitment to AL&P as well as the hydraulic limit of the reservoir did not allow sufficient surplus water to power an additional generator. Thus Sitka would have to build an entirely new facility. Under the leadership of City Manager Fermin "Rocky" Gutierrez, the utility embarked on the Green Lake project which would provide an additional installed

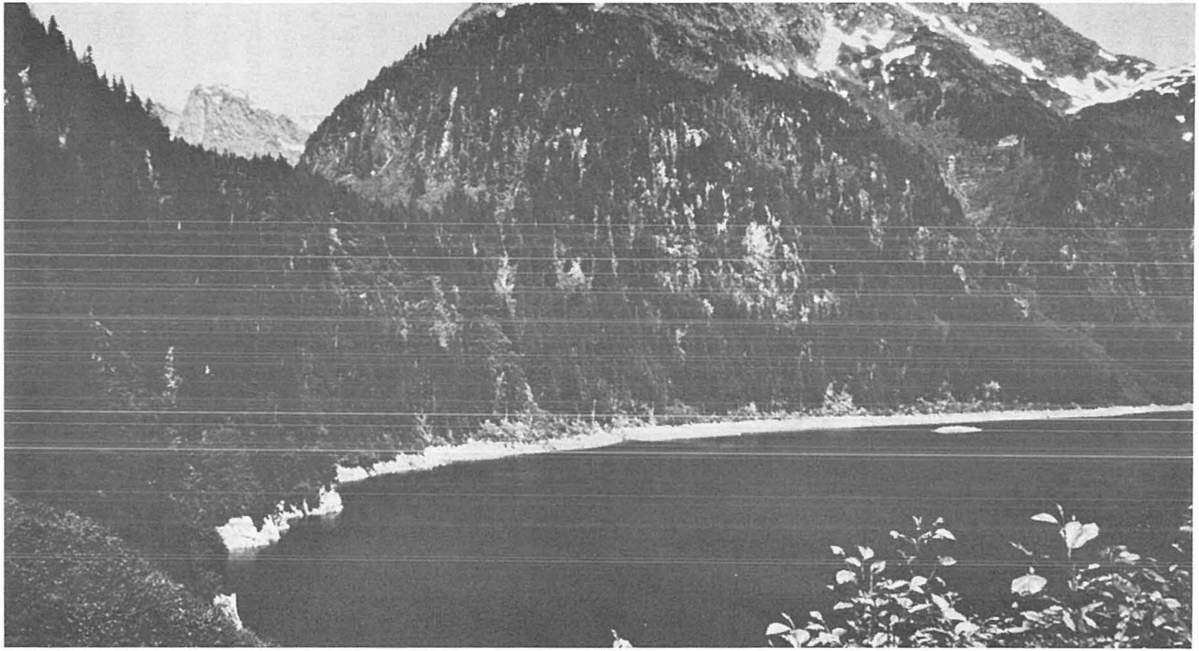

Figure 25. Sitka's Blue Lake is typical of the reservoirs that provide the source of power for many of Alaska's hydroelectric plants.

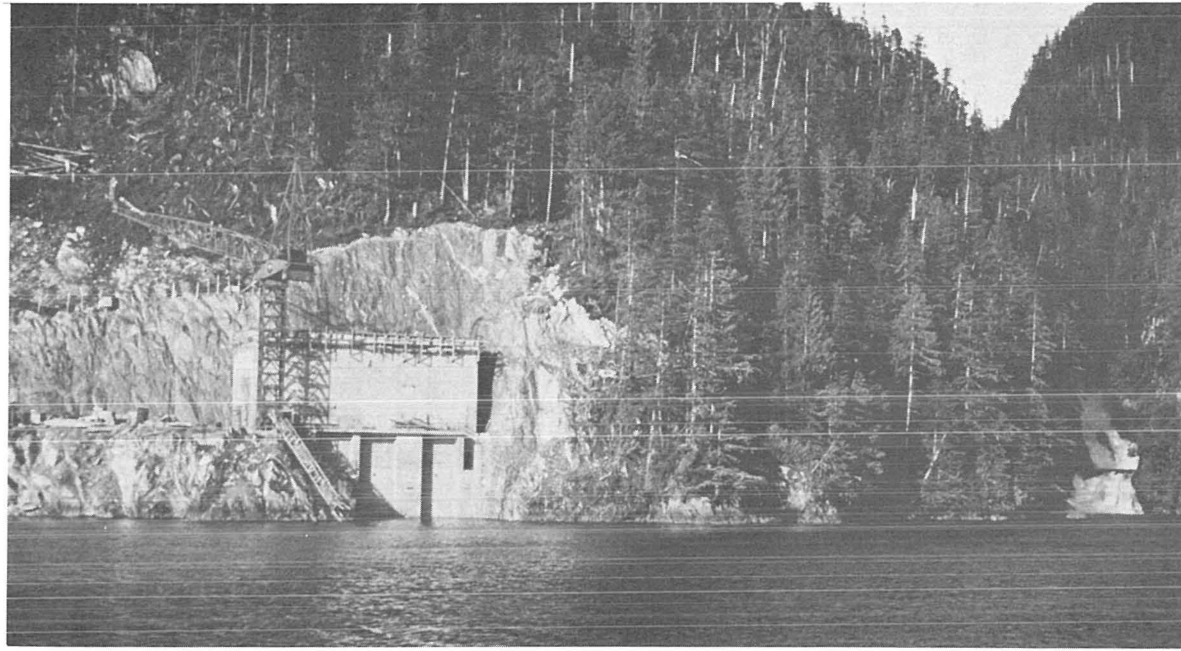

Figure 26. The powerhouse of Sitka's Green Lake hydroelectric plant, shown here under construction in 1981, nestles on the shore of Silver Bay.

capacity of 16,500 KW at a price tag of over $50 million. How would the city finance it? Sitka's population in 1975 stood between 6,000 and 7,000. Would bond houses look any more favorably on the community than they had in 1959? And would Sitka's voters approve such a massive bond sale?

Like Ketchikan, Sitka looked for financial aid wherever it could find it. In 1976 the city obtained a $450,000 planning grant from the state; in 1978 Sitka received an $8.6 million state loan to complete the planning and prepare the site. The Alaska Legislature had been generous, but City Manager Gutierrez did not want to rely on the state political process to complete Green Lake. He wanted to keep the initiative at the local level, particularly as Sitka was beginning to feel the effect of increasing diesel generation on its price structure after 1978. For the year ending June 30, 1978, the city generated 3.7 million kwh in diesel power compared to 37.8 million in hydropower. For the year ending March 31, 1979, matters were worse. Sitka generated 6.9 million kwh in diesel compared to 38.7 million in hydro. As in Ketchikan, diesel power cost about 10 times as much to generate as hydropower—5.9 mills for hydro vs. 58.6 mills for diesel in 1979. Accordingly, Sitka's power prices jumped from $20.90 for 500 kwh in 1976 to $28.90 in 1979. Prices in these years were less than in Ketchikan, but this was hardly a cause for rejoicing. To push the construction of Green Lake, Gutierrez persuaded the municipal council to pass an ordinance in June 1979 authorizing the sale of $54 million in utility revenue bonds at 7-5/8% interest. The scenario of 1959 did not repeat itself. Sitka was able to market its bonds through Dillon, Read and Co.—but under conditions which some might not consider ideal.

Standard and Poor's, the bond rating service, gave Sitka a BBB rating indicating an adequate, though not outstanding, credit risk. Furthermore, Dillon, Read required Sitka to refinance its outstanding debt as a portion of the new bond issue.[12] Thus Sitka was forced to pay 7-5/8% interest on some of the Blue Lake bonds it had originally sold at 4%. The utility was also required to raise its electric rates so that revenues would bring in 1.25 times the amount required for debt service. This translated into an overall 45% increase in Sitka's electric rates. That 500 kwh of power which cost

$25.60 in 1979 rose to $38 in November 1980, making electricity in Sitka more expensive than in Ketchikan.[13] Thus Sitka chose to accept a substantial, though somewhat more predictable, rate increase to prevent the potentially uncontrollable rate rise which might come from increased diesel generation or the potential bankruptcy which might come from waiting for a legislative appropriation.

With financing obtained, Sitka let a construction contract for Green Lake in 1979. The discovery of rock during construction in an abutment near the dam led to a cost overrun of approximately $5 million or about 10% of the total project cost. In May 1981, the city authorized the utility to borrow up to $9 million to cover this and any additional cost overruns. In addition to these added construction expenses, mild winters in 1979 and 1980 slowed the growth of electrical demand thus forcing Sitka to lower its future revenue projections. In June 1981, the Sitka Public Utilities predicted that rates would have to rise again in 1982 and 1983. The construction of Green Lake was exacting an ever higher price from the citizens of Sitka.

Just as Sitka contemplated these rate increases, good news came from the Alaska Legislature. The same bill which appropriated construction funds for Swan Lake in Ketchikan provided a grant, not a loan, of $60 million for Green Lake.[14] Sitka could immediately free itself of its bonded indebtedness; its electric rates could potentially drop from an average 7.5¢ per kwh to 2.5¢ per kwh. This sounded too good to be true. Sitka took a second look.

Another legislative bill contained several clauses which caused concern. If Sitka accepted the $60 million, it would have to transfer ownership of the project to the state. The Alaska Power Authority would administer Green Lake for the state. But the Sitka Public Utilities could continue to operate it under contract. The bill also specified that power rates would not be determined locally, but on a statewide basis. Thus the rate would be set at a price to cover the combined operating costs of all power projects financed with state funds. Initially Green Lake and Solomon Gulch in Valdez would be the only state-owned hydroelectric projects. But as the years went on, other projects would enter the pool. Sitka feared that in the future it would have to pay for poorly operated or poorly conceived projects in other parts of Alaska.

A final clause, the so-called "Susitna Blackmail Clause," also warranted attention. The Legislature specified that if funds totalling at least $5 billion, presumably to construct the Susitna project between Anchorage and Fairbanks, were not appropriated, the grants to all previous hydro projects would be redesignated as loans at 10% interest. Power rates would thus rise to reflect this new cost—which was more than the 7-5/8% interest on Sitka's Green Lake bonds. Accepting the state's money seemed as risky as generating electricity with diesel oil. A favorable short-term approach to finance might lead to unending instability in the future.[15]

Sitka had constantly sought stable, reasonably predictable financing of its hydro projects. Thus the municipal council decided to reject the state's money and to retain ownership of the project. The success of its original bond sale made this choice possible. Ketchikan, of course, had no such choice.

Finally, in June 1982, the Legislature agreed to lend Sitka $15 million at 4% interest.[16] No ownership transfer was involved. With these new funds, those cost overruns authorized for payment in May 1981 could be handled at a lower rate. Funds would also be available to cover a group of law suits against the city which were filed by various contractors on the Green Lake project. Depending on the final outcome of the suits, Green Lake's total cost will be approximately $62 million.[17] With the 1982 state aid, Sitka was able to hold its power rate at the 1980 level.

In the summer of 1982 Green Lake was supplying power to Sitka, having first gone on line in February of that year. Sitka had its new power project and owned it outright. What can we learn from the story of the small town and its big bonds?

1. The comparison between Sitka's ability to sell bonds and Ketchikan's reluctance to do the same may cause some people to speculate as to which city is better managed or which city has a sounder financial base. This report will not seek to make such a judgment. Sitka is certainly a well-run municipality, but its story indicates how difficult it is for a small city, no matter how well run, to sell bonds to finance a

hydro project even if it has the willingness to do so. Both Ketchikan and Sitka should be seen as examples of the extreme financing difficulties which face small communities with isolated load centers.

2. In previous chapters we have noted potentially decreasing costs coming from the operation of hydro plants after their amortization period. But there is a reverse side to that coin. There are also increasing costs of power which result from the initial construction of a hydro project. In 1981 these increasing costs figured more heavily in the mind of Sitka's City Manager Gutierrez than any decreasing costs which might come in 35-40 years. Hydropower may be very cheap in the long run, but it can be very expensive in the short run—particularly during the construction phase of a project when interest must be paid before new revenues begin. We may well ask how great a price increase the rate payers of a small community can be expected to bear to develop hydropower.

3. The Blue Lake story is an example of the extraordinarily long time it can take a small community to develop a hydro site. The existence of a good site does not force its development. In Sitka it took 50 years to bring Blue Lake on line. Again, we see the difficulty faced by a small community in utilizing its resources.

4. Finally, let us compare Ketchikan and Sitka once again. Though the two communities are only 175 miles apart and though they both possess an abundance of potential waterpower, their development of hydro resources over a period of 60-70 years was vastly different. Ketchikan produced an abundance of power for 40-50 years before Sitka had even minimal facilities. Later it appeared that Sitka was more willing or aggressive to build a large project than Ketchikan. Thus we may well conclude that the isolated nature of Alaskan communities has given the state an uneven development of one of its major resources.

Footnotes

1. 1957 power prices are from U.S. Federal Power Commission, *Alaska Power Market Survey 1960* (San Francisco: U.S. Federal Power Commission, 1960), p. 67. 1976 figures are from Alaska Power Administration, *Alaska Electric Power Statistics 1970-76* (Juneau: Alaska Power Administration, 1977), p. 37.
2. For the early history of Sitka Wharf and Power Co. see J.C. Dort, *Water Powers of Southeastern Alaska* (Washington: Government Printing Office, 1924), pp. 142-43.
3. Dort, pp. 142-43.
4. For Gruening's role see Ernest Gruening, *Many Battles* (New York: Liveright, 1973), pp. 288-92. Les Yaw, former President of Sitka Public Utilities, defended the purchase of Sitka Wharf and Power in an interview with the author in Sitka, June 12, 1981.
5. The early history of Sitka Public Utilities is taken from *The Sitka Blue Lake Hydroelectric Story* (Sitka: Sitka Public Utilities, 1961).
6. Further details on the state of Sitka's electric system in 1950 can be found in U.S. Bureau of Reclamation, *A Report on the Blue Lake Project, Alaska* (Juneau: U.S. Bureau of Reclamation, 1954).
7. *The Sitka Blue Lake Hydroelectric Story* (Sitka: Sitka Public Utilities, 1961).
8. See U.S. Bureau of Reclamation, *A Report on the Blue Lake Project, Alaska* (Juneau: U.S. Bureau of Reclamation, 1954) and U.S. Bureau of Reclamation, *A Report on the Swan Lake Project, Alaska* (Juneau: U.S. Bureau of Reclamation, 1951).

9. The discussion of the financing of Blue Lake comes from *The Sitka Blue Lake Hydroelectric Story.*
10. 1968 prices come from U.S. Federal Power Commission, *Alaska Power Survey, 1969* (San Francisco: U.S. Federal Power Commission, 1979), p. 30. 1969 figures furnished by Sitka Public Utilities.
11. Generation statistics furnished by SPU in *Official Statement $54,000,000 City and Borough of Sitka, Alaska, Municipal Utilities Revenue Bonds, 1979* (New York: Dillon, Read and Co., 1979), p. 7.
12. Bonding information from *Official Statement $54,000,000.* The BBB rating (Moody's Baa) does not necessarily reflect any inherent weakness in Sitka's financial structure. Ratings are based on a formula ratio of bonded indebtedness to assets. Obviously a hydro project in a small community will produce a high ratio of debts to assets. In contrast, Fairbanks and Anchorage utility revenue bonds enjoy much higher ratings, in some cases Aaa. The Baa rating for Sitka does mean that it will have to pay a higher interest rate than would be the case with Aaa bonds.
13. Price for 500 kwh computed with 1977-79 rates and 1980 rates supplied by SPU as follows:

    1977-79 rates
    First 100 kwh @ 8¢ per kwh
    Next 200 kwh @ 5¢ per kwh
    Next 300 kwh @ 3.8¢ per kwh

    1980 rates
    First 100 kwh @ 12¢ per kwh
    All additional kwh @ 6.5¢ per kwh

14. *Session Laws of Alaska 1981,* Chapter 90.
15. *Session Laws of Alaska 1981,* Chapter 118. The clauses under discussion revised the statutes governing the Alaska Power Authority (A.S. 44:83). Subsequent legislation in 1982 (Session Laws of Alaska 1982, Chapter 133) allowed a *separate* wholesale power rate to be established by the Alaska Power Authority for each power project. The 1982 legislation retained state ownership of projects and the major provisions of the "Susitna Blackmail Clause."
16. *Session Laws of Alaska 1982*, Chapter 141. This loan was made through the Alaska Power Authority. Sitka chose to accept the $15 million loan even in light of the revised 1982 legislation cited above.
17. Three lawsuits were filed against the city relating to the construction of Green Lake: 1) S.S. Mullen Co., contractors for the access road, and 2) S.J. Groves Co., general contractors, sued over faulty geological data furnished by the city (both contractors claimed the faulty data led to increased construction costs), and 3) a class action suit was filed against the city and the Alaska Lumber and Pulp Co. by workers who claimed they were paid less than minimum wage for clearing the dam site. As of July 1982, the city had settled out of court with S.J. Groves for approximately $5 million; the city is appealing a $1.8 million court decision to S.S. Mullen. The class action suit is still pending. (Telephone conversation with City Manager Rocky Gutierrez, July 15, 1982.)

