Waterpower Resources Near Petersburg and Juneau, Southeastern Alaska

GEOLOGICAL SURVEY WATER-SUPPLY PAPER 1529

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By F. A. JOHNSON

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A discussion of potential development of power on 12 Alaska streams

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WATERPOWER RESOURCES NEAR PETERSBURG AND JUNEAU, SOUTHEASTERN ALASKA

By F. A. Johnson

ABSTRACT

The bulk of the potential waterpower on the narrow strip of mainland in southeastern Alaska between Petersburg and Juneau is available at powersites on 12 mountain streams. The aggregate potential is 190,000 kw of primary power. Detailed surveys and geologic examinations of most of these sites were made by the U.S. Geological Survey between 1949 and 1958, and quadrangle maps compiled from aerial photographs of 1948 cover all but 3 of the stream basins on a scale of 1 inch to 1 mile. Streamflow records were collected by the Geological Survey and the U.S. Forest Service on several of the streams at intervals between 1915 and 1946 and have been collected by the Geological Survey since 1946. The streamflow records, surveys, geologic examinations, and other data were used for appraisals of the powersites which are described in this report. Suggested methods of development generally follow plans described by the Federal Power Commission and Forest Service in 1947, modified to accord with information obtained after 1947.

The geographic, climatic, and hydrologic conditions are described briefly and discussed in relation to their effect on power development. Very few places are suitable for industrial sites and towns, because of the mountainous terrain. Transmission of power to these places would be relatively difficult, and on some routes would require use of submarine cables for transmission across waterways. Heavy winter snowfall and relatively cloudy, cool summers account for the many glaciers and snow banks in the mountains. Perennial snow has an appreciable equalizing effect on the amount of annual runoff at some of the sites.

The 12 powersites are in 3 groups, 1 at the southern end of the mainland strip, within about 15 miles of Petersburg, and 2 near the northern end, within about 35 miles of Juneau. Storage for equalization of seasonal runoff is essential for generation of dependable power since 80 to 90 percent of the annual runoff occurs in a 6-month period. Eight of the sites have good storage possibilities in lake basins at relatively high altitude near tidewater. Sufficient storage could be developed at nearly all the sites for substantial equalization of the annual runoff.

Powersites on Delta Creek, Cascade Creek, and Scenery Creek, tributaries to Thomas Bay near Petersburg, have an aggregate potential of 44,500 kw of primary power of which about half is at the Cascade Creek site. Storage for regulation could be obtained at lakes on each of the streams by damming the outlets or tapping the lakes at depth with tunnels. The lakes are within 2 or 3 miles of tidewater, and heads of more than a thousand feet could be developed. Petersburg on Mitkof Island is the nearest community at which

the power could be used. It is within a transmission range of about 20 miles, which includes several miles across Frederick Sound that would require transmission by submarine cable. Undeveloped areas on the mainland near Point Agassiz, about 8 miles southwest of Cascade Creek, are topographically suitable for industrial sites and supporting communities not far from the water supplies of Delta Creek.

The second group of powersites is about 35 miles southeast of Juneau near Port Snettisham, a fiord extending northeastward from Stephens Passage. One of the powersites is on Sweetheart Creek, a tributary to a southern arm of Port Snettisham called Gilbert Bay. The others, on Tease Lake, the Long River, the Speel River, and Crater Lake are located around the head of the Speel Arm of Port Snettisham about 10 miles north of Gilbert Bay. The estimated potential of the entire group aggregates 113,000 kw of primary power, of which 50,200 kw is at the Speel River site. This site appears to be the least favorable of the group. Storage at natural lakes could be developed at all of the sites except the Speel River, where sizable dams on the river and at a saddle would be required. A considerable amount of reserve capacity would be needed at this site for catchment of the heavy sediment load of the river. Power from all the sites could be transmitted some 50 miles to the Juneau area to serve new industrial development. The advantages of an existing community favor this possibility. An undeveloped area just south of Gilbert Bay is topographically suitable for location of factories and a community in the immediate vicinity of the Sweetheart Creek site and within transmission range of about 18 miles from the sites at the Speel Arm.