Chapter 5
Anchorage—Hydro Faces the Challenges of Nature and Natural Gas

Juneau, Sitka, and Ketchikan presented hydro stories in the context of isolated communities which were unconnected with each other. Certain problems emerged as a result. Those communities, however, also presented cases of fairly unified electric generating and distribution systems. In both Sitka and Ketchikan one utility generates and distributes all electric power. In Juneau the story is slightly more complicated. A private utility, the Alaska Electric Light and Power Company, generates and distributes hydropower. An agency of the federal government, the Alaska Power Administration, generates power and sells it to AEL&P and to an REA co-op, the Glacier Highway Electric Association. Despite this diversity, the federal agency and the two utilities are relatively dependent on each other. All three are headquartered and administered in Juneau. In southeastern Alaska it is possible to trace the development of hydropower through a few local sources.

As we move westward to Anchorage, Alaska's largest city, both the problems and the organization of hydropower change drastically. Anchorage lies not on an isolated island but in a relatively accessible area of southcentral Alaska where power transmission is not limited to a small area. The Anchorage load center stretches some 45 miles north of Anchorage to the Matanuska Valley and the towns of Palmer and Wasilla; it descends south to the Kenai Peninsula, extending 127 miles to Seward and 226 miles to Homer. We might expect some of those problems associated with small isolated population areas to vanish in the state's principal metropolitan area.

The advantages of population and geography in the Anchorage area are not matched with a unity in the organization of the electric generating and distribution system. There is not one utility, but several. An agency of the federal government, the Alaska Power Administration, produces hydroelectric power at the Eklutna project 35 miles north of Anchorage but administers the project from Juneau. Though the federal government is the principal producer of hydropower, it does not distribute it. The Anchorage Municipal Light and Power Department distributes hydropower from Eklutna but does not produce hydropower itself; the municipal utility does generate power from diesel generators and gas turbines.

The Anchorage-Kenai area is also served by a number of REA electric cooperative associations. One of these, the Chugach Electric Association, is the largest utility in the state and sells most of its power to urban customers. Chugach generates electricity from its Cooper Lake hydroelectric facility south of Anchorage on the Kenai Peninsula, as well as from gas turbines and steam plants at various locations. It also buys hydropower from Eklutna. Chugach distributes this power to its customers as well as to the Seward Electric System and the Homer Electric Association. Finally, to complete the picture, another REA cooperative, the Matanuska Electric Association, produces no electricity of its own but buys power from Eklutna which it distributes to its own customers.

To complicate matters further, we must also note that the relative size and importance of these different producers and distributors has changed over the years. Until 1955 the Anchorage Municipal Light and Power Department was the principal producer of power. From 1955 to 1963 the U.S. Bureau of Reclamation, the precursor to the Alaska Power Administration, took the lead.[1] Since 1963 the Chugach Electric Association has been the major overall power producer, though the Alaska Power Administration remains the principal hydro producer.

Against this backdrop of many producers and distributors, hydropower has faced more challenges to its successful operation in Anchorage than in southeastern Alaska. Hydro's oft noted advantage of long-term price stability became a liability with the discovery of cheap natural gas on the Kenai Peninsula. Nature has also tested hydro with an earthquake and temporary conditions of restricted water intake.

How has hydro responded to these challenges? The diversity of producers and distributors makes it impossible to trace the development of hydropower through one source. In Anchorage there has been no unified record of decision making. Different decision makers operating under different conditions and different pressures have responded to the challenges. Thus the picture of hydro development in Anchorage may not appear as coherent as in southeastern Alaska. Nonetheless, let us piece together what we can.[2]

Early Hydro Development in Anchorage: The Two Eklutna Projects

If southcentral differs from southeastern Alaska in many ways, it has one striking similarity—an abundant supply of waterpower sites. As early as 1914, C.E. Ellsworth of the Department of the Interior noted over a dozen sites on the Kenai Peninsula alone, including the Cooper Lake site which was later developed. The availability of waterpower for Anchorage was known even before the community developed a need for power.[3]

Anchorage itself did not emerge until 1915 when it became the construction, and later administrative, headquarters for the Alaska Railroad. The railroad initially produced its own power with a 900 KW steam electric system which also supplied the needs of the emerging town. Anchorage grew modestly over the next decade. In 1920 its population stood at 1,856; in that same year the municipality incorporated.[4]

The new municipality realized a few years later that it could not depend on the railroad's steam plant for future growth and accepted the responsibility for distributing and selling electric power. In 1927, the city entered into an agreement with a private company, the Anchorage Light and Power Company, to produce electric power. That company then proceeded to build a hydro plant at Eklutna Creek, approximately 30 miles north of Anchorage, with a small earthen dam and a 1,000 KW generator. Eklutna produced its first power in 1929. By 1930 the city had a population of 2,277, and it continued to grow over the next decade. To meet increased demand the company added a second 1,000 KW generator to the Eklutna powerhouse in 1935. In 1937 the company purchased a 700 KW diesel generator to replace the power generated by the railroad's steam plant which was temporarily retired from service. Even though diesel power had entered the city, hydropower was the principal source of energy for this small growing community of 3,495 people in 1939.

This was probably the last year in which Anchorage could be described as a small growing community. The impact of the Second World War was tremendous, and the pattern of growth that ensued has not stopped to the present day. The construction of Ft. Richardson and Elmendorf Field provided protection for America's northernmost territory and brought hundreds of military personnel to the city. For every military job a civilian followed to join in the construction of new facilities and the provision of support services. By 1948 the U.S. Department of the Interior estimated Anchorage's population at 19,000; the U.S. Postmaster for Anchorage claimed that up to 35,000 people lived in the metropolitan area! (In 1950, census figures showed a population of 11,254 within the city limits and 32,060 in the metropolitan area.)

With such a population increase in the 1940s, the city's electric system was hard pressed to keep up. The private utility, Anchorage Light and Power, found it impossible to finance expansion of its system, and sold the Eklutna plant and its diesel generator to the city as early as 1943. Thus, wartime expansion forced the city to become both the principal producer and distributor of electric power. But even the municipal utility had difficulty increasing its electric generating capacity. During the war years military authorities installed their own power systems which were interconnected with the city for whatever surplus power they could supply. In 1945 the city purchased another diesel generator to keep slightly ahead of demand. Even the old Alaska Railroad steam plant was called back into service—unreliable as it was.

As the post war years wore on, matters did not improve. In 1947 the city, almost out of desperation, first leased and then purchased a wrecked Liberty ship named the "Sackett's Harbor" and used its steam plant to generate electricity. If Sitka's electric system was pathetic at the end of the war, Anchorage's was downright comical. In 1948, Anchorage had a utility capacity of 6,800-7,700 KW including a 2,000 KW hydro plant, 1,300 KW in diesel generators, a beached Liberty ship producing 3,500 KW, and the ancient steam plant of the Alaska Railroad which had a 900 KW capacity on the days it was operational. In contrast, Ketchikan had a capacity of 6,225 KW with the completion of its Beaver Falls plant in 1947 for a population of only 7,000. Juneau, with the same number of people, possessed more than 15,000 KW of hydro capacity, including the system of the Alaska Juneau Mines which ceased operation in 1944.

Anchorage's makeshift power supply rarely met demand; the city appeared to be in a permanent state of crisis. According to the U.S. Bureau of Reclamation, "More than 3,000 people just outside the city limits of Anchorage are without electric service for their newly constructed homes. In the city the demand is so great that circuit breakers are alternately opened on various sections of the power system, thereby plunging entire areas into darkness."[5] Even when power could be obtained, it was expensive—$17.08 for 500 kwh compared to $9.50 and $10.82 for the same amount in Ketchikan and Juneau, respectively. The amazing thing about this price was not that it was so high, but that it was so low. The power produced by the Liberty ship was sold at a loss of approximately 1¢ per kwh. Hydropower subsidized the diesel and steam power. If Anchorage was to increase its power supply and hold to its existing prices, more hydropower seemed to be required.

The Eklutna project could be expanded by utilizing waterpower directly from Lake Eklutna rather than from its present outlet at Eklutna Creek. But who would pay the cost? In 1948 the Mayor of Anchorage Z.J. Loussac announced, "The city has been advised that it will take an expenditure of more than 15 million

Figure 27. The Eklutna project near Anchorage was the first federal hydroelectric plant in Alaska.

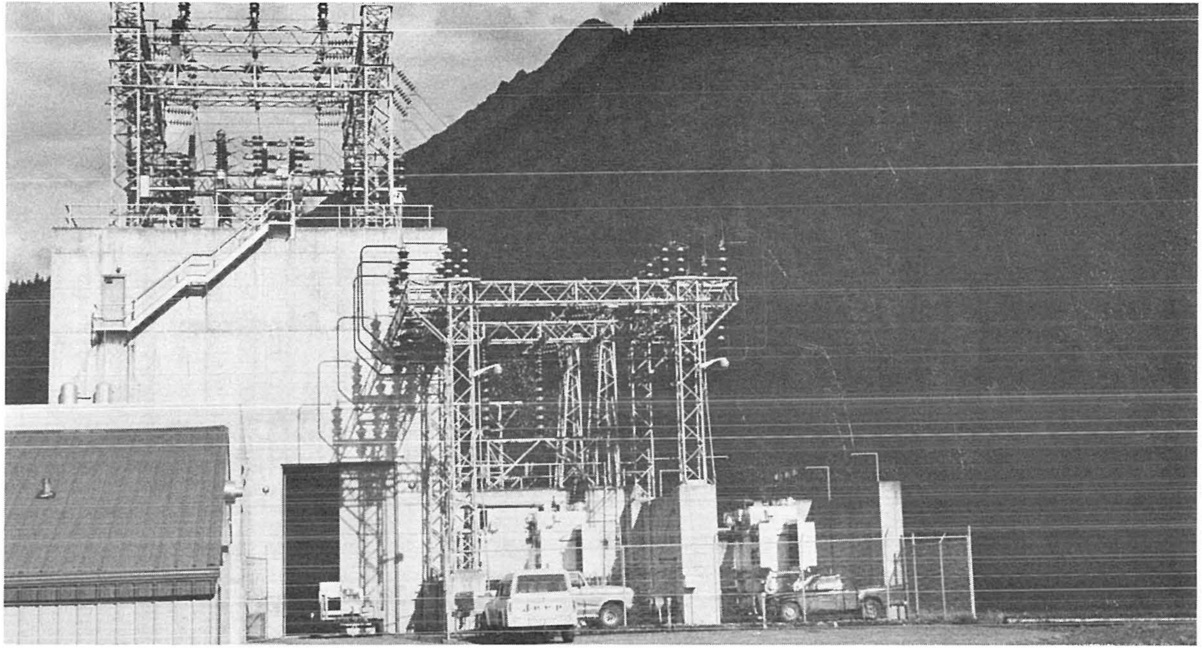

Figure 28. The Eklutna project, with a 30,000 KW capacity, supplies electricity to Anchorage and the Matanuska Valley.

dollars to develop the Eklutna generating plant to its ultimate capacity; that sum is beyond the ability of the city to raise."[6]

Into the vacuum stepped the federal government. The U.S. Department of the Interior had begun to study the possibility of the development of Alaska's water resources immediately after the war. In 1948, the Bureau of Reclamation received a special appropriation of $150,000 in the department's budget for a specific study of the Eklutna project. By the end of the year, the Bureau concluded that it would be feasible to draw water directly from Lake Eklutna by building a small dam to raise the lake level two feet and by constructing a 4.5 mile tunnel from the lake through Goat Mountain. The tunnel would then connect to a penstock which would drop the water 1,250 (later 1,375) feet to a power plant with 30,000 KW capacity.

According to the Bureau the project would cost $21,580,900 of which $20,365,400 was reimbursable through power sales; the remaining cost would be borne by the National Park Service to create a recreational facility at Lake Eklutna. The total price would include purchase of the existing Eklutna plant from the city. The new project, the Bureau predicted, could produce wholesale power at a rate of 8.5 mills per kwh compared to approximately 9.5 mills for existing Eklutna hydropower and 25-35 mills for power from "Sackett's Harbor." This new price would obviously result in substantial savings to Anchorage power customers. The Bureau would sell power to the Anchorage municipal utility as well as to the Matanuska Electric Association, and possibly to the proposed Chugach Electric Association which was then being organized to serve the southern areas of Anchorage. According to the Bureau, there would be a market for all of Eklutna's power as soon as its four-year construction period was completed. The Bureau recommended in January 1949 that Congress immediately authorize the project and appropriate funds for it.

The Eklutna project had much to commend it. It would be the first federal power project in Alaska, and the need for power was clearly evident. Much of this need came from the presence of federal employees in Alaska. Not only would power from the project provide electricity for the city of Anchorage, but also for the

Matanuska Valley where the federal government had attempted to plant an agricultural colony in 1935. Low-cost power might finally bring the dream of self-sufficient agriculture to the territory. On top of all of this, the presence of substantial military installations in Alaska would probably require the creation of a permanent reliable power supply from another source if Eklutna were not built. In sum, there was a strong federal presence in the Anchorage area and a clear federal—as opposed to merely a local—interest in the project.

Congress responded, not immediately, but in what seems a relatively short period. In July 1950, it passed the Eklutna Act (P.L. 81-628) which authorized construction of the project for a reimbursable cost of $20,365,400 at 2.5% interest to be paid back over a "reasonable" period of years (50). An appropriation of $1.1 million was made to get the project going, and construction was underway by early 1951. A year later the Bureau revealed that it had seriously underestimated the cost and projected that Eklutna would cost up to $35,000,000—over 50% more than the original project cost. Such an expenditure would require further congressional authorization as well as additional appropriations.[7]

A controversy ensued in the Congress on the Eklutna issue. Some congressmen wondered if the Bureau was competent to build the project and wanted to drop Eklutna altogether. Others pointed out that $11,000,000 had already been spent. Should that investment be scrapped, they asked? After some debate, the Congress, under the prodding of Alaska's Territorial Delegate E.L. "Bob" Bartlett, passed another bill in 1953 upping the authorized spending limit to $33 million. The project would be required to reimburse this new cost, thus raising the wholesale price of power to 11 mills. With this infusion of fresh funds, Eklutna had a new lease on life. Construction proceeded and in January 1955, Eklutna power came on line—only a year later than the 1954 date which the Bureau had originally targeted. Eklutna's final construction cost came in under the authorized limit at $30,521,183.

With the completion of Eklutna, Anchorage entered a new phase in its history of power production. Hydropower had now shifted out of municipal control and into federal hands. Also, the federal government became the major power producer in Anchorage, with a 1957 capacity of 30,000 KW compared to 6,736 KW for the municipal system and 10,600 KW for the Chugach Electric Association which had been growing rapidly since 1950.[8]

What would this mean for the future? Would Anchorage become a northern version of the Tennessee Valley Authority? Would federal power be the lifeblood of Alaska? And what would this bode for the future of hydropower? Would the other utilities now look to the federal government for future projects? With so many power producers and distributors in Anchorage, who would direct the future of hydroelectric development in the territory's largest load center?

In the five to seven years after Eklutna went on line, it appeared as if hydropower and Anchorage would march hand in hand into the future with the federal government in the lead. By 1957 Eklutna had brought lower electricity rates to Anchorage; 500 kwh cost $14.50, a 15% drop from 1948. But Anchorage's electric demand had exceeded Eklutna's supply. In 1957 the city's peak demand was 34,360 KW. By 1970 the peak was projected to be 102,650 KW. Where would the additional capacity come from?[9]

The Expansion of the Chugach Electric Association: Cooper Lake Hydro and the Arrival of Natural Gas

The direction of future planning for new power production in Anchorage was not entirely clear in 1957. Both the Anchorage Municipal Light and Power Department and the Chugach Electric Association had installed steam and diesel generators. But hydro still seemed to be the most promising future development. In 1960 the Federal Power Commission spoke glowingly of the future of hydro development for Anchorage. The U.S. Corps of Engineers foresaw the building of a 46,000 KW hydro plant at Bradley Lake near Homer, which would produce power for the Kenai Peninsula and Anchorage. Of course, such a plant would require congressional authorization as Eklutna had. Federal plans also included possibilities for the gigantic Rampart project on the Yukon and the Devil Canyon or Susitna project about 150 miles north of Anchorage. Hydro advocates saw Devil Canyon with 580,000 KW of power as a possibility for supplying the electrical needs of both Anchorage and Fairbanks.

All the initiative for hydro development did not lie with the federal government. In 1957 the Chugach Electric Association planned to construct a hydro facility at Cooper Lake, 65 miles south of Anchorage on the Kenai Peninsula, to supply power to Homer, Seward and Anchorage. The plant would initially be installed with 15,000 KW capacity and with the potential for another 15,000 KW, making it as large as Eklutna. Chugach had obtained financing from the REA with a $12.5 million loan. Construction of Cooper Lake was underway by 1958.[10]

The Cooper Lake project had much to commend it. At $12.5 million it was a cheaper installation per kilowatt than Eklutna. When raised to 30,000 KW for small additional cost, it would be a bargain. Even more, engineering for Cooper Lake could profit from the experience at Eklutna.[11] In fact, Chugach seemed so interested in hydro that it also obtained a license to build another 10,000 KW plant at Grant Lake. By 1960 it appeared as if Chugach was in a position to challenge the federal government as the principal hydro producer in Anchorage—unless Rampart, Devil Canyon or Bradley Lake were built. Would the REA take the lead?

The Cooper Lake facility was completed in December 1960, at a final cost of $10 million for the dam and power plant. But there were delays in getting power on line. In May 1961, Chugach announced that Cooper Lake would go on line to serve Homer; in June Cooper Lake was ready to serve Seward. But Chugach encountered difficulty in getting the U.S. Forest Service to grant a permit to run a line from Cooper Lake through the Chugach National Forest to Anchorage. The Forest Service opposed Chugach's Johnson Pass line along the Seward Highway for "aesthetic reasons." Chugach opposed a Forest Service route which would

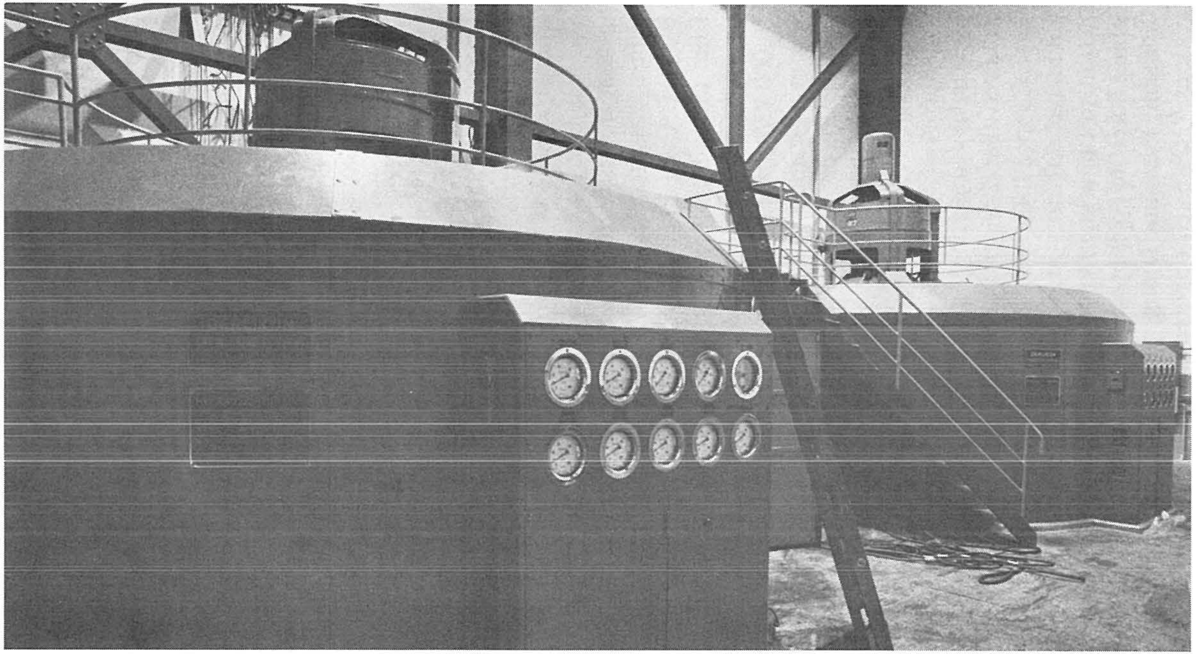

Figure 29. Compare these turbine generators at Eklutna to the older generators shown in previous figures.

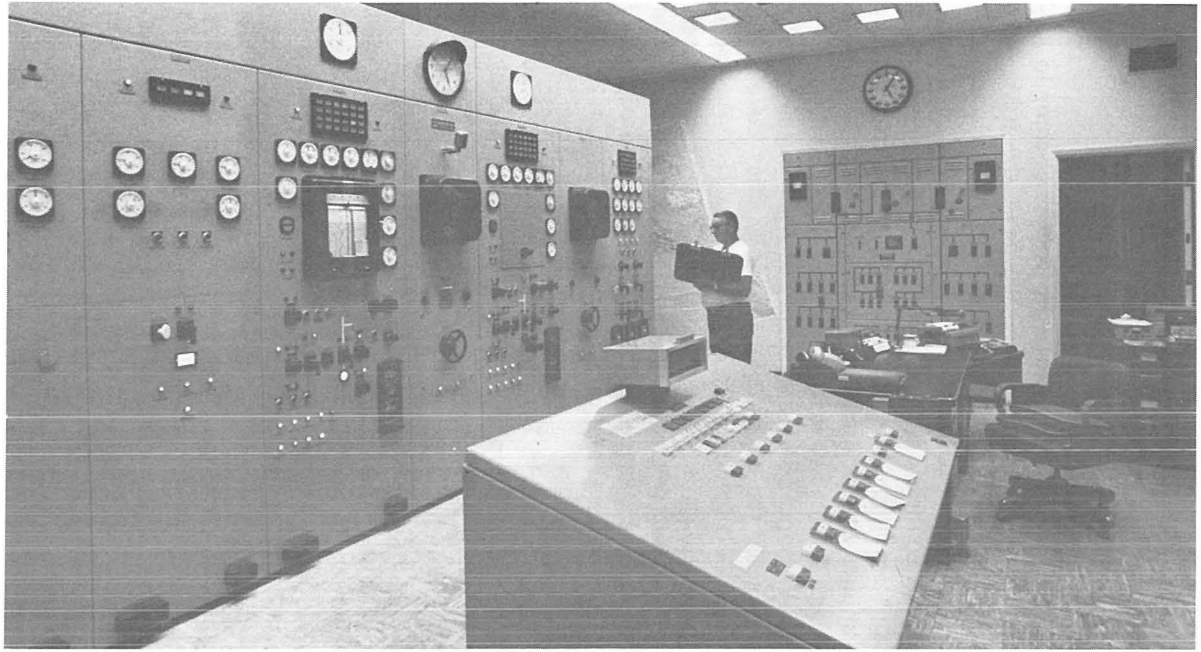

Figure 30. Ray McCarthy monitors Eklutna's power production from this control room.

cross Turnagain Arm because of avalanche conditions, snow deposits, difficulty in maintenance, and higher cost.

While Chugach and the Forest Service wrangled, a cold winter in 1961 increased power usage and brought Anchorage almost to its production limit. But Cooper Lake hydro could not come to Anchorage's rescue as Eklutna once had. Chugach General Manager Bud Schultz said at the time, "The Cooper Lake hydroelectric project is the only reserve in existence in the area today and, of course, it's not connected to the Anchorage area; it's a real sadness to me." Finally a transmission line was completed, and power from Cooper Lake was supplied to Anchorage in November 1962—18 months after the project supplied power to Homer.[12]

Just before Cooper Lake came on line to Anchorage, the U.S. Congress authorized the construction of the Bradley Lake hydro project in the Flood Control Act of 1962 (P.L. 87-874). Hydro seemed to be reaching its stride in Anchorage. Two years later, however, hydropower seemed to be receding into the past. The Corps of Engineers announced that there would be no customers for Bradley Lake power at a price of 9-10 mills per kwh. What had happened?

In 1957, the Richfield Petroleum Company discovered the Swanson River oil field on the Kenai Peninsula, signaling the availability of locally produced oil and natural gas. Chugach was alert to the possibilities of natural gas for power production. As early as 1960 the utility noted that power produced from Kenai gas might cost slightly less than 5 mills per kwh—compared to 11 mills for Eklutna power. In addition, the low initial capital cost of gas turbines would allow Chugach to install many more kilowatts of capacity in gas turbines than in hydro.[13]

The possibilities of gas became realities in 1962-63 when Chugach signed a contract to deliver electric power to the Standard Oil refinery which would process the new Kenai oil. In 1963 Chugach opened its first combustion turbine plant at Bernice Lake. By 1965 Chugach had installed 37,550 KW in gas turbine power; AML&P had installed 30,260 KW in gas.

Over the next few years, even greater opportunities for gas power became evident with the discovery of natural gas at Cook

Inlet in the Beluga Field. Beluga gas would also allow Chugach to produce power at the 5 mill rate. In 1968 Chugach opened its first gas turbine facility at Beluga with 32,000 KW capacity. As a result of cheap gas, the price of electric power dropped in Anchorage. Chugach could now sell 500 kwh of electricity for $12.95—down from $14.50 in 1957.[14]

Of course, cheap gas power depended on the continued low price of natural gas. Fortunately Chugach was able to negotiate a long-term contract for the delivery of 373 billion cu. ft. of Beluga gas between 1973 and 1998 at a fixed price. As a result of this favorable price arrangement, Chugach continued to increase its gas turbine capacity. In 1976 Chugach had a total generating capacity of 345,500 KW including 15,000 KW in hydro, 14,500 KW in steam and 316,000 KW in gas turbine including 230,000 KW at Beluga alone. (In 1976, AML&P had 121,000 KW in capacity of which 118,900 KW was gas turbine.) This was quite a change from 1961 when Chugach's capacity was 15,000 KW in hydro and approximately 14,000 KW in steam. The utility had grown more than 10 fold in 15 years. Though the price of power had risen slightly since 1968, Chugach could still deliver 500 kwh for $16.00 in 1976.[15]

In the growth of Chugach, hydro was pushed aside because the Anchorage area had a low-cost alternate fuel available. Gas was competitive with hydro on an operational basis, and it did not require the vast initial capital costs which were associated with hydro. Thus, it did not require waiting on congressional appropriations. Chugach was able to obtain financing from the REA, its only funding source, for the capital costs of gas turbine plants. It is questionable whether it could have obtained funding for similar increases in hydro capacity. If natural gas had not been available in Anchorage, hydro development at Bradley Lake and Susitna could have been done only by congressional appropriation; the plants would have been owned and operated by the federal government. Thus Chugach would have been left as a distributor for federal power rather than as the major producer of its own power. Gas provided Chugach the attractive possibility to emerge as not only the largest distributor of electric power in Anchorage, but also the largest producer. Gas gave Chugach an independence it probably would not have gained if hydro had become the major source of power in Anchorage.

Operational Problems at Eklutna and Cooper Lake: Water Flow and Earthquakes

The development of hydropower has been arrested in Anchorage from 1963 to the present day. But in this period Eklutna and Cooper Lake have continued to operate. How have they fared?

Both Eklutna and Cooper Lake have encountered a high annual variation in power production resulting from variations in annual water intake. In some years power production has been substantially below the firm annual energy target. Why has this occurred, and is it a matter of concern?

When the Bureau of Reclamation completed its feasibility report for Eklutna in 1948, it admitted that it had almost no hydrologic information for Lake Eklutna. No streamflow records were established until 1946. There were, however, records of power production back to 1929 for the old Eklutna project. In the absence of streamflow information, the Bureau tried to use the variation in annual power production as a possible correlation to future streamflow variation at Lake Eklutna. Obviously such a comparison presented problems. The old Eklutna project was considerably downstream from the new project. Trying to correlate power production at one location to potential streamflow at another was risky at best. The Bureau did not try to hide the problem and noted, "it was recognized that the above method was quite arbitrary. . . . Consequently there are no long-term stream runoff records available which logically might be used for correlation."[16]

With this severe limitation in data, the Bureau estimated that Eklutna could produce critical year firm energy of 100 million kwh and nonfirm energy of 43.6 million kwh (i.e., 100 million kwh could be produced under the most severe water conditions). More streamflow data accumulated during the years of construction, and the Bureau revised the critical year estimate to 137 million kwh in 1955. Later the figure was raised to 153 million kwh.

In the first decade of Eklutna's operation, water flow was sufficient to maintain a high level of generating capacity. In 1968 Alaska Power Administration Commissioner Gus Norwood proudly noted, "Good water experience, coupled with the original conservative estimates, and the fine cooperation of the power purchasers have enabled the project to produce and market more than the originally estimated 153 million kwh of marketable energy annually."[17] No sooner had Norwood uttered these words than the glacier-fed water flow changed. From 1969 to 1976 a period of poor water years severely lowered Eklutna's power production. The APA drew down the reservoir for a number of years to maintain capacity but in 1973 even this option was no longer viable. In FY 1974 Eklutna produced only 86.5 million kwh of power—less than 57% of its estimated firm annual production. Low power production continued in FY 1975. However, exceptionally good water years came after 1976, and in FY 1980 Eklutna produced 198,864 kwh or 130% of its firm annual supply. Table 5.1 illustrates the power variations at Eklutna.

A similar water flow problem has been encountered by Chugach at Cooper Lake. Cooper Lake's annual firm energy output is approximately 41 million kwh. Chugach representative Tom Kolasinski noted, however, that annual generation has fluctuated between 24 million and 60 million kwh. As a result of this fluctuating water flow, Chugach did not deem it feasible to raise Cooper Lake's installed capacity to the anticipated 30,000 KW.[18]

Annual water-flow variation and a resulting variation in power production are expected in all hydroelectric projects. But the variation in Anchorage seems high. At Eklutna, production has fluctuated between 199 million kwh and 87 million kwh—a drop of 57% from the high to the low. Similar figures hold for Cooper Lake. By comparison, power production in Ketchikan has fluctuated between 68 million kwh and 57 million kwh for all three plants—a drop of 16% from the high to the low. One may well wonder if such wide variations as those in Anchorage indicate that

Table 5.1 Annual Generation of Eklutna Power Project[a].

FY		Million kwh
1955		43.8[b]
1956		119.3[b]
1957		136.7[b]
1958		164.5
1959		165.8
1960		188.2
1961		198.8
1962		150.5
1963		156.5
1964		159.1
1965		135.3[c]
1966		138.9
1967		184.2
1968		164.3
1969		168.0
1970		160.8
1971		127.3
1972		159.2
1973		142.8
1974		86.6
1975		120.9
1976		160.2
1976	(Third Quarter)	24.7[d]
1977		174.4
1978		193.6
1979		153.0
1980		198.9
1981		196.3

a Source: Alaska Power Administration, March 1982.

b Project capability exceeded demand in early years of operation.

c Low production mainly due to draw down of reservoir in 1974 to permit repairs to earthquake damage.

d After FY 1976 the federal fiscal year changed from July 1—June 30, to October 1—September 30. This entry covers July 1, 1976, to September 30, 1976.

hydropower in certain locations is an unreliable power source. What would have happened if low water years had come 10 to 15 years earlier when Anchorage was more dependent on Eklutna's production? In 1957, for example, the energy demand in Anchorage was 154 million kwh. If Eklutna's production had dropped from 140-150 million kwh to 86.6 million kwh, Anchorage would have faced a power crisis. Chugach and AML&P would have been hard pressed to fill the gap from their steam and diesel plants since their combined capacity was little more than half of Eklutna's.