The third group includes Dorothy Creek, Turner Creek, and Carlson Creek, tributaries to Taku Inlet; and Sheep Creek, a tributary to Gastineau Channel. These sites have an aggregate potential of 31,800 kw of primary power, with Lake Dorothy on Dorothy Creek accounting for more than half of the power. Storage could be developed readily there by tapping the lake with a tunnel, at the sacrifice of only a small part of the 2,421 feet of head below the natural surface. Sufficient storage for control of Turner Creek could be provided by construction of a dam of moderate height at the outlet of Turner Lake, but not by drawdown since the lake is at a low altitude. Sizable dams would be required on Carlson Creek and Sheep Creek to develop the needed storage there. Power from the Dorothy Creek and Turner Creek sites could be transmitted about 20 miles to the Juneau area, and over shorter routes from the Carlson Creek and Sheep Creek sites. The transmission line from Dorothy Creek to Juneau, including 2 miles of submarine cable across Taku Inlet, could be designed to serve also for transmission of power from the Port Snettisham area along 15 miles of the route.

The development of a substantial portion of the power from any of the groups of sites of the Petersburg-Juneau area depends upon industrial development and the accompanying growth in population. In 1959 the electric energy being used in the service areas of Petersburg and Juneau was less than 2 percent of that available from the primary potential of 190,000 kw that could be developed at the waterpower sites.

INTRODUCTION

PURPOSE AND SCOPE

This report deals with three groups of waterpower sites on streams of the Alaska mainland from Thomas Bay near Petersburg northwestward to the vicinity of Juneau. It presents descriptions of the sites and estimates of the potential power based on surveys, examinations, and streamflow records of the Geological Survey between 1948 and 1958; and on the results of previous investigations. Schemes of development in accord with the topography and geology are outlined and used with the water-supply data available to 1956 for estimating the potential power.

The power possibilities are discussed only on the basis of regulated flows because natural flows are very low during winter periods; the demand for seasonal power is small, and the possibility of supplementing much of it from fuel-electric sources for production of firm power is unlikely.

Lands in most of the stream basins of this report have been withdrawn as potential powersites by classification of the Geological Survey or as a result of applications to the Federal Power Commission. Information presented in the report, and particularly the recent map data, make it possible to determine more closely whether retention of all the withdrawals is justified or whether some modifications should be made.

The present report consists largely of material from three open-file reports of the Geological Survey (Colbert, 1955; Johnson, 1955, 1957), as revised and brought up to date, and it accordingly supersedes these reports.

GENERAL DISCUSSION

The conditions for waterpower development in southeastern Alaska were described by Hoyt (1910) and more recently by the Federal Power Commission and U.S. Forest Service (1947), and by the U.S. Army Corps of Engineers, (1952). Hoyt pointed out that development is favored by the existence of many precipitous streams discharging from lakes which offer excellent storage facilities near tidewater, but is greatly hampered by the difficulty of transmission. The routes from powersites to industrial sites or to existing communities generally are along very steep mountainsides which extend to tidewater, and on which avalanches are common. Furthermore, the mainland shore is indented in places by long inlets or fiords which would necessitate indirect transmission routes or crossings by means of submarine cables.

In some places large tidal glaciers would practically bar transmission along the mainland. The rugged terrain at the powersites generally would prevent location of sizable factories and supporting communities in their immediate vicinity.

The transmission costs from some of the more favorable sites in southeastern Alaska to load centers such as Petersburg and Juneau were estimated by the U.S. Army Corps of Engineers (1952). These are approximately 50 percent of the cost of generation, with transmission-line distances of about 50 miles. It was stated in the Army report that interconnection of load centers is impracticable because of the distance and the difficult terrain between them.

Most of the many sites in southeastern Alaska have a potential of only a few thousand kilowatts of primary power, and only a few have potentials greater than 20,000 kw. The potentials are low because most of the stream basins are relatively small, so that in spite of the heavy runoff per unit area, streamflows generally are not very great.

The powersites discussed in this report include some of the most favorable ones in southeastern Alaska from the standpoint of conditions at the sites, amount of potential power, and location with respect to possible service areas. They are described separately as 3 groups, within each of which power from several sites could be interconnected.

The first group comprises sites on Delta Creek, Cascade Creek, and Scenery Creek, all located at Thomas Bay near Petersburg (see fig. 3). An aggregate of 44,500 kw of primary power could be generated at these sites for transmission to the now underdeveloped areas at or near Thomas Bay. Alternatively, power could be transmitted to Petersburg on Mitkof Island by means of about 20 miles of line from Cascade Creek, including several miles of submarine cable. The Cascade Creek site has about half the potential power of the Thomas Bay group (21,900 kw) and is judged to be the best of the 3.