Alaska Power Administration head Bob Cross has noted that the variation in Eklutna's production requires closer scrutiny. Before 1968 APA operated Eklutna on a "critical year" mode. Water in the reservoir was conserved in good water years so that the firm target of 137 million kwh could be met in poor water years. After 1968, when hydro was no longer the major source of power in Anchorage, APA shifted its mode of operation to "maximum annual energy production." Under this mode all the available reservoir capacity was used for energy production in good years rather than stored for poor years. According to Cross a severe drop in power production would not have occurred if poor water years had come earlier. He estimated that under critical year operation Eklutna could still have produced 130 million kwh annually under drought conditions.[19]

Cross' explanation is helpful. But let us look at the figures again. Even under "critical year" operation, the variation in Eklutna's power production would have been substantial if a drought had occurred. From 1958 to 1968 Eklutna produced substantially more than 137 million kwh, except in the earthquake year of 1964. If a drought had come in the late 1950s or early 1960s, Eklutna's production could have fallen by as much as 65-70 million kwh from a high of 199 million (1961) to an estimated low of 130 million kwh—a drop of 35% between the high and the low. This would still have been a greater variation than we noted in Ketchikan. Chugach and AML&P would not have been as hard pressed to generate the difference with diesel and steam, but the price of electricity would certainly have risen in the days before natural gas became an alternative fuel. Public sentiment, which tends to be volatile to any sudden rise in the price of electricity, might well have been adverse to hydropower. Juneau residents certainly reacted in such a manner in 1974-75 when transmission problems at the Snettisham project forced the city to generate diesel power to replace hydro (see Chapter 6 for a discussion of this situation).

Much of my above concern is hypothetical. The poor water years came after Eklutna had acquired a reputation for good service to Anchorage and at a time when alternate energy production was cheaper than hydro. Still, I imagine that the public image of hydropower was considerably enhanced by the fortuitous timing of poor water years later rather than earlier in Eklutna's history.

While variations in annual water flow in the early 1970s caused hydro production to fall at Eklutna and Cooper Lake, the Good Friday Earthquake of March 27, 1964, left both facilities relatively unscathed. The quake struck at 5:36 p.m. and immediately plunged the city into darkness. Damage was done to the transmission line between Cooper Lake and Anchorage, but the plant and the dam were unharmed. In contrast, Chugach's Knik Arm steam plant in central Anchorage suffered extensive damage, later estimated at $1.7 million, and the Bernice Lake turbine facility was also damaged. By 7:00 p.m. Cooper Lake power was restored to Soldotna on the Kenai Peninsula. As repairs on the other plants proceeded in the months after the quake, Chugach noted it would be able to draw down the reservoir at Cooper Lake to make up partially for the power lost at other installations.[20]

At Eklutna, power was restored to Anchorage by 10:00 p.m. on the 27th. An hour later pressure dropped on the penstock and power was lost once again. But by 3:00 a.m. on the 28th, Eklutna power was once again on line. Twenty-four hours after the quake Eklutna and Cooper Lake were supplying reliable power for Anchorage and the Kenai Peninsula. The hydro projects had weathered Alaska's greatest disaster as if it had been only a major storm.

Early investigations at Eklutna revealed no damage to the power plant, tunnel, or penstock, though there was some damage to the intake structure of the tunnel. In addition, it was evident that a considerable amount of debris, sand and rock would have to be removed from the tunnel. At first look, investigators thought that no damage had occurred at the dam. But in July 1964, the Bureau discovered that there had been settling at the base of the dam and a general weakening of the structure. It soon became evident that substantial rebuilding of the dam, particularly of the spillway, would have to take place. The estimated cost of all repairs at Eklutna came to $3.1 million—slightly less than 10% of the project's original construction cost in the 1950s. Even with this damage to the dam, Eklutna had nonetheless survived the earthquake remarkably well and had produced power during Anchorage's time of need.[21]

The repairs to Eklutna, when completed, came in slightly under the estimated cost at $2,885,415 which included building a new dam rather than merely rehabilitating the old one. Under the terms of the original Eklutna Act of 1950, such costs were required to be fully reimbursable through power rates. Eklutna's wholesale power rate would have to increase by one mill as a result.

Soon after the earthquake Alaska's Senators Bartlett and Gruening tried to introduce bills making the repairs a gift of the federal government so that Alaskans would not have to bear the extra cost. As long as the proposed legislation affected only the Anchorage rate payers, the senators found little support in Congress. But as the 1960s progressed, the federal government itself developed an interest in lowering the cost of Eklutna power. The additional mill would make federal hydropower uncompetitive with natural gas. Though Eklutna had long-term contracts with its distributors, AML&P, Chugach and MEA, there was a fear that they might not renew their contracts upon expiration. Assistant Secretary of the Interior Kenneth Holum told the House Committee on Interior and Insular Affairs in 1968, "This rate differential, in addition to penalizing the ultimate consumers, will add to the problem created by current competitive natural gas prices in future contract negotiations for Eklutna power."[22]

Now that Congress had a clear interest in maintaining the viability of its own project as well as bringing relief to the power users of Anchorage, legislation moved more quickly. In September 1968, Congress passed Public Law 90-523 making $2,805,415 of the repair costs nonreimbursable. This legislation, coupled with the fact that Eklutna had generated more revenue prior to 1968 than originally projected, allowed the Alaska Power Administration to lower Eklutna's prices by 10% in 1968 to stay roughly competitive with natural gas. With the Rehabilitation Act of 1968, the story of Eklutna and the earthquake drew to a close.

Eklutna and Cooper Lake in the Long Run

Aside from the variation in annual water intake, neither Chugach nor the Alaska Power Administration have voiced dissatisfaction with other aspects of the operation of Eklutna and Cooper Lake. Tom Kolasinski of Chugach noted that there were few, if any, operational problems with the plant and only minor problems with the transmission line. In contrast, Chugach has encountered much greater difficulty with the underwater transmission cable from its Beluga gas facility to Anchorage. Kolasinski also reported that Chugach had no hesitation in renewing its contract for Eklutna power in 1980.[23]

The Alaska Power Administration reports that revenues from Eklutna are fully meeting the requirements for its 50-year repayment schedule. Even the poor water years do not appear to be causing financial problems. The APA noted in its 1979 report that low revenues in poor water years can easily be offset by additional sales in good years. Anchorage's demand for power has increased to the point that Eklutna can sell as much power in any year as it can produce. According to APA, "The available supply is far less than customer demands, so the marketing strategy focuses on optimizing energy production each year."[24] The price differential between hydropower and natural gas generation has also narrowed. Natural gas prices, though still protected at Chugach by long-term contact, rose substantially at AML&P in the late 1970s. By 1979 it was beginning to appear that Eklutna had not only survived an earthquake but also variable annual intake and even the competition of natural gas. Looking to the future, several intriguing possibilities for Eklutna power lie ahead.

Eklutna has operated for over a quarter century. It will be fully amortized in the year 2005. What will happen then? According to Section 4 of the Eklutna Act of 1950, "Upon completion of the amortization of the capital investment allocated to power, the Secretary is authorized and directed to report to the Congress upon the feasibility and desirability of transferring the Eklutna project to public ownership and control in Alaska." Not only will the power users of Anchorage potentially inherit the Eklutna project, but the price of Eklutna power will probably fall dramatically. A few figures will help illustrate this. In 1979 the wholesale power rate at Eklutna was 12.5 mills—a slight increase since 1968 resulting from increased operation and maintenance expenses. At least half of that price, however, included interest and amortization expenses. The operation and maintenance costs at Eklutna for FY 1979 were $693,928; if the allowance for plant depreciation is added the costs rise to $882,496. These costs divided by the firm annual energy generation of 153 million kwh would yield a price for Eklutna power of 5.8 mills per kwh, including depreciation, and 4.5 mills per kwh, excluding depreciation.[25] It is possible that operation and maintenance expenses may rise over the years. In fact, APA announced a 21% price increase in January 1980. This, however, may be offset by increased generation through rewinding the generators and upping their capacity by 15%. Soon after the turn of the 21st century, it is definitely possible that Eklutna will become a gift to the state producing power for less than 1¢ per kwh in 2005 prices. What other known source of power offers these possibilities? Chugach's long-term gas contract will expire at the latest in 1998. At Eklutna, the phenomenon of decreasing prices over time which we noted in Juneau and Ketchikan is again clearly possible.

The prospect of cheap Eklutna power in 2005 is a fitting point to bring the story of hydropower in Anchorage to a close. Through more than 50 years of power crises, earthquakes, and an assortment of power producers and distributors, are there any conclusions we can draw? A few, I think, are worthy of mention.

1. The importance of natural gas as a fuel for the generation of electricity in Anchorage over the last 15-20 years

should not obscure the fact that hydropower has a long record in the southcentral city. Hydroelectric power has been generated there continuously from 1929 to the present day. From 1929 to the mid-1960s, it was the principal source of power. Without hydropower the price of electricity would have been much higher in the initial years of Anchorage's World War II expansion.

2. The relatively short period in which Eklutna was built—6.5 years from initial feasibility report to on line power—should offer evidence that a federal power project can be constructed on schedule to meet a projected need. The Eklutna story should be kept in mind as a contrast to the Snettisham story in Chapter 6.

3. Fluctuations in hydroelectric power production resulting from the variability of water intake require thought for future development. The Alaska Power Administration does not consider this an *operational* problem in its hydro installations. But consumers may think differently in the future for other reasons. In the lower 48 states, many run-of-the-river hydro projects have a *seasonal* variation in generation; more power is available in the summer than in the winter. Consumers can adjust to such regular seasonal variations as power costs rise in the winter and fall in the summer. But in Alaska's tapped lake projects, the waterflow variations occur over a longer period of time (e.g., 10 good water years followed by three poor years). Hydrologists cannot predict when those good and poor years will occur. Consumers who have enjoyed an abundance of cheap hydropower for several years may react negatively to a drop in hydro production and a consequent rise in electric rates if power must be generated with a more expensive fuel.

In future hydro developments it may be wise to make the potential fluctuations in production known to consumers—particularly if they are to vote approval for future projects. It might even be advisable to include an allowance for alternative fuel generation in the rate structure to smooth

Figure 31. The Cook Inlet Aquaculture Association maintains a salmon hatchery in conjunction with the Eklutna power plant. These Zingerboxes are stacked five high with one million eggs per stack.

out any fluctuation in power prices between good and poor years. Obviously the need for such a policy would depend on the percentage of power generated by hydro in any one load area, the cost of alternate production, and the potential degree of annual fluctuation.

4. The diversity of power producers in Anchorage does make it difficult to piece together a history. Whether this situation has had any effect either in developing or retarding the growth of hydropower is difficult to discern. APA Administrator Cross feels that such a diversity is not uncommon in less populated areas of the United States.[26] In the spring of 1982, however, the Chugach Electric Association and several small REAs in the Anchorage area explored the possibility of closer cooperation to achieve better financial and technical stability. Would a more unified system help, hinder or be neutral to future hydro development? This question has not been answered. But I think the existence of three power producers and several additional distributors in one load area is worthy of mention. The possible effects of such diversity would require further study.

5. Finally, the Eklutna and Cooper Lake stories both raise a perplexing question—Should the advantages or disadvantages of hydropower be analyzed in the long run or in the short run? In terms of short-run disadvantages, Eklutna and Cooper Lake experienced (1) high fluctuations in power generation due to a variable annual water flow and (2) the competition of natural gas. Eklutna also experienced initial cost overruns. All of these disadvantages were cited at one time or another as reasons to abandon, delay or be disappointed with hydropower. However, in the long run both Eklutna and Cooper Lake have survived a major earthquake and offer advantages of long-term price stability. In the case of Eklutna, the possibility of decreasing prices is also evident. Which are more important, the short-run disadvantages or the long-run advantages? Should the power purchasers who will consume electricity in the next five years be given

preference over those who will consume power in 30 years? In Ketchikan figures showed that hydro had both long-term and short-term advantages over diesel and gas. But in Anchorage there has been a different record over the last 20 years. Hydro has not always held the short-run advantage. Yet in the long run, it has proved reliable. Which should be given greater consideration? That may be the major question which the Anchorage experience presents us.

Footnotes

1. The Alaska Power Administration succeeded the Bureau of Reclamation as the operator of all federal hydro projects in Alaska in June 1967. It was an agency of the Department of the Interior until October 1977, when it was transferred to the Department of Energy.
2. More published information was available from the Alaska Power Administration than the Chugach Electric Association. The treatment of the Anchorage story reflects this uneveness of data between the two Anchorage hydro producers.
3. C.E. Ellsworth, *A Water Power Reconnaissance in South-central Alaska* (Washington: Government Printing Office, 1915).
4. For the early history of electric development in Anchorage see U.S. Bureau of Reclamation, *Eklutna Project Alaska* (Juneau: U.S. Bureau of Reclamation, 1948), pp. 37-39.
5. *Ibid.,* p. 11.
6. *Ibid.,* Appendix, p. 1.
7. A full discussion of the politics behind the Eklutna Act is traced in Claus-M. Naske and William R. Hunt, *The Politics of Hydroelectric Power in Alaska* (Fairbanks: Institute of Water Resources, University of Alaska, 1978), pp. 48-57.
8. 1957 capacity figures taken from U.S. Federal Power Commission *Alaska Power Market Survey 1960* (San Francisco: U.S. Federal Power Commission, 1960), p. 63.
9. 1957 peak demand and 1970 projected demand from U.S. Federal Power Commission, *Alaska Power Market Survey 1960* (San Francisco: U.S. Federal Power Commission, 1960), p. 83.

10. Information on the early plans for Cooper Lake and other hydro projects planned for Anchorage can be found in U.S. Federal Power Commission, *Alaska Power Market Survey 1960* (San Francisco: U.S. Federal Power Commission, 1960), pp. 89-92.
11. See Anchorage *Times*, February 10, 1959, for construction details on Cooper Lake.
12. For Chugach's problems with a power line to Anchorage see Anchorage *Times*, February 10, 1959, for construction details on Cooper Lake.
13. For Chugach's early interest in gas see Anchorage *Times,* October 7-11, 1960.
14. 1965-68 figures and further details on Chugach's shift to gas come from U.S. Federal Power Commission, *Alaska Power Survey 1969* (San Francisco: U.S. Federal Power Commission, 1969), pp. 30-47.
15. Details on Chugach's gas contract from U.S. Federal Power Commission *Alaska Power Survey 1976*, Vol. 1, (Washington: U.S. Federal Power Commission, 1976), pp. 5-12. 1976 rate figures from Alaska Power Administration, *Alaska Electric Power Statistics 1960-76* (Juneau: Alaska Power Administration, 1977), p. 37.
16, U.S. Bureau of Reclamation, *Eklutna Project Alaska* (Juneau, 1948), pp. 29-31.
17. Alaska Power Administration, *First Annual Report 1968* (Juneau: Alaska Power Administration, 1969), p. 6.
18. Interview with Tom Kolasinski, Chugach Electric Assn., July 1, 1981.
19. Letter, Robert Cross to the author, April 26, 1982.
20. Information on Cooper Lake is taken from Chugach Electric Assn., *Survey of Damage Caused by the Great Alaska Earthquake* (Anchorage: Chugach Electric Assn., 1965).

21. Information on Eklutna from U.S. Bureau of Reclamation, *Eklutna and the Alaska Earthquake* (Juneau: U.S. Bureau of Reclamation, 1966).
22. U.S. Congress, House, *Providing for the Rehabilitation of the Eklutna Project, Alaska,* H. Report 1852, 90th Congress, 2nd Session, 1968.
23. Interview with Tom Kolasinski, Anchorage, July 1, 1981.
24. Alaska Power Administration, *1979 Annual Report* (Juneau: Alaska Power Administration, 1980), p. 9.
25. Cost data on Eklutna from Alaska Power Administration, *1979 Annual Report* (Juneau: Alaska Power Administration, 1980), p. 25.
26. Letter, Robert Cross to the author, April 26, 1982.