The second group includes sites on Sweetheart Creek at the head of Gilbert Bay of Port Snettisham; and sites on Tease Lake, the Long River, the Speel River, and Crater Creek, all near the head of the Speel Arm of Port Snettisham (see fig. 8). An aggregate of 113,000 kw of primary power could be generated at these 5 sites, but 50,200 kw would be from the Speel River site, which probably is the least favorable of the 5. Power could be transmitted for 20 miles from the 4 sites near Speel Arm to a flat area of several square miles just south of Gilbert Bay, and for 2 miles from Sweetheart Creek to this undeveloped area. Alternatively, the power could be transmitted for about 50 miles from Speel Arm to Juneau by overland lines and 2 miles of submarine cable crossing Taku Inlet.

The third group includes sites on Dorothy Creek, Turner Creek, Carlson Creek, and Sheep Creek in the vicinity of Taku Inlet near Juneau (see fig. 14). An aggregate of 31,800 kw of primary power could be generated at these sites, of which 17,800 kw would be from the Lake Dorothy unit of Dorothy Creek, probably the best of the 4 sites of this group. Power could be transmitted from the Dorothy Creek and Turner Lake sites to Juneau, some 23 miles and 15 miles respectively, by means of overland lines and a submarine crossing of Taku Inlet, in part on the same route that might be used for transmission from the sites at Speel Arm to Juneau. Power could be transmitted to Juneau from Carlson Creek and Sheep Creek sites by shorter, overland lines.

The development of a substantial part of the potential power of any of the three groups of sites depends on industrial development and the accompanying growth in population. The use of power in southeastern Alaska has been very limited to date [1959]. As tabulated by the U.S. Army Corps of Engineers (1952), the installed capacity of existing developments in 1952 was about 39,000 kw, of which only about 24,000 kw was for hydroelectric generation. The installed capacity was increased substantially by the construction of a pulpmill at Ketchikan in 1954. This mill is served by a steamplant fueled largely by waste products. The construction of pulpmills at other communities in southeastern Alaska was being considered in 1958 and may lead to some increased use of waterpower either directly or through an accompanying growth of population.

PREVIOUS INVESTIGATIONS

Investigation of some of the powersites was made before 1915, as shown by streamflow records for 1908 and 1909 for the outlet of Turner Lake, construction of a powerplant on Sheep Creek in 1910, and application to the Forest Service for powersites at Crater Lake and Long Lake in 1913 and on Carlson Creek in 1914.

Dort (1924) discussed the Cascade Creek, Sweetheart Creek, Tease Lake, Long River, Crater Creek, Turner Creek, and Carlson Creek sites. His figures of potential storage capacities at the Cascade Creek and Sweetheart Creek sites were determined from topographic surveys made by him in 1921. The potential capacities at the Long River and Crater Creek sites were determined from surveys made by the Speel River Project, Inc., a corporation which began investigation of the sites near Speel Arm as early as 1913. Dort was assigned to his study of the waterpower of southeastern Alaska by the Forest Service, and his report was to the Federal Power Commission.

Reconnaissance investigations of waterpower sites throughout southeastern Alaska were continued by the Forest Service in cooperation with the Federal Power Commission after the time of Dort's investigation. Data collected in these and earlier investigations were analyzed and used as a basis for discussion of the power possibilities of 200 sites scattered throughout southeastern Alaska. The report was published jointly by the Federal Power Commission and U.S. Forest Service (1947) and includes descriptions of the 12 sites discussed herein.

The U.S. Department of the Interior (1950) issued a reconnaissance report concerning the development of water and related resources in Alaska. It gives an appraisal of the outlook for the use of water in Alaska for power and other purposes in the light of economic conditions and trends at the time of the report.

The U.S. Army Corps of Engineers (1952), has reported on harbors and rivers of southeastern Alaska. The report contains estimates of the potential power of the eight largest sites between Thomas Bay and Juneau and estimates of the cost of generation and transmission. The physical conditions in southeastern Alaska, the economic development, and the outlook for future development are discussed in some detail.

An estimate of the potential power of Lake Dorothy was made and a plan of development described by the U.S. Bureau of Reclamation (1955). The bureau programmed field investigations and offices studies of the Crater Lake and Long Lake sites in sufficient detail for preparation of a report on the feasibility of the project.

Discharge records for most of the streams of this report have been collected by the Geological Survey and the Forest Service over periods since 1915. These records and some furnished by private companies are available through the 1956 water year (U.S. Geological Survey, 1957, 1958a, 1958b). (The 12-month period ending September 30 each year is called the water year, and the water year is designated by the calendar year in which it ends.)

ACKNOWLEDGMENTS

Acknowledgment is due the offices of the Forest Service in Juneau and Petersburg for the loan of equipment and facilities to the field parties. Radio communications with field camps near Juneau and Petersburg were handled by the Alaska Communications System.

GEOGRAPHY

LOCATION AND EXTENT OF AREAS

The principal part of southeastern Alaska extends northwestward between the Pacific Ocean and Canada about 400 miles from lat 55° N., near Ketchikan, almost to lat 60° N., near Skagway. It covers a rectangular area roughly 120 miles wide which includes a number of large islands and a narrow, irregular strip of mainland.

The powersites lie within the part of the mainland strip which extends from near Petersburg to near Juneau between lat 57°00′ N. and 58°20′ N. The group of sites in the Thomas Bay area is near the southeastern end of this reach; the groups in the Port Snettisham and Taku Inlet area are near the northwestern end. (See fig. 1). It is judged from available information that the power possibilities along the mainland between these groups are small and relatively unfavorable. Only three sites in that area were considered by the Federal Power Commission and U.S. Forest Service (1947, map 5), and the aggregate potential of these was estimated as only 560 hp (about 420 kw) of primary power.

ACCESSIBILITY

Transport to Petersburg and Juneau or to available natural harbors or landing places is dependent on ships or airplanes. Boats or barges of light draft might be required for transport of equipment and materials from harbors to the vicinity of some of the powersites where there are tidal mudflats at low tide, as at the head of Speel Arm.

Except for the Sheep Creek basin, there are no roads in or near any of the sites. Construction of arterial roads or railroads would be impracticable in the foreseeable future because of the extremely rugged terrain, the existence of glaciers extending to tidewater in places, and the limited service areas.

A road from Juneau to the mouth of Sheep Creek could be extended to Carlson Creek, but transport of heavy equipment