Chapter 6
Snettisham—Too Much Power?

Snettisham is the largest hydroelectric facility in Alaska with an installed capacity of 47,160 KW. Operated by the Alaska Power Administration, it lies approximately 28 air miles or 40 miles by water southeast of Juneau, the city whose power needs it was built to serve. As an engineering achievement, it is in many ways a very commendable project. It contains the only underground powerhouse in Alaska, and the tailrace of the plant has created a constant warm water area that has made possible the establishment of a salmon hatchery. There are few, if any, problems in generating electric power at the Port Snettisham site. On the other hand, there have been serious problems in transmitting the power to Juneau and in finding a market for that power when it arrives.

Since its completion in 1973, Snettisham's transmountain transmission lines have fallen down with what sometimes seems natural regularity, plunging Juneau into darkness and requiring a substantial investment in standby reserve diesel generating facilities. Even when the power reaches Juneau, there has yet to be a full demand for it. In FY 1979 Snettisham sold only 80.45 million kwh of power out of its firm generating capacity of 168 million kwh—less than 50%. In fact, the demand of the entire Juneau area for 1979 was only 138.9 million kwh; the remaining 58.5 million kwh was supplied by the older hydro facilities and diesel generators owned by the Alaska Electric Light and Power Company.[1]

The underutilization of power at Snettisham reflects one of the trickiest problems facing any hydroelectric development—matching the installed capacity of a project to a future demand for power. The vast majority of all costs associated with a hydro project are initial, and they cannot be adjusted once the project is completed. There is no way to change the construction cost of a completed project. Usually there is no way to change the interest rate at which the project is amortized. The annual operating and maintenance costs are relatively small compared to the construction and finance charges. And even these costs do not vary significantly with the amount of power generated. As a result there is little marginal cost to the production of hydropower. Expenses can not be appreciably lowered by generating less electricity. Thus, if the demand for power is less than the projected generation, the unit price of a kilowatt-hour can skyrocket. Cheap hydropower can suddenly become very expensive.

There is, however, one way to avert financial disaster. If the financier is the United States Government, the Congress can pass laws to change the way in which the repayment schedule of the project is arranged. This is what has happened at Snettisham. The Water Resources Development Act of 1976 (P.L. 94-587, Sec. 201) has temporarily fixed the price of power and altered the normal repayment schedule for 10 years so that a full demand for Snettisham can be developed. The development of this load heavily depends on a shift in residential heating from oil to electric heat pumps. Whether this is a wise decision or not will be discussed later. First, let us see why Snettisham has faced both transmission and capacity problems.

Planning for Snettisham

Snettisham was not constructed until the late 1960s, but the site for the project had been well known and investigated for over 50 years. The site consists of two lakes, Long Lake and Crater Lake, which provide natural reservoirs of water. By tapping these lakes, their water can be conducted via separate tunnels and penstocks to a common powerhouse. (Presently only the Long Lake portion of the project has been developed.) In short, the Snettisham project is quite similar to the Annex Creek project.

As early as 1913 the Alaska Treadwell Mining Company investigated the Snettisham or Speel River site, but rejected it because of the fear of transmission difficulty over the mountainous, avalanche prone, windy route to Juneau. In 1915 Alaska Gastineau thought of constructing a facility at Speel River if the Alaska Juneau Company would agree to purchase power. Gastineau's engineer, H.L. Wollenberg, told Bart Thane in 1915, "They (Alaska-Juneau) state however, that they positively will not contract for Speel River power at this price unless power is available from some other source to insure continuity of supply in the event of the interruption of the Speel River power."[2] Thus, in figuring the price of Speel River power, Alaska Gastineau based its estimates on the certainty that power transmission would be interrupted from time to time. The company included the cost of an auxiliary steam turbine in town in the overall price of constructing such a hydro facility.

Alaska Gastineau postponed Speel River in favor of Annex Creek which it thought would have fewer transmission problems. As we have seen in Chapter 2, the ups and downs of the mining industry required no additional hydro construction after Annex Creek. By the mid-1950s, Juneau was still endowed with an oversupply of hydropower—so much so that several of the older seasonal facilities such as Nugget Creek and Sheep Creek had fallen into disrepair. Even with such an abundant power supply, plans were revived for Snettisham in the 1950s. Why?

We have noted in previous chapters that federal interest in developing both the economy and the water resources of Alaska picked up after World War II. Feasibility studies of Eklutna, Swan Lake, and Blue Lake were completed in 1948, 1951 and 1954, respectively. There was also a great interest on the part of both Alaskans and the federal government in developing the timber industry of southeast Alaska. Pulp mills opened in both Ketchikan and Sitka in the 1950s. Juneau, too, hoped that it could switch the base of its economy from the now defunct gold mines to its forests. In 1950 the Federal Power Commission prophesized the installation of a pulp mill in Juneau by 1960 which would require additional hydropower.[3]

The pulp mills in Ketchikan and Sitka, as we have previously noted, did not require additional hydropower because electricity was produced as a by-product of their own internal steam processing of pulp. So it might also have been in Juneau. But in the mid-1950s the Georgia-Pacific Corporation, a major timber and paper company, expressed interest in manufacturing newsprint as well as producing pulp. A newsprint plant would require additional external electricity at a cheap rate. As a result of Georgia-Pacific's interest, Juneau soon began to hope that timber would stimulate hydro development in the way the mining industry had done 50 years before. Interest in the old Speel River or Snettisham site quickly mounted. Juneau, like so many other Alaskan communities, turned to the federal government for aid and support. As the Congress had renewed its appropriation for feasibility studies of hydro projects in Alaska in 1955, there was a clear chance of a positive federal response. In 1958 the Bureau of Reclamation conducted such a study for the Snettisham project.

The Bureau's final 1959 report proposed tapping both Long Lake and Crater Lake, and installing a powerhouse with a 48,000 KW capacity. The estimated cost of Snettisham was $40,090,000; power rates were projected at 6.1 mills per kilowatt-hour. There was, however, a major proviso in the Bureau's recommendation: Snettisham was feasible only if the Georgia-Pacific plant was built. According to the Bureau, "Economic feasibility of the project as proposed in this report depends on construction of a newsprint mill in the area. Construction of such a mill, however, is dependent, to a considerable extent, on availability of lower cost power. . . . Cost of the project rules out development by local interests." Since the mill was a necessity for Snettisham, the Bureau recommended that "immediate steps be taken to determine the interest of Georgia-Pacific Alaska in constructing a newsprint mill in the Juneau area." The Bureau concluded by saying, "if Georgia-Pacific confirms its intent to build a newsprint mill and its willingness to contract for power . . . congressional authorization should be sought."[4]

To understand why the mill was necessary for the construction of Snettisham, let us look at Juneau's existing power supply and its projected demand. In 1957 Juneau had a total installed power capacity of 26,605 KW of which 9,700 KW was fully operative.[5] The Bureau predicted that Juneau's utility load would grow from a peak demand of 5,105 KW in 1958 to 20,360 KW by 1975. This need could be met by rehabilitating the existing facilities. However, the Bureau concluded that if the newsprint plant was built, Juneau's peak demand would be 53,060 KW by 1975; the annual power requirement would be 336,500,000 kwh including transmission losses. Snettisham could be expected to provide 292 million kwh of that requirement; 230 million kwh would go to Georgia-Pacific, 47.4 million kwh would go for utility use and 14.6 million kwh would be absorbed in transmission losses. The remaining power requirement would be supplied by Juneau's existing facilities.

The Federal Power Commission confirmed the Bureau's findings in 1960. The FPC predicted that Juneau's utility growth would be 6.3% a year. Based on this figure, peak demand would hit 19,630 KW in 1980. Using a high annual growth figure of 7.3%, the peak might hit 24,490 KW by 1980.[6] According to everyone's figures, Snettisham with 48,000 KW installed capacity was not feasible, and not needed, without the newsprint mill. Juneau, unlike Anchorage, faced no power crisis.

Though Juneau faced no power crisis for technical reasons, it did face one for emotional reasons. The citizens of Juneau, as we noted in Chapter 2, did not like the source of their overabundant supply of power—Alaska-Juneau Industries. Juneau's utility customers, even if they did not need Snettisham power, wanted it. Snettisham was the way to free themselves of Alaska-Juneau. The Bureau's feasibility report gave some support to this negative feeling for the California-based company. Without mentioning specific names the report said, "The Juneau area has sufficient hydroelectric power to meet its present power requirements. However, the usual benefit of low-cost power from hydro sources is not apparent. No data are available which would show the actual cost of hydro generation."[7] The Bureau could only report that wholesale power from Alaska-Juneau cost 17 mills per kwh—11 mills more than Snettisham's projected rate.

Figure 32. The Snettisham project lies 28 air miles southeast of Juneau along Speel Arm.

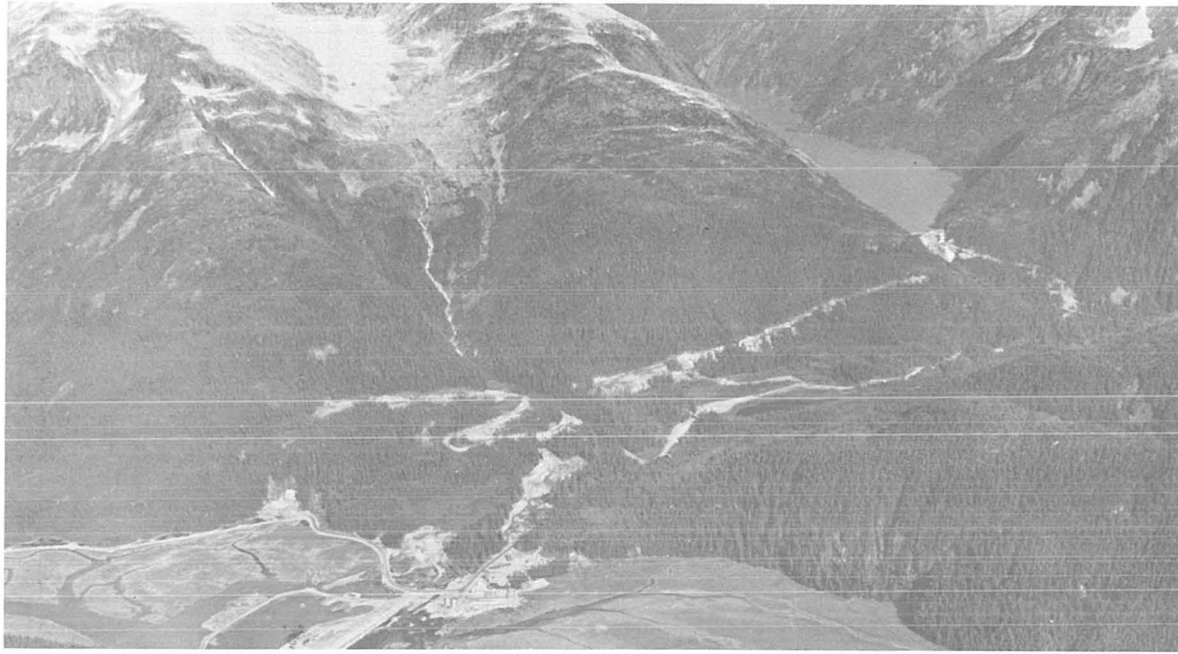

Figure 33. The Long Lake reservoir supplies power to Juneau's Snettisham project.

In 1959 Snettisham meant all sorts of things to the citizens of the capital of the new 49th state. It symbolized the possibility for a renewed economy and the possibility of freedom from continued exploitation by outside interests. And this latter kind of freedom had been a major reason for statehood. Without Snettisham, Juneau had little to look forward to. There would be no newsprint mill without it. And there was always the fear that without an economic revival the citizens of the state might decide to move their capital from the declining southeastern city to Anchorage or another booming spot. After all, when Juneau flourished as a mining town 50 years earlier, it snatched the capital away from Sitka. Without Snettisham, Juneau could well have little more to hold on to than its proud past. There was little glory in being the new state capital if the territorial frustration of outside exploitation continued. Snettisham meant much more than just a cheaper source of power.[8]

The high expectations of 1959 took an unexpected turn for the worse two years later. In June 1961 Georgia-Pacific announced that it was relinquishing its timber rights in the Tongass National Forest and dropping its plans to build a newsprint mill. The company merely noted that the Juneau enterprise was less economically attractive than it had originally appeared because of high costs and adverse market conditions.

Georgia-Pacific's decision threw Juneau for a jolt. Considerable progress had been made by the Alaskan congressional delegation since 1959 in preparing Snettisham for congressional authorization. Both the Department of the Interior and the Bureau of the Budget recommended the project pending a final confirmation of a contract for power from Georgia-Pacific. In the summer of 1961 all seemed lost. Report after report had stated over and over again that Juneau needed no new power without the newsprint mill. What could be done?

For reasons which are not entirely clear, Daryl Roberts, Alaska District Manager of the U.S. Bureau of Reclamation, suddenly revised his estimates of Juneau's future utility demand and issued a new report in November 1961. According to Roberts, statehood had brought a quickened growth of power demand in the

Juneau area which he thought might continue in the future. Roberts noted that while annual power growth for the 1950-60 decade had been 7.7%, growth since 1958 had accelerated at an annual rate of 9.3%. He then extrapolated for the next two decades and announced, "In considering the proposed construction and general economic growth in the area, it appears that the probable future power requirements will increase at an average annual rate of 10 percent or more during the next several years. In forecasting future power requirements, however, a conservative rate of growth of 9.3 percent per year was used until such time as the Snettisham project might be completed."[9]

Based on these new growth projections, Roberts figured that Juneau's power demand, even without a newsprint mill, could justify the construction of Snettisham. The utility load would take approximately a decade longer to reach the same peak demand which the newsprint mill could have provided. Thus Roberts recommended that Snettisham be constructed in stages rather than in the original three-year period.

A staged development constituted a new kind of project in many ways. The original plans for Snettisham, like those for Eklutna, had been based on an immediate need for power. In contrast, Roberts' staged plan was based on an anticipated need for power at some point in the future. This new plan assumed that there would be a certain amount of surplus power (i.e., excess capacity over demand) in Snettisham's early years which would be absorbed in the future years. Since so much of the cost of the project would include initial construction expenses, the Bureau knew that Snettisham would not produce sufficient revenues in its early years to cover the full annual operating and amortization costs. Snettisham's 50-year repayment schedule was thus calculated on sustaining early financial losses which would be capitalized and repaid in later years. Obviously there was a built-in gamble with Snettisham. It was economically feasible only if Juneau grew according to Roberts' projections.

The staged plan also required a projected rise in the cost of power from 6.1 mills per kwh to 7.47 mills. But that would still be cheaper than the 17 mills per kwh charged by Alaska-Juneau Industries. Backed by these new projections for Juneau's growth, Roberts recommended immediate congressional authorization for the project. Tables 6.1 and 6.2 illustrate both the original 1959 growth projections and Roberts' revised projections of November 1961.

Why had Roberts changed his figures? This is difficult to say. Clearly Juneau wanted Snettisham. Both Roberts and the Bureau of Reclamation were located in Juneau. The agency and its manager may well have shared a desire to see a project which they had previously recommended succeed in the community where they were headquartered. Also growth figures were difficult to project at this time. In 1959 the Bechtel Corporation, a leading national engineering firm, predicted in a private report to the Alaska Electric Light and Power Company that Juneau's electric demand would grow at a rate of 6% a year. But Bechtel also noted, "any estimates of growth are largely conjectural. It is conceivable that the growth rate may be much more rapid than 6% since Juneau is to be the capital of a new state."[10]

Roberts did not invent his figures, but they clearly reflected the optimism and hope of Juneau in the years immediately after statehood. Supported by Roberts' new figures, Juneau citizens, power companies and political figures sent an unending stream of letters to Washington. A delegation from the city even traveled to the capital to testify before a Senate subcommittee on Snettisham in March 1962. The Juneauites claimed there that any future industrial development was doomed without cheaper power. One aspect of the high cost of living in Alaska, they pointed out, was high electric rates. Snettisham would bring those prices down.