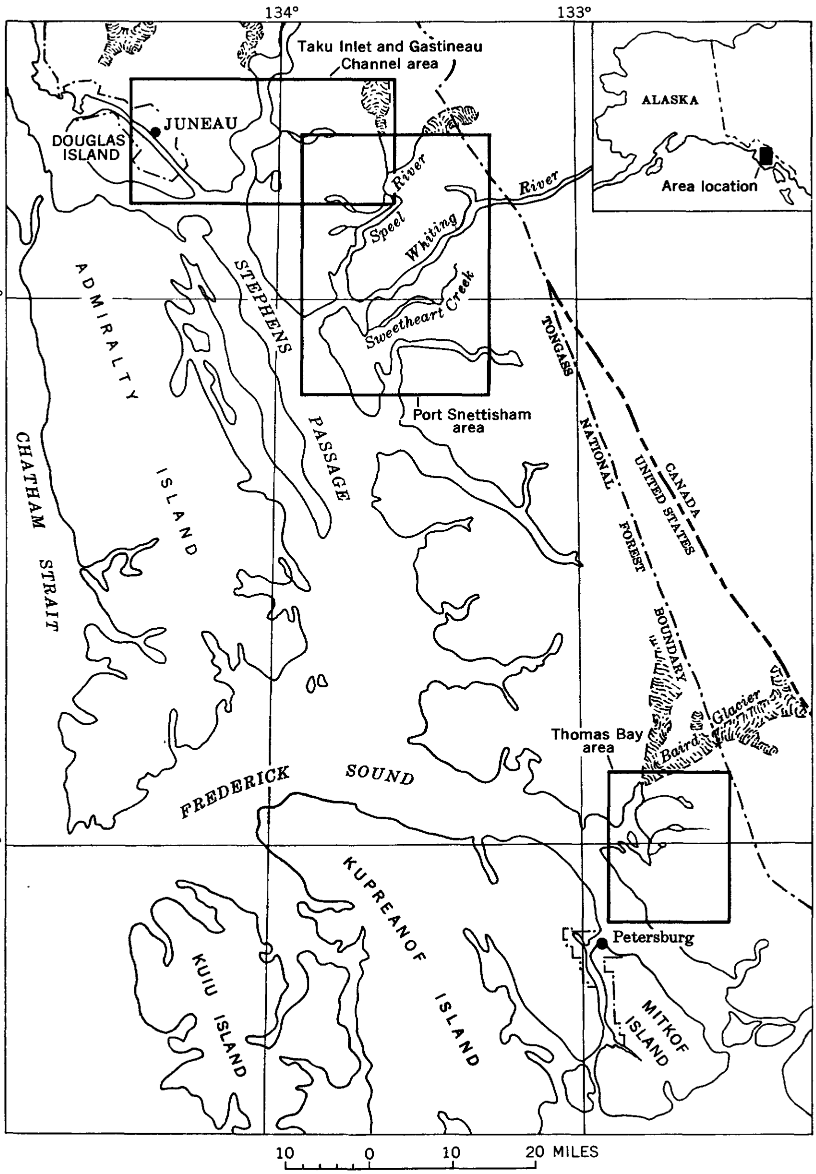

FIGURE 1.—Map of southeastern Alaska showing location of powersite areas between Petersburg and Juneau.

or materials to the mouths of the other streams, as well as to Juneau, would be dependent on boats. Swan Lake on Cascade Creek, Scenery Lake, Lower Sweetheart Lake, Long Lake, Crater Lake, Lake Dorothy, and Turner Lake are accessible by float plane for transport of men, camp supplies, or light equipment.

Short access roads could be constructed part of the way from tidewater to some of the reservoir sites. Tramways could be constructed on the steeper part of the routes, and at some of the sites they probably would be the more practical means of transport over the entire route.

LAND USE AND POTENTIAL VALUE

Steep mountainsides extend down to tidewater along almost all of the mainland shore. Most of the area is within the Tongass National Forest and is generally timbered below an altitude of about 2,500 feet. The timber consists mainly of spruce and hemlock, which is of pulp grade below an altitude of about 1,500 feet. Most of the commercial timber is within 3 miles of tidewater, readily accessible for logging and transport to mills.

The slopes above the timberline generally are featured by extensive exposures of glaciated rock. Glaciers are present at higher altitudes in all of the basins discussed herein, with very extensive ones in the upper part of the Speel River basin. The ridges surrounding the stream basins extend to altitudes of several thousand feet. Cirque glaciers are common above an altitude of 3,500 feet.

All the basins except that of Sheep Creek are uninhabited, primitive areas and probably are visited only occasionally, mainly for recreational and forest-management purposes. The mountains, glaciers, and lakes have great scenic beauty, but they are relatively inaccessible.

There are a number of mining claims and inactive mines in the Sheep Creek basin. Acquisition of some of these would be necessary for power development, but mining in this area appears to be a declining activity. Most of the basin is outside the forest reserve within the Juneau townsite.

Commercial fishing, mainly for salmon and halibut, is an important activity in the waterways along the mainland, but most of the tributary streams are so precipitous that they are inaccessible to migratory fish.

The few areas of moderate relief along the shore, and within feasible transmission range of the powersites, have potential value for industrial sites. The areas suggested in following sections concerning the powersites were selected only on the basis of reconnaissance examinations or map data, and detailed examinations would be essential for close appraisal of their suitability.

At present [1959], the most likely future use of the undeveloped lands in southeastern Alaska seems to be logging for the manufacture of wood pulp. The forest reserves are administered by the regional office of the Forest Service at Juneau, Alaska. Some information concerning the character, amount, and location of the timber in southeastern Alaska has been given by Heintzleman (1928).

It may be feasible to mine deposits of iron ore at Port Snettisham at some future time. The ore is magnetite with some titanium, and according to the U.S. Bureau of Reclamation (1955, p. 6, 21–22) smelting by electric furnace would be necessary for economic recovery. The estimated power requirement was stated to be at least 40,000 kw. The deposits are within transmission range of the powersites near Gilbert Bay and Speel Arm of Port Snettisham.

MAPS AND PHOTOGRAPHS

All the mainland area of Alaska between Petersburg and Juneau is shown on maps of the Geological Survey Reconnaissance Topographic Series covering the Petersburg, Sumdum, Taku River, and Juneau quadrangles on a scale of 1:250,000. Topographic maps on a larger scale are available for areas of the powersites and are listed herein in the sections relating to the three groups of sites.

Aerial photographs are available in files of the Geological Survey, Denver Federal Center, Denver, Colo.

GEOLOGY

The geologic conditions at the powersites near Thomas Bay and Port Snettisham, except Sweetheart Creek and Tease Lake, were described by Miller (1955, 1956), and those of the sites near Taku Inlet, except Dorothy Creek, by Plafker (1956). The geologic conditions at the Dorothy Creek powersites were described by the U.S. Bureau of Reclamation (1955, appendix 1). The Geology of southeastern Alaska was described by Buddington and Chapin (1929).

Brief mention of the geology of many sites is included herein in the descriptions of the sites.

CLIMATE

The climate at sea level is characterized by heavy precipitation, much cloudiness, and relatively mild weather for such northerly latitudes. The average annual precipitation is about 90 inches at Juneau and 106 inches at Petersburg. The average temperature at both places is about 42° F. The temperatures at Juneau for the period November through February are about the same as at Spokane, Wash., but the summer temperatures are substantially lower. During a 20-year period the number of clear days recorded at Juneau averaged only 54 per year.

Cloudiness and fog, as well as precipitation and temperature, are influenced greatly by local topography, and the irregular configuration in southeastern Alaska results in considerable variability. For example, the average annual precipitation at Annex Creek on Taku Inlet, only 10 miles east of Juneau, is about 20 percent greater than at Juneau, whereas the average number of clear days per year is 94 as compared with the 54 at Juneau.

The precipitation in the mountains near the waterways is much heavier than at sea level and the winter temperatures are much lower. As estimated from the runoff records, the average annual precipitation on the Carlson Creek basin, for example, is more than twice that at Juneau although the center of the basin is about 5 miles from Juneau. The bulk of the winter precipitation in the mountains is snowfall, as shown by the low winter runoff and the prevalence of glaciers.

The precipitation results from relatively warm, moist winds from the Pacific Ocean rising over the mountain barriers of the islands and mainland. These winds generally are from the south and are of moderate velocity. Exceptionally strong winds occur when there is a flow of cold air from inland, notably through waterways such as Taku Inlet or through mountain passes.

PRECIPITATION

Precipitation records have been maintained at Juneau since 1881 but are incomplete or lacking for many of the years before 1912. Furthermore, the amounts recorded in some of the early years, notably 1910 and 1911, appear to be abnormally small and probably are not representative of areal amounts. Figures of monthly and annual precipitation for Juneau are listed in table 1 for the water years 1916–57, which include several series of wet and dry years and which probably are a representative sample of the long-term pattern.

Records for Petersburg near Thomas Bay, Speel River on Speel Arm, and Annex Creek on Taku Inlet have been collected for various periods. The records for the water years of complete record for these stations are summarized below for comparison with the mean values at Juneau for the water years 1916–57.

TABLE 1.—*Monthly and annual precipitation, in inches, Juneau, Alaska*

[Data from records of the U.S. Weather Bureau. The published figures were rounded to the nearest tenth and added to obtain the annual totals]