Various senators expressed some concern over building a project which was tied only to the anticipated growth of one city. Despite such reservations, the committee seemed overwhelmingly favorable to helping the new state. Alaska's Senator Ernest Gruening was a member along with a number of men who had voted for Alaskan statehood. Committee chairman Clinton Anderson of New Mexico complimented the Alaskans for their testimony and enthusiastically stated, "I agree . . . that the greatest problem that Alaska has to whip is the problem of the very, very high cost of liv-

Table 6.1 1959 U.S. Bureau of Reclamation Feasibility Report of Utility Load Growth in Juneau[a].

	Peak (thousand KW)	Annual Generation (million kwh)
1952 (actual)	4.1	16.70
1958 (actual)	5.1	24.4
1960 (projected)	6.6	29.2
1962	7.6	33.64
1965	10.9	47.9
1970	15.3	67.61
1975	20.4	89.72

[a] Source: U.S. Bureau of Reclamation, *Snettisham Project Crater—Long Lakes Division* (Juneau: U.S. Bureau of Reclamation, 1959).

ing up there. Anything that contributes toward lowering the cost of living is worthwhile.''[11]

With this kind of enthusiastic backing, Congress authorized Snettisham in July along with the Bradley Lake project in Homer in the Flood Control Act of 1962 (P.L. 87-874, Sec. 204). Snettisham was authorized at a cost of $41,634,000 to be repaid at 3% annual interest. The act also stated that the project would be built by the Corps of Engineers, not the Bureau of Reclamation. Earlier in 1962 the Army and the Department of the Interior agreed that all future water resource projects in Alaska would be built by the Corps and administered by the Bureau. This agreement laid to rest the old competition between the Bureau and the Corps for control of hydro projects which many people thought had hampered Alaska's development in the past.

The Flood Control Act of 1962, unlike the Eklutna Act of 1950 which covered only that facility, was an omnibus bill including several hundred public works projects throughout the United States. As a new state, Alaska was no doubt entitled to something in such a bill. And Senator Gruening was from Juneau. It is probably safe to say that Snettisham was saved from oblivion not only by Roberts' figures but also by the good will of the Congress for a new state, the natural local interest of a senator for a hometown project, and the fact that many other projects were authorized at the same time.

Congressional authorization was one thing; appropriations for construction were another. Congress showed little enthusiasm for supporting the project after 1962. In Juneau matters grew worse. The feud between A-J Industries and AEL&P continued. The local utility purchased additional diesel generators in an attempt to produce its own power at a cheaper rate. As a result, A-J generated less electricity and raised its wholesale rate to 22.5 mills. The power users of Juneau were the losers. They wanted Snettisham more than ever.[12]

To stimulate the interest of Washington, Juneau tried to prove that the promising future it had proclaimed in 1962 was real. In 1966 Juneau proudly announced that it had found another timber company that needed Snettisham power. This time the St. Regis Paper Co. was the key to Juneau's future growth. Finally Congress

Table 6.2 Daryl Roberts' 1961 Reappraisal of Utility Load Growth[a].

	Peak (thousand KW)	Annual Generation (million kwh)
1958 (actual)	5.1	24.4
1960 (actual)	5.8	29.2
1962 (projected)	7.2	34.9
1965	9.4	45.5
1970	15.2	73.4
1975	24.3	116.9
1976	26.5	127.6
1977	28.9	139.1
1978	31.4	151.3
1979	34.1	164.3
1980	37.0	178.1
1981	40.0	192.7
1982	43.2	208.1
1983	46.6	224.7
1984	50.4	242.7
1985	54.4	262.1
1986	58.8	283.1
1987	63.5	305.7

[a] Source: U.S. Bureau of Reclamation, *Reappraisal of the Crater-Long Lakes Division, Snettisham Project,* (Juneau: U.S. Bureau of Reclamation, 1961).

decided in October of that year to make the first appropriation for construction; bids could be let in early 1967. The future of both Snettisham and Juneau looked bright. The time for planning was over; now construction could begin.

Building Snettisham

The delay in appropriating funds for Snettisham had irritated the citizens of Juneau. But soon there were signs that the delay might not have been so bad after all. In early 1968 it appeared that a better, more technologically advanced project loomed on the horizon.

The original Snettisham design as proposed by the Bureau of Reclamation called for an overhead transmission line, crossing rugged terrain from the powerhouse to Juneau. Such a line would be subject to high winds and avalanches. In April 1968, the Corps of Engineers and the Alaska Power Administration, successor to the Bureau of Reclamation, announced that Snettisham would be linked to Juneau via two 45 mile underwater cables. The new cables would convert Snettisham's AC current to DC for transmission and then reconvert it to AC for distribution. Gus Norwood, the first administrator for the APA, cited numerous advantages to the underwater cable over the aboveground line. In the agency's first annual report, Norwood explained, "Snow avalanches, rock slides, costly access roads, timber clearing, maintenance hazards, and the spoiling of the scenic Inland Passage steamer lane into Juneau loomed large in the search for a better solution." In fact, the report's cover contained a picture of the Inland Passage and noted, "The world famous Inland Passage of southeast Alaska will retain its unspoiled beauty upon completion of the Snettisham Project."[13]

The cables to Juneau were only a part of the new and exciting possibilities which the APA held in store for Snettisham. Norwood went on to propose that a 125 mile underwater cable could be laid from Snettisham to Sitka. This would be very advantageous because Snettisham would have "considerable surplus power in the early years." The APA saw a southeast power pool as the way of the future, thus eliminating the necessity of building many small isolated hydro projects. Such was the optimism presented by the new power administration in 1968-1969. Any potential dilemma in transmitting or marketing Snettisham power seemed to have been both anticipated and resolved. Unfortunately, the agency was not able to be so optimistic after this report.

The APA's hopes for the future were first thwarted in January 1970 when bids for the underwater cable were finally received. Only one bidder, General Electric, submitted an offer. The Corps of Engineers considered the bid of approximately $20 million excessively high. The bid was so much higher than expected, according to informed sources, because American electrical firms were not highly skilled in the techniques of DC transmission. Yet the technology to build the underwater AC/DC/AC system did exist on a worldwide basis. Foreign firms, particularly Swedish firms, might well have submitted a feasible bid. Some feel that G.E.'s bid included the expense of developing the needed technology.[14]

Before the Corps actually decided to reject the bid, G.E. withdrew its offer. Plans for the underwater cables came to an abrupt halt, and the Corps decided a few months later to build the cheaper overhead line. Since environmental groups objected to a shoreline route for aesthetic reasons, the Corps agreed to build the line over a higher, though more mountainous and hazardous, route. Later the Corps would be severely criticized for choosing this route. But at the time the Corps really had only two choices—build the overhead line or abandon the entire Snettisham project. If additional time were taken to investigate new firms to bid on the underwater cable or to engage in lengthy litigation against the environmental groups for the shoreline route, the entire momentum behind the Snettisham project might have been lost. If the momentum of congressional appropriations for construction lapsed while further investigation and litigation continued, the Congress might have abandoned the project altogether. Eight years had already passed since Snettisham was first authorized. If Snettisham was to be completed, there was a necessity to keep construction of the project on some kind of schedule. Thus the Corps probably concluded that it would be better to risk the problems associated with an overhead line than to risk the project altogether. After all, this was not the first calculated risk that had been taken to save the Snet-

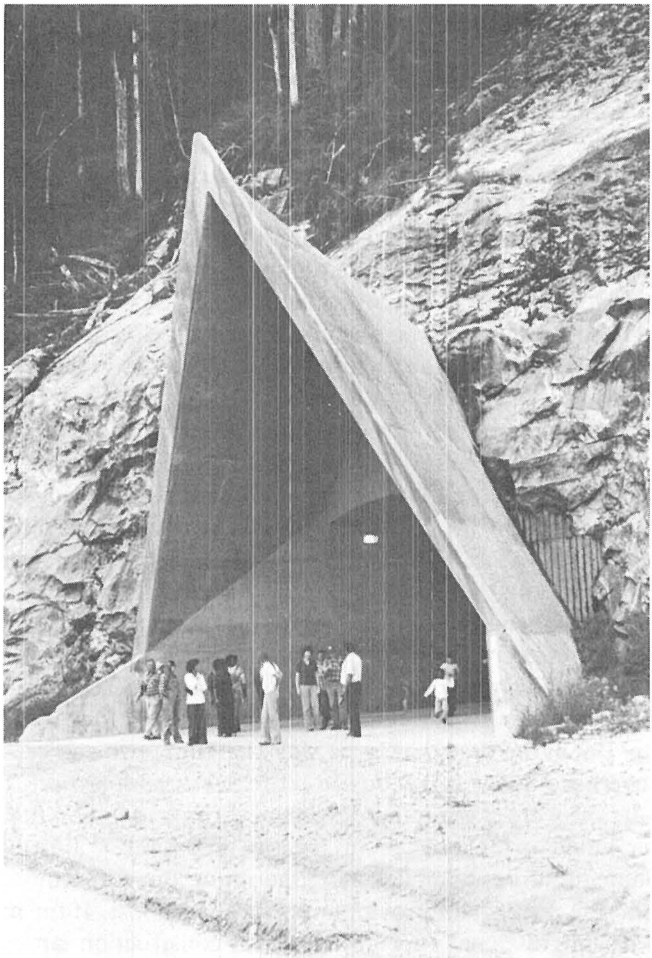

Figure 34. Snettisham's underground powerhouse is reached through a tunnel entrance.

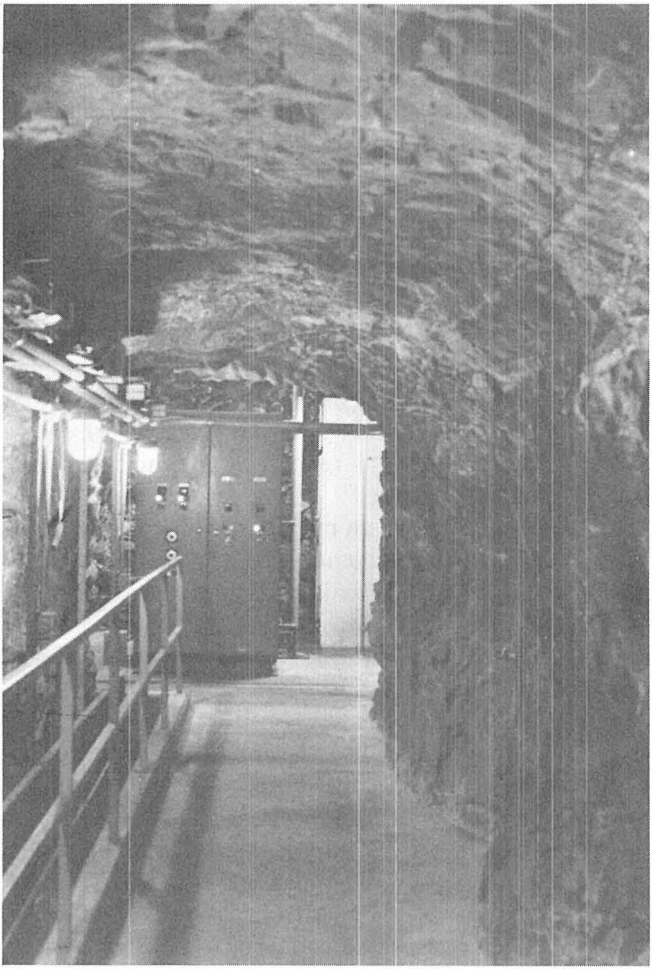

Figure 35. The Snettisham hydroelectric project near Juneau is noted for its underground powerhouse.

tisham project. Daryl Roberts' recalculation of Juneau's electric power growth in 1962 was no less risky than the Corps' decision to build the high elevation overhead line. In 1970 no one really knew what the future would hold for the power line or the power market.

The decision to abandon the underwater cable had another impact on the future of Snettisham. If there could be no cable to Juneau, then there certainly could not be a cable three times that length to Sitka. The dream of a southeast power pool died with the underwater cable. The APA's second annual report simply noted, "Southeast Alaska Power Pool: Southeast Alaska's beautiful fiords, rugged coast and forested islands present a formidable challenge for building transmission lines. Direct current submarine cables are technically, but not yet economically, feasible. More study is needed to meet the many power problems of southeast Alaska." The agency's annual reports would not mention the power pool for another decade.[15]

By early 1970 the Snettisham project had narrowly escaped extinction a number of times. Nonetheless, the project proceeded forward on the somewhat shaky basis of providing power solely to Juneau via an above ground line over terrain much more hazardous than the Annex Creek line. But at least Snettisham was still alive.

Keeping the project going over the next few years was no easy matter. Further problems plagued its construction every step of the way. Like the bid for the underwater cable, the Corps considered the bid it received for the main construction contract too high—over 35% above the estimates. This problem was resolved when the Corps concluded that Long Lake was really a natural reservoir and did not require the construction of a dam as in the original plan. The dam was abandoned in favor of a smaller weir, and a smaller cost. As construction continued, another crisis arose in August 1972, when the State of Alaska stopped construction on the project because one of the subcontractors was not a licensed electrical contractor. To complicate matters further, approximately 100 men refused to work on the transmission line because the helicopters which were used for transport did not have proper water safety floats.[16]

Finally in December 1973, Snettisham went on line. Its final cost of $64,000,000 was 50% more than the original authorization in 1962. To some people the six-year construction period from 1967 to 1973 and the cost overruns may indicate mismanagement on the part of the Corps of Engineers. A closer look, however, may lead to another interpretation. Fifteen years had elapsed from the 1958 feasibility report to on-line power in 1973. This long delay occurred, among other reasons, because Juneau could get along without Snettisham. There was never a power crisis in Juneau such as the one in Anchorage which propelled the rapid construction of Eklutna. It is really remarkable that Snettisham was completed in face of all the obstacles thrown in its path. Snettisham is a testimony to the ability of the Bureau of Reclamation, the Alaska Power Administration, the Corps of Engineers, Alaska's congressional delegation, and the citizens of Juneau to keep a project alive.

The increased cost of the project, though regrettable, was not particularly out of line with the general rise of prices between 1962 and 1973, and the erratic nature of congressional appropriations for public works projects which can thwart the best laid plans of engineers and accountants. The increasing cost did take its toll on the Snettisham power rate. The projected 1962 price per kwh of 7.47 mills was closer to 15 mills by 1973. Still that was lower than the 17-22.5 mill rate of A-J Industries which sparked the drive to keep Snettisham alive.

While there might have been much to criticize in the building of Snettisham, there was also much to take comfort in. The final completion of Snettisham in many ways symbolized the ability of Juneau to keep a grasp on its own future 14 years after statehood. And there was a need to hold on to something in 1973. Unfortunately that second hope for a timber industry in 1966 proved shortlived. The St. Regis Paper Company decided not to go through with its plans in 1967. In its place, U.S. Plywood—Champion Papers accepted the same contract with the U.S. Forest Service in 1968. Champion then proceeded to bring a staff to Juneau to lay the groundwork for the future operation. But in 1970 the Sierra Club filed a suit against the Forest Service and Champion, blocking the sale of timber in the Tongass National Forest for environmental reasons. By 1973 the sale was hopelessly tied up in litigation. Juneau's economic future was once again in jeopardy. But at least the city had held on to its modern hydroelectric facility.[17] As an emotional and political symbol, Snettisham was a success. Once completed, however, it would have to function as a power supplier. Success in that line would be another story.