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Annual
1916	9.1	8.6	8.9	0.9	6.7	3.3	4.8	4.2	6.0	5.0	6.5	12.2	76.2
1917	14.6	8.0	7.9	10.3	5.9	4.2	1.7	3.5	5.3	10.5	11.1	12.3	95.3
1918	18.6	16.8	6.4	8.6	5.8	4.3	5.9	5.6	3.8	2.3	11.5	12.4	102.0
1919	14.0	15.0	10.3	11.4	3.1	4.4	6.5	5.0	3.7	6.4	5.9	11.4	97.1
1920	12.5	9.9	7.7	14.3	10.1	4.6	4.6	6.1	4.9	1.4	9.7	8.2	94.0
1921	10.9	5.6	6.0	4.1	8.9	6.5	4.0	6.1	1.9	7.1	7.9	8.6	77.6
1922	11.6	6.0	12.7	11.6	3.8	5.1	10.9	5.1	2.7	3.2	9.2	10.3	92.2
1923	6.5	11.4	2.2	5.2	13.4	8.0	5.4	3.2	1.4	4.1	6.9	16.5	84.2
1924	8.7	11.7	13.1	6.8	7.2	7.5	8.9	7.4	1.0	8.2	8.0	18.8	107.3
1925	12.7	9.5	4.3	5.8	3.7	6.5	6.2	4.3	4.9	7.6	7.7	8.7	81.9
1926	8.9	11.7	10.1	11.6	5.8	8.7	7.6	3.7	2.6	4.0	2.9	3.3	80.9
1927	13.5	3.2	14.4	3.8	4.3	8.6	4.0	3.9	1.9	1.4	5.5	10.4	74.9
1928	13.6	3.6	7.5	13.5	5.3	6.7	4.7	8.2	.9	4.6	6.1	8.4	83.1
1929	11.4	9.0	10.4	9.1	7.2	6.2	3.3	4.7	4.2	4.8	5.1	5.5	80.9
1930	17.3	17.6	4.6	.9	8.6	10.1	4.0	3.9	3.8	6.3	9.5	9.8	96.4
1931	14.5	13.2	12.9	9.1	8.3	3.4	7.4	8.6	5.1	5.7	11.3	9.4	108.9
1932	15.9	7.8	5.6	11.8	9.3	2.8	2.8	4.9	10.6	5.8	2.5	11.8	91.6
1933	9.7	7.0	5.4	6.0	6.7	3.9	7.1	4.6	6.9	3.7	11.7	4.6	77.3
1934	14.1	13.2	.9	14.9	7.6	4.6	6.6	2.8	3.9	3.4	7.8	5.2	85.0
1935	12.3	5.6	4.4	5.9	7.5	3.2	5.0	7.6	4.7	7.2	10.4	11.9	85.7
1936	5.9	11.2	9.3	4.9	2.4	7.7	7.2	5.6	.5	6.5	2.8	12.3	76.3
1937	18.7	25.9	9.1	5.6	3.8	6.1	5.8	5.8	4.8	8.2	11.6	9.9	115.3
1938	14.8	6.4	7.0	10.3	6.1	5.7	5.7	8.2	8.9	7.3	4.9	13.2	98.5
1939	9.9	12.1	11.7	10.2	8.4	9.1	4.8	5.6	4.6	8.4	12.2	14.1	111.1
1940	19.1	13.1	9.7	4.0	2.2	5.2	3.3	6.4	6.1	4.5	10.8	9.3	93.7
1941	9.7	6.8	6.2	6.4	1.6	6.2	5.0	3.8	5.2	7.3	1.3	5.6	65.1
1942	16.2	11.5	5.0	10.6	7.5	7.9	4.6	1.7	6.0	6.2	7.6	8.4	93.2
1943	17.2	5.1	4.6	10.3	5.4	2.9	8.2	3.6	3.5	8.7	11.9	16.8	98.2
1944	15.0	13.4	18.5	9.2	3.6	8.4	4.1	6.1	3.7	3.1	6.6	5.0	96.7
1945	15.8	10.5	6.1	5.4	8.8	9.3	5.2	2.5	5.6	11.5	4.5	12.1	97.3
1946	15.2	4.0	4.8	6.8	4.4	6.5	7.8	3.6	1.4	6.8	8.3	8.1	77.7
1947	13.3	12.5	6.1	8.7	3.4	11.2	7.3	5.7	4.2	3.3	9.9	17.8	103.4
1948	10.6	11.9	8.6	11.1	2.4	5.8	.5	5.1	4.0	7.2	5.2	17.6	90.0
1949	16.6	20.2	7.1	15.4	2.6	5.6	10.0	5.1	7.4	5.3	5.7	10.3	111.3
1950	14.8	12.0	5.1	1.2	3.1	3.3	4.5	6.2	1.6	9.9	5.4	10.9	78.0
1951	7.0	4.2	4.8	4.0	4.8	7.0	10.1	3.8	6.1	4.1	3.8	5.5	65.2
1952	5.4	6.8	5.3	6.5	5.9	6.8	7.8	10.5	3.6	4.0	8.0	14.1	84.7
1953	17.3	12.4	5.7	3.6	11.6	9.0	7.2	4.2	4.3	3.6	9.4	10.8	99.1
1954	20.9	5.4	13.8	5.2	11.7	4.3	3.6	4.2	2.0	4.7	1.7	8.8	86.3
1955	10.6	11.0	14.0	9.0	6.8	9.7	5.3	10.0	3.3	2.7	10.3	8.3	101.0
1956	12.4	4.0	3.4	2.7	6.0	4.9	4.5	9.0	2.9	3.6	14.2	7.3	74.9
1957	12.9	17.6	14.8	2.8	6.5	2.4	8.7	3.8	2.7	2.9	2.4	9.3	86.8
Mean	13.1	10.3	8.0	7.6	6.1	6.1	5.8	5.3	4.1	5.5	7.5	10.4	89.9

Mean precipitation, in inches, at stations near sea level from Petersburg to Juneau, Alaska

[Data from records of the U.S. Weather Bureau]

Month	Petersburg	Speel River	Annex Creek	Juneau
October	17.3	21.0	17.3	13.1
November	10.6	18.4	13.3	10.3
December	10.6	14.2	9.5	8.0
January	9.4	11.1	8.7	7.6
February	7.6	10.8	7.4	6.1
March	7.0	11.2	6.5	6.1
April	7.0	7.4	5.8	5.8
May	6.2	6.3	5.7	5.3
June	4.8	4.2	4.8	4.1
July	5.1	7.9	6.5	5.5
August	7.6	11.6	10.1	7.5
September	11.6	18.0	13.9	10.4
Mean annual	105.8	142.2	109.4	89.9

The station at Petersburg, at lat 56°49′ N., long 132°57′ W., has been operated intermittently since 1924 and continuously since 1937, with 23 years of complete record to 1957. The station at Speel River was on the east shore of Speel Arm, at lat 58°08′ N., long 133°34′ W. It was operated between 1916 and 1930, with 10 years of complete record.