Operating Snettisham

The Corps took a certain risk in building the overhead line, much as Alaska Gastineau had done 60 years earlier with the Annex Creek line. The new line incurred *exactly* the same fate as the old one. No sooner did Snettisham go on line than the transmission line collapsed. The problem occurred on a particularly vulnerable section of the line called Salisbury Ridge where the line had no protection against high winds at all. Damage first occurred to the towers on the ridge in early 1973, even before Snettisham went on line. Then in February 1974, three towers collapsed. It was not until September 27, 1974, that Snettisham was back in operation. And no sooner was it on line the second time than it went out again—this time during the Christmas season. The citizens of Juneau were irate. Most of their wrath was directed toward the Corps of Engineers. An editorial in the *Southeast Alaska Empire* boldly announced a few days before Christmas 1974 that "the blame rests with the Army Corps of Engineers bureaucratic officials in Washington, D.C. Alaskan engineers originally recommended that Snettisham's line be run underground or underwater, where transmission would not be interrupted by violent weather conditions on Salisbury Ridge. However, officialdom thought this would be too expensive, so now we have a fine hydroelectric power facility, an engineering masterpiece, which has one slight problem—it doesn't work when the wind blows."[18]

A few days later the same paper noted that it was awarding the "Bozo" award to the "Corps of Engineers for their clever placement of Snettisham's transmission lines on Hurricane Ridge against the advice of most Juneauites. But what do we know, we just live here."[19]

Though Juneauites may have been disgruntled at being plunged into darkness at Christmas, their charges against the Crops were not entirely justified. When the Corps held a hearing on the overhead line in June 1970, most of those present voiced only minor concern with the line. The greater concern was to keep it out of sight rather than out of the wind. In reporting this hearing, the *Empire* noted, "Most of those who came forward to testify were enthusiastically in favor of the Corps' construction plans. A substantial cross section of the Juneau business community was represented. Endorsements of the project came from both the Juneau and state chambers of commerce. Attorney James Bradley had the final say. The power is needed. Snettisham is out of sight of most travelers, and no one has taken a flat stand against the overland line."[20]

Nonetheless, the Corps of Engineers accepted the blame for the 1974 line failure. Both the Corps and the APA frankly admitted, "Salisbury Ridge, then, is particularly unsuitable for transmission lines. The lines and towers were exposed to incredibly severe weather conditions much of the time and repairs were impossible because of the ridge's inaccessibility."[21] The Corps proceeded to repair the line until it could relocate it on a better route. Power was restored to Juneau in February 1975. Good service continued until the spring of 1976 when an avalanche toppled a tower near the power plant. Repairs to this tower were made in a few weeks, but further problems with "snow creep" caused three poles to collapse on Salisbury Ridge in May. In the summer of 1976 the transmission line was finally relocated along a lower route. Table 6.3 gives a chronology of the power failures.

The transmission problems at Snettisham from 1974 to 1976 not only marred the project's image of reliability, but also took a toll on its financial accounts. The repairs and subsequent relocation of the Salisbury Ridge line cost almost $11 million. According to the Flood Control Act of 1962, such costs were fully reimbursable in increased power rates. Also, while Snettisham was off line it pro-

Table 6.3 Snettisham Transmission Problems[a].

Summer 1972	Salisbury Ridge section of line constructed.
Winter 1972-73	Three towers on the ridge seriously damaged by wind.
Summer 1973	Corps of Engineers repairs Salisbury Ridge part of line.
Fall 1973	Construction of transmission line completed.
December 1, 1973	Snettisham goes on line.
January 1974	Minor transmission outages occur.
February 14, 1974	Three towers on Salisbury Ridge collapse.
March 1974	Plans initiated to temporarily repair and then relocate the Salisbury Ridge portion of line.
Summer 1974	Corps makes temporary repairs on critical section of line.
September 27, 1974	Snettisham goes back on line.
November 1974	New series of outages begins with onset of winter storms.
December 25, 1974	Minor hardware failure on line causes outage.
December 25, 1974 —February 1975	Wind and low clouds prevent repair crew from reaching line.
February 1, 1975	Line repaired. Snettisham back on line.
Summer 1975	Some hardware in Salisbury Ridge section of line replaced. Tower by tower inspection made by APA and Corps of Engineers. Bolts on towers tightened, defective hardware replaced, adjustments made to guy wires.
Summer 1975— Spring 1976	Snettisham provides essentially uninterrupted service.
April 7, 1976	Avalance topples tower 5 miles from powerplant.
April 27, 1976	Tower repairs done and Snettisham back on line.
May 1976	Three wood poles on Salisbury Ridge damaged by snow creep.
June 15, 1976— June 18, 1976	Transmission outage occurs as a result of snow creep damage.
Summer 1976	Work begins on Salisbury Ridge line relocation. Also studies initiated on ways to mitigate avalanche danger to transmission towers.
September 20, 1976	Relocation of Salisbury Ridge section of transmission line completed.

[a] Source: Alaska Power Administration, *1974, 1975, 1976, Annual Report* (Juneau: APA, 1977).

duced no power; hence it raised little revenue. The project was obviously not meeting its repayment schedule. A rate rise was inevitable.

Juneau had expected cheap power from Snettisham, not ever-rising prices. Residents of the city remembered that Eklutna's power users had been spared the cost of repairing that project in 1968 because of congressional intervention. As early as 1974 Juneau residents and businesses began writing their congressional delegation for similar legislation. Continued outages and repairs over the next two years swelled this demand. The outcry was particularly strong because the cost of buying and operating diesel generators for standby power raised electric rates even more.

Finally, in October 1976, Alaska's Senators Mike Gravel and Ted Stevens secured relief for Juneau in Section 201 of the Water Resources Development Act of 1976. The Act provided that the cost of relocating the Salisbury Ridge line ($5,641,000) would be nonreimbursable. This was justified, according to a senate report, for the following reason: "Due to Corps of Engineers error, the Salisbury Ridge portion of the transmission line was placed on top of the ridge, in a location extremely vulnerable to ice and high winds."[22] Once again the Corps was forced to take the blame.

Making the cost of the line nonreimbursable was only part of the solution to keeping rates down. What could be done about the underconsumption of Snettisham power which we noted earlier? To compensate for the problems in the marketability of Snettisham power, the Water Resources Development Act of 1976 also altered the project's repayment schedule. It extended the total amortization period from 50 to 60 years. And in the first 10 years, the Act required that Snettisham's revenues cover only a small portion of the interest and principal payments in addition to operation and maintenance expenses. At the end of the first 10 years, the deferred interest would be added to the total investment and amortized over the succeeding 50 years. Thus all interest charges will eventually be paid, but on a deferred schedule. This legislation allows Snettisham to hold its power rate at 15.6 mills per kwh until 1986. Power rates will then rise to 25.8 mills per kwh according to APA's estimates.

At this point we might well ask why there was such a surplus of power in Juneau in 1976. There were two principal reasons.

1. The need to produce standby power for Snettisham induced AEL&P to rely on the old hydro facilities it had purchased from A-J Industries in 1972. The utility soon came to look favorably on these plants for base load operation. Annex Creek and Salmon Creek were soon competing with Snettisham. This was a situation which the federal government had never anticipated. The Bureau of Reclamation and later the Alaska Power Administration had always assumed that the old plants would be shut down as soon as Snettisham went on line. According to APA Administrator Cross, nearly everyone thought the old plants were too expensive to repair and operate efficiently.[23]

Why such an assumption was made is a bit perplexing. It is true that A-J Industries had not kept the plants in good repair; the mining company had also kept the financial operation of those facilities in complete secrecy. On the other hand, the Bechtel Corporation advised AEL&P in 1959 that the old plants would be a good investment at the right price.[24] The structures may have been in disrepair, but the water supply at each site was good. In 1966 Van Scoyoc and Wiskup, Inc., a utilities consulting firm retained by the city of Juneau, recommended the repair and continued operation of the old plants. Van Scoyoc thought Annex Creek and Salmon Creek should remain in operation after Snettisham came on line to provide a "yardstick" for Snettisham power rates. Nothing in the plans for Snettisham guaranteed a future price for power. Power prices from Annex Creek and Salmon Creek would provide a ceiling for any potential price increase at Snettisham.[25]

The secrecy surrounding the operation of A-J's facilities explains to some extent why the federal government did not see the old hydro plants as future competitors. But we must also remember that it was not in the interest of either AEL&P

or APA to think about rehabilitating the plants. Continued power generation from those sources would only raise questions about the potential market for Snettisham power.

2. Aside from the issue of competition, the power market in Juneau simply had not developed as rapidly as Daryl Roberts predicted in 1961. From 1960 to 1973, the year Snettisham went on line, Juneau's peak demand grew from 5,837 KW to 15,500 KW; annual generation grew from 29.15 million kwh to 75.75 million kwh. These figures indicated an annual growth rate of 7.8% for peak demand and 7.6% for generation—less than the *conservative* 9.3% which Roberts predicted. Although electric demand grew at a faster rate between 1973 and 1976 (8.5% for peak and nearly 12% for annual generation) the actual figures were still below Roberts' 1961 estimates. The growth in the market has tended to lag behind Roberts' predictions by about 3-4 years. Table 6.4 provides the actual growth from 1962 to 1981. It should be compared with the predictions in Tables 6.1 and 6.2.

The combination of competition from the older hydro plants and the slower than anticipated growth of the Juneau power market resulted in a surplus of power at Snettisham. Of course, the original repayment schedule assumed there would be a surplus of power for a temporary period. Early revenue shortfalls would be capitalized and repaid in the future. The Water Resources Development Act of 1976 simply prolonged this temporary period. But how long can such a delaying action go on? A temporary surplus of power can well become a permanent supply of too much power. Such overcapacity would spell the financial doom of Snettisham or send its power rates even beyond the 25.8 mill predicted for 1986. Can anything be done about this?

Table 6.4 Actual Generation of Power in the Juneau Area[a].

	Peak (thousand KW)	Annual Generation (million kwh)
1960 (Calendar Year)	5.8	29.2
1961	7.8	32.3
1962	7.1	34.7
1963	9.0	37.2
1964	9.4	41.5
1965	10.0	43.5
1966	10.9	48.3
1967	10.5	49.5
1968	11.1	52.8
1969	11.8	56.0
1970 (Fiscal Year)	12.4	58.3
1971	13.8	63.8
1972	14.9	70.3
1973	15.5	75.8
1974	16.2	83.1
1975	17.8	94.6
1976	19.8	106.3
1977	20.4	112.2
1978	23.4	122.2
1979	23.1	133.5
1980	26.2	143.1
1981	32.2	160.7
1982	42.2[b]	

[a] Source: Alaska Power Administration, March 1982.

[b] January 1982.

Selling Snettisham's Power

How has Snettisham fared since 1976? In terms of transmission, only minor problems have occurred—not unlike the outages which occur from time to time in the utilities of most cities. No transmission failures have significantly altered the annual production of energy generated at Snettisham. As a result, Snettisham's annual output rose from 46.8 million kwh in FY 1976 to 80.4 million kwh in FY 1979. The figure for 1981 reached 118 million kwh or 70% of its annual firm energy capability of 168 million kwh.

To develop a full load for Snettisham by 1986, the Alaska Power Administration is exploring two paths: 1) a renewed investigation of the possibilities for interconnection with other southeastern cities; and 2) marketing its surplus power for residential electric heating in Juneau. Though the agency has published reports on both possibilities, the latter is being more actively pursued.[26] The Federal Building in Juneau is now heated electrically, and both the APA and its distributor (Alaska Electric Light and Power) look favorably on the installation of electric water heaters and heat pumps in both new and existing residences.

The potential market for such installations is quite large. In 1979 only 24% of Juneau residences used electric hot water heaters; only 1% of the residences were "all electric" and only 30 of the efficient electric heat pumps were in service. While customers with no electric water heaters consumed an average of 5,887 kwh annually, those with water heaters used 11,140 kwh—and the all-electric homes used 21,315 kwh.[27]

APA's figures indicate that increased use of electric heating will bring Snettisham to a full load by 1983. To continue the conversion to electric heat after that date, the agency now advocates construction of the remaining stages of Snettisham—the Crater Lake portion and an upgrading of the generating capacity of Long Lake. These additions, which are financially attractive because they could be built at the 1962 authorized interest rate of 3%, would raise Snettisham's total installed capacity to 74,160 KW with annual firm generation of 331 million kwh. Such increased capacity would supply Juneau's heating and electric needs to 1992. After that date new hydro sites would have to be developed.

APA sees this market for electric heat as the only way, barring the possibilities of interconnection with other cities, for Snettisham to reach its full load in the Juneau area. Without electric heat, APA estimates that Snettisham will not reach capacity until sometime between 1995 and 2000. And should the capital of Alaska move from Juneau, Snettisham would never reach capacity without conversion to electric heat. Table 6.5 gives these APA estimates. If either of the two "no heat" cases occur, the price of power will probably have to be recalculated when the provisions of the WRDA of 1976 expire.

Will the electric heating strategy succeed and solve Snettisham's surplus power problem? According to APA, the price of heating oil has created such a demand for electric heat that the market does not have to be stimulated or induced. It is there. But such a new power market may create as many problems as it solves. According to APA, the growth of electric heating must be halted in 1983 unless construction of the Crater Lake addition to Snettisham begins. Even if Crater Lake is completed, the whistle on electric heating will have to be blown in 1992. One may well ask if such a strategy can be so finely tuned. Is it possible to encourage people to convert to electric heat and then quickly stop this process as the system approaches capacity?

If the demand for electric heat grows too fast, then diesel-generated electricity must be added to pick up the load. In that case the problems we have noted in Sitka and Ketchikan will occur in Juneau. And the utility managers in Ketchikan and Sitka had no hesitancy in announcing that they would never encourage electric heating. Their main concern has been how to control it. To them such a new demand would only result in reaching system capacity too quickly. The result would be increased diesel generation and a renewal of the turmoil it takes to finance and construct a new hydro project. Don Bowey in Ketchikan remembered that the utility had once encouraged electric heating in the late 1930s. When this increase in demand later pushed the utility to its system capacity, KPU raised its electric rates to discourage use. According to

Table 6.5 Alaska Power Administration Estimates for Electric Power Growth for the Juneau Area With and Without Electric Heat[a,b].

	"No Heat"		Additional Electricity for Heating		Total Load	
	Annual Generation (million kwh)	**Peak Demand (thousand KW)**	**Peak Demand (thousand KW)**	**Annual Generation (million kwh)**	**Peak Demand (thousand KW)**	**Annual Generation (million kwh)**
(1) "MEDIUM" OR EXPECTED GROWTH CASE						
1979	27.5	138	—	—	27.5	138
1980	27.4	144	5.0	13	33.0	157
1985	32.0	168	32.0	83	64.0	251
1990	35.0	183	64.0	168	99.0	351
1995	39.0	207	92.0	243	131.0	450
2000	43.0	228	118.0	310	161.0	538
(2) CAPITAL MOVE CASE						
1980	27.4	144	5.0	13	33.0	157
1985	32.2	169	27.8	73	60.0	242
1990	23.2	122	27.8	73	51.0	195

Table 6.5 Alaska Power Administration Estimates for Electric Power Growth for the Juneau Area With and Without Electric Heat[a,b] (Continued).

	"No Heat"		Additional Electricity for Heating		Total Load	
	Peak Demand (thousand KW)	Annual Generation (million kwh)	Peak Demand (thousand KW)	Annual Generation (million kwh)	Peak Demand (thousand KW)	Annual Generation (million kwh)
1995	26.9	142	39.8	104	66.7	246
2000	30.6	161	51.8	136	82.4	297

[a] Source: Alaska Power Administration, *Juneau Area Power Market Analysis* (Juneau: Alaska Power Administration, 1980), p. 25.

[b] Explanation: APA estimates that the hydro plants owned by AEL&P will generate 37 million kwh until 1983 and 45.3 million kwh after 1985 when Salmon Creek is rehabilitated. Thus for Snettisham to reach its full load of 168 million kwh annually the total net demand would need to be 205 million kwh before 1983 and 213 million kwh after 1985. Using these figures we can see that such a demand would not be reached without electric heat until approximately 1997 in the medium growth case and never with the capital move case. APA's estimates of AEL&P's hydro generation may be conservative. In FY 1979 AEL&P generated 47.6 million kwh in hydro power. With the scheduled rehabilitation of Salmon Creek AEL&P's generation would well be closer to 55-60+ million kwh. In that case total demand would need to be closer to 230 million kwh before Snettisham reached a full load.

Bowey, the editor of the *Ketchikan Daily News* became permanently bitter at the utility for this action.[28]

Alaska Power Administration head Robert Cross acknowledged that electric heat might quickly lead to the hydro system reaching capacity, thus necessitating the generation of diesel power. Nonetheless, he noted that heat pumps, even if powered by diesel-generated electricity, would be a more efficient heating system than oil-fired hot water and would save oil.[29] Though there is logic to Cross' position, one may well wonder how Juneauites will react if the cost of electricity suddenly rises when the hydro system reaches its capacity. Will they remember the high cost they once paid for fuel oil to heat their houses? Or will they simply accuse the power administration of encouraging them to use electric heat to save Snettisham's repayment schedule without consideration of future ramifications on the consumer? Such questions will be left for future investigators to explore.

In 1982 the solution to Snettisham's surplus power predicament remained perplexing. The rise in heating oil prices had created a potential market which was not previously anticipated. This market could readily absorb Snettisham's surplus power. But the new market is in some ways too good to be true. It is potentially too big. Unless the growth of demand for electric heat is finely tuned, Snettisham's surplus will be quickly exhausted and diesel power will have to be generated at a much higher cost than hydro.

What should be done at Snettisham? Should the surplus power be preserved by discouraging or restricting the installation of electric heat? In that case electric rates would have to rise to meet the repayment schedule. Or should the surplus be sold as quickly as possible? In that case Juneau would face the task of building new hydro facilities or generating higher cost power from diesel. It took over a decade to build the first stage of Snettisham from authorization to on-line power. How long would it take to build the last stage? That would be determined by politics. All at once Snettisham has too much power for the old market and too little for the new.

With this perplexing problem in mind, let us put the future aside for the moment and reflect on those conclusions we can draw from Snettisham's past.

1. The Snettisham story clearly illustrates that a host of forces other than the simple need for electrical power can propel the construction of a hydroelectric project. The symbolic qualities of Snettisham (freeing Juneau from outside exploitation, reviving an economy, and modernizing a new state capital) were as important, if not more so, than the need for more electricity.

2. The long planning time and effort put into a hydro project can often give it a life of its own above and beyond the needs for which it was originally planned. Snettisham stayed alive after its original industrial need disappeared, among other reasons, because so many people had invested years of time and energy planning the project. Hydro projects do not quickly die when the need for which they were initially proposed dies.

3. Symbolic qualities can also give a negative image to some facilities even when they are technically sound. The older hydro projects in Juneau acquired a negative symbol because they were owned outside Alaska and their operation was cloaked in secrecy. The plants were also part of an older industrial heritage which had died out. When the symbolism and secrecy were removed from the older projects, they came to be seen as efficient and economical sources of power.

4. The Snettisham story, particularly when combined with the history of Annex Creek, should show that the transmission of hydropower over hazardous routes should be approached with as much concern as its generation. Costs for the production of standby power in the case of transmission outages should be considered as normal operating expenses in computing the overall cost of power. Juneau's need to generate diesel power to cover Snettisham's outages should be considered an *expected*, not an *extraordinary* expense.

5. Surplus capacity as well as initial cost overruns can substantially raise electric rates. The cost overruns in the Snettisham project from 1962 to 1973 raised the kwh price from 7.47 to 15.6 mills. Under the terms of the WRDA of 1976, rates will rise from 15.6 mills to 25.8 mills by 1986. According to the APA, approximately half of the increase is related to surplus capacity (5 mills). Cost overruns in the tens of millions of dollars attract dramatic press coverage. Surplus capacity has a silent effect in raising rates. It is the cancer of hydro projects.

6. The provisions of the Water Resources Development Act of 1976 in fixing the price of Snettisham power raise serious questions about the kind of continuing involvement which a government—in this case the federal government—should take in the operation of a self-funding project. It is questionable whether Juneau's residents should be shielded from facing the economic consequences of Snettisham's transmission and capacity problems. The price of power would be higher without the price-fixing arrangement of 1976, but it would probably be lower than the alternative of diesel-generated power. Sitka and Ketchikan cannot look to federal legislation to lower their power costs. The price-fixing authorized by the Water Resources Development Act thus creates an artificially low price for power in Juneau. In future planning, the precedent of the WRDA may induce Juneau as well as other communities to propose optimistically large projects for construction by federal or state agencies with the expectation that further governmental intervention will keep prices down by altering the repayment schedule. If such a precedent should become commonplace, the price of hydropower would become a perpetual object of political manipulation. The economics of government financed hydropower is peculiar because legislatively determined finance rates and periods of amortization form such a large part of the cost. As a result, political price manipulation is much easier than with power produced from fossil fuel.

7. This report has emphasized the problems, particularly those of surplus capacity, connected with Snettisham. However, Juneau might well have encountered greater problems if Snettisham had not been built. Without Snettisham, a number of alternative scenarios might have developed.

A. A-J Industries might have continued to exploit Juneau.

B. The federal government might have shown no interest in a smaller hydro project which lacked the symbolic qualities of Snettisham.

C. The city of Juneau and AEL&P might have encountered insurmountable difficulty in financing a smaller hydro project given Juneau's declining industrial economy and the uncertainty of the city remaining the state capital. Private financial houses might have looked less favorably on the optimistic forecasts of Juneau's growth than the U.S. Congress.

D. Without the addition of any new hydro facilities or the rehabilitation of the older plants, Juneau might have been forced to generate ever-increasing amounts of diesel power, thus raising its electric prices far beyond any price whichmight be placed on Snettisham power.

The construction of Snettisham was heavily entwined with the very survival of the city itself. Snettisham has encountered problems, but it is still a valuable asset to Juneau. Its benefits might not have been duplicated in any other way.

Footnotes

1. Figures from Alaska Power Administration, *1979 Annual Report* (Juneau: APA, 1980), p. 11. Also see Chapter 1 for a description of the older hydro facilities in Juneau.
2. Letter, H.L. Wollenberg to Bart Thane October 28, 1915. AEL&P archives, Juneau.
3. U.S. Federal Power Commission, *Alaska Power Market Survey 1950* (San Francisco: U.S. Federal Power Commission, 1950).
4. U.S. Bureau of Reclamation, *Snettisham Project Crater-Long Lakes Division, Alaska* (Juneau: U.S. Bureau of Reclamation, 1959), p. 76.
5. *Ibid.,* p. 33.
6. U.S. Federal Power Commission, *Alaska Power Market Survey 1950* (San Francisco: U.S. Federal Power Commission, 1960), p. 98.
7. U.S. Bureau of Reclamation, *Snettisham Project,* p. 32.
8. My feeling for the symbolism of Snettisham and the hopes of Juneau in 1959 was greatly aided by conversations with Juneau economist George Rogers and APA administrator Robert Cross in June 1981.
9. U.S. Bureau of Reclamation, *Reappraisal of the Crater-Long Lakes· Division, Snettisham Project, Alaska* (Juneau: U.S. Bureau of Reclamation, November, 1961), p. 5.
10. Bechtel Corporation, "Preliminary Report to AEL&P", 1959. AEL&P archives, Juneau.
11. U.S. Congress, Senate Committee on Interior and Insular Affairs, *Snettisham Project Alaska Hearing* before a Subcommittee on Irrigation and Reclamation on S. 594, 87th Cong., 2nd Sess., 1962.

12. AEL&P purchased two diesel generators between 1962 and 1966 giving it a total of five diesels. Diesel power could be produced for a wholesale cost of 14-15 mills per kwh. While this was cheaper than A-J's 22.5 mills, it was certainly more expensive than the marginal cost of running A-J's hydro plants at full capacity rather than 2/3 capacity. The competitive practices of the two companies were not the best for power consumers.
13. Alaska Power Administration, *First Annual Report 1968* (Juneau: Alaska Power Administration, 1979), p. 10.
14. Much of my interpretation of the problems with the underwater cable bid comes from conversations with APA administrator Robert Cross and former Ketchikan Public Utilities Manager Don Bowey in June 1981. In the 1960s the principal underwater cables in operation were 1) between Sweden and Gotland, 60 miles and 2) under the English Channel, 38 miles. Both were built by Swedish firms.
15. Alaska Power Administration, *1969 Annual Report* (Juneau: Alaska Power Administration, 1970), p. 2.
16. For details on these problems see Juneau *Southeast Alaska Empire,* August 23-30, 1972.
17. From 1974 to 1976 Alaska's Governor Jay Hammond attempted to bring the various parties to an out-of-court settlement. In March 1976 U.S. Plywood—Champion asked to be released from its Forest Service contract. The company claimed that its plans were no longer economically feasible. Juneau's hopes for a timber industry finally came to an end.
18. Juneau, *Southeast Alaska Empire,* December 23, 1974.
19. Juneau, *Southeast Alaska Empire,* January 2, 1975.
20. Juneau, *Southeast Alaska Empire,* June 1, 1970.

21. Alaska Power Administration, *1974, 1975, 1976 Annual Report* (Juneau: APA, 1977), p. 8-9.
22. U.S. Congress, Senate Committee on Public Works, *Water Resources Development Act of 1976,* S. Rept. 1255 To Accompany S. 3823, 94th Congress, 2nd Sess., 1976.
23. Letter, Robert Cross to the author, April 26, 1982.
24. Bechtel Corporation, *Preliminary Report to AEL&P, 1959.* AEL&P archives, Juneau.
25. Van Scoyoc and Wiskup, Inc., *Power Survey of Juneau Area and Recommendations for Future Action: Report to City of Juneau, City of Douglas, and the Greater Juneau Borough* (Washington: Van Scoyoc and Wiskup, 1966).
26. Alaska Power Administration, *Juneau Area Power Market Analysis* (Juneau: Alaska Power Administration, 1980); Alaska Power Administration, *Snettisham—Ketchikan Transmission System* (Juneau: Alaska Power Administration, 1980).
27. Alaska Power Administration, *Juneau Area Power Market Analysis* (Juneau: Alaska Power Administration, 1980), p. 14.
28. Interviews with "Rocky" Gutierrez, Sitka City Manager, June 1981, and Don Bowey, former Director Ketchikan Public Utilities, June 1981.
29. Interview with Robert Cross, Juneau, June 1981.

Chapter 7
Conclusions

The preceding case histories of hydroelectric projects in Alaska should make it clear that Alaska has a long and venerable record in the production of hydropower beginning at the turn of the 20th century. On the whole this has been a successful record. Save for the one disastrous collapse of the mountain face at the Silvis project in Ketchikan, the operation of Alaska's hydro facilities has been extraordinarily reliable. The plants have provided a long-term dependable source of electric power; some have been operating continuously for periods over 65 years with the originally installed equipment. No hydro project in the four cities studied has worn out. Several have been rehabilitated to provide increased capacity and more efficient production. A few plants in Juneau have been abandoned because they were unneeded, not because they were inoperable.

There have been some problems in the operation of Alaska's hydro facilities. The variability of annual water intake has led to fluctuations in power production. These variations have been widest in the Anchorage load area. But in no location has the water supply dried up or been so restricted that a facility was abandoned. Transmission difficulties, particularly in Juneau, have also led to periods in which electric power could not be delivered to a load center. On the other hand, the projects in this study have not attracted major environmental concern. Environmental objections to the Snettisham project centered mainly on the aesthetic quality of a visible power line along the Inland Passage.

In addition to operational problems, other difficulties have occurred. A particular source of concern has been the financing of hydro projects—particularly by small isolated communities. Some communities have resisted acquiring the long-term debt associated with a hydro project, while others have had difficulty in obtaining such financing. This report notes such problems in both Ketchikan and Sitka. However, the political makeup of these two communities has been quite different and has affected the financing problems in different ways.

Cost overruns have also been a problem in some projects, but for different reasons. At Eklutna it appears that there was an initial lack of expertise in estimating construction costs in Alaska. At Snettisham the cost overruns were connected to long delays in congressional appropriations.

Finally, surplus capacity has been a problem. Though this could potentially occur in any project, it has only been pronounced at Snettisham. The surplus problem is particularly heightened at this Juneau project because the city's geographic isolation provides no easy way to transfer Snettisham's excess power to other localities.

The cases in this study should make one extremely careful in generalizing about "hydro problems in Alaska." What has happened at one project in most cases bears limited applicability or comparability to other projects.

There is, however, one generalization which does seem to arise from all the projects. For nearly 75 years, Alaskans have hoped that the provision of hydroelectric facilities would lead to an expansion of industry. For the most part this has been an illusion. Only in the gold mining industry of Juneau was there a direct connection between the provision of cheap hydropower and industrial production. Ironically, the two companies that built hydro plants for their mining needs went bankrupt in a short time. The two principal industries which have come to Alaska since World War II, wood pulp and oil, have not needed hydropower. The pulp industry was able to produce its own electricity through the use of wood wastes. The oil industry satisfied its electric needs through the use of natural gas which it produced. Natural gas, in fact, provided such a cheap fuel for general utility production that it has effectively stymied the development of hydropower in Anchorage for almost 20 years. The availability of hydropower has not led to a growth of industry. The growth of certain industries has, in contrast, put a damper on the development of hydropower—at least in the state's principal electric load area.

To complete this report it would be well to return to the initial questions we asked—Why has hydropower not been further developed in Alaska and why has hydro's share of electric production fallen since World War II?

There have been two principal reasons. The first is financial. It has been unusually difficult for Alaska's small isolated load centers to sell revenue bonds in the private market to pay for hydro projects. As already noted, small local communities have not been able to obtain the most favorable credit ratings, and voters in local communities have been hesitant to acquire long-term capital indebtedness. Even when funds have been obtained from the federal or state government, the case histories make it clear that the financing of nearly every hydro project has been an *ordeal.*

Secondly, the availability of natural gas in the Anchorage area temporarily halted the growth of hydropower in the state's largest population area. The initial low cost of natural gas coupled with the extremely favorable long-term delivery contract negotiated by the Chugach Electric Association has kept gas in the forefront longer than the rise in its open-market price might otherwise have dictated. In the future gas may not always provide cheaper power than hydro. Had gas not been discovered in Anchorage, additional hydro facilties would likely have been built. Historical records indicate that plans for future hydro projects were well on the way until gas was discovered.

There is little in the historical record which argues against the future development of hydro—and much which commends it. The decreasing cost phenomenon which we have noted in several of the older projects should warrant particular attention in the face of an inflationary future.

A few caution signs, however, should be observed in any future hydro plan.

1. The problems of annual waterflow variation in some areas and transmission difficulties in other areas indicate that attention should be given to the provision of and cost of standby sources of power.

2. The existence of surplus capacity at Snettisham provides a warning that it can be risky to build an optimistically large project. The mere existence of a hydro project has not attracted industry or other new customers. Alaska's experience indicates that estimates for future electric demand should be based on the needs of existing customers or potential customers who would come for reasons other than the availability of hydropower. The hope that hydropower will attract customers has been an unfulfilled dream in Alaska for over half a century.

3. Thought should be given to the role which the federal or state government plays in the continuing operation of a project financed by a legislative appropriation. If a government continually intervenes to fix the price of power, hydropower could become such a volatile political issue that its political repercussions could well offset its economic benefits. Sitka's rejection of state financing for Green Lake should draw attention to this concern.

4. Cost overruns should be watched with care. But their importance should not be exaggerated—as is often the case in press reports. Cost overruns have indeed been substantial at Eklutna and Snettisham. But in neither case did the increase in construction cost make hydropower particularly expensive or noncompetitive. At both Eklutna and Snettisham the price of power was still cheaper than it had previously been. Initial construction costs are amortized over a long period of time. The interest rate in most cases contributes more to the price of power than the cost of construction. A cost overrun in a project financed at 3% (the rate at Snettisham) can affect the

price of power less than a rise in interest rates. A community that hesitates to obtain financing and later finds that the interest rate has risen is in a similar predicament to one that encounters cost overruns in a project financed at a favorable rate. Obtaining a favorable interest rate is as important as worrying about cost overruns.

5. The final price per kwh of hydroelectric power is subject to many variables including interest rates, cost overruns and surplus capacity. Hydropower can be very cheap. But changes in any of these variables may suddenly raise the price at any one project. Once a plant has been completed, it is almost impossible to lower the price of power to compete with a cheaper alternative fuel. Hydropower is not a magical, guaranteed key to the cheapest possible power price at all times. Consumers should be aware of these variables and of the risks involved. This is particularly important in Alaska where consumers often vote approval for the construction of projects.

Caution should be taken in planning the future development of hydropower. But past experience indicates few reasons for delaying or avoiding hydro developments that meet the normal tests of economic feasibility. Those problems which have been encountered have mainly been short run. In the long run hydro has provided benefits, particularly of price stability and long-term efficient operation, which have not been forthcoming from any other power source. Hydroelectric power has served Alaska well.

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Upper left, Eklutna powerplant, by Alan C. Paulson

Upper right, Treadwell's central powerplant, courtesy of the Alaska Electric Light and Power Co.

Bottom, construction of the Salmon Creek Dam, courtesy of the Alaska Electric Light and Power Co.

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