The station at Annex Creek is on the west shore of Taku Inlet, at lat 58°19′ N., long 134°06′ W. It has been operated continuously between 1917 and 1951 and intermittently since 1951, with 34 years of complete record.

The average monthly distribution of precipitation relative to the annual amount evidently is similar at the four stations and probably would be nearly the same if the periods of record were the same. The estimated average annual amounts for the 42 water years 1916–57, computed by comparison with Juneau, are about 105 inches for Petersburg, 148 inches for Speel River, and 108 inches for Annex Creek. The Speel River station was at an altitude of 15 feet; the other 3 stations were at various altitudes within about 200 feet of sea level.

Several stations were operated at mining camps within a few miles of Juneau for brief intermittent periods, generally between 1916 and 1922. These stations were at altitudes of 750 to 3,500 feet. Figures compiled by the Federal Power Commission and U.S. Forest Service (1947, p. 17) show that precipitation at these stations ranged from about 120 to 190 percent of that at Juneau.

The mean annual precipitation on stream basins for which streamflow records and reliable estimates are available for a substantial number of years can be approximately determined from the mean annual runoff. The estimates are given below for some of the streams discussed in this report.

Stream	Mean annual runoff (inches)[1]	Mean annual precipitation (inches)[2]	Normal, by comparison with Juneau, water years 1916–57 (inches)
Cascade Creek	144	154	157
Sweetheart Creek	126	136	135
Long River	188	198	198
Crater Creek	220	230	232
Dorothy Creek	128	138	136
Carlson Creek	176	186	182
Sheep Creek	149	159	159

[1] Different periods in each basin.
[2] Runoff plus an estimated mean annual evapotranspiration of 10 inches.

In general the mean precipitation in the mountain stream basins is substantially greater than was recorded at stations near sea level. The amounts evidently depend not only on the altitude of the basins, but also on their aspect and location with respect to nearby topographic features. The mean altitude of the Dorothy Creek basin, for example, is roughly 2,500 feet and is somewhat higher than that of the adjacent Long River and Crater Creek basins, yet the precipitation is much less. The headwaters of the Dorothy Creek basin lie northwest, on the leeward side, of a high ridge; those of Long River and Crater Creek are southwest of this ridge.

Snowfall records for Juneau and Annex Creek are summarized below.

Station	Altitude (feet)	Period of record (calender years)	Mean annual snowfall (inches)
Juneau	72	1937 - 43	84
Do	72 - 204	1917–43	106
Annex Creek	24	1937–43	213
Do	24; 45	1917–24, 1926–43	265

The data for both periods show that the snowfall at Annex Creek is about 2.5 times that at Juneau. If the average water equivalent of the snow was on the order of 0.1, as is possible, snowfall at Juneau accounted for about an eighth of the precipitation and that at Annex Creek for nearly a quarter of the precipitation during the period 1917–43.

TEMPERATURE

Mean monthly and annual temperatures, in degrees Fahrenheit, for Juneau, Petersburg, and Annex Creek were computed from the recorded figures and departures from long-term means as given by the Weather Bureau in the annual summary of climatological data for 1957, and are listed below.

The mean temperatures are approximately the same at Juneau and Petersburg but are appreciably lower at Annex Creek, especially in winter months. The difference probably is largely due to cold air flowing from inland through Taku Inlet.

Only a few temperature records have been collected at stations much higher than sea level in southeastern Alaska. Fragmentary records were collected at several mining camps near Juneau in 1917 and 1918. These camps were at altitudes of 750 to about

2,800 feet. The mean monthly temperature generally ranged from about the same as at Annex Creek to several degrees lower.

Period	Juneau	Petersburg	Annex Creek
October	44.0	43.9	41.8
November	36.2	35.9	32.6
December	30.6	31.1	25.4
January	29.4	28.6	23.4
February	29.9	30.3	25.9
March	34.4	34.8	32.7
April	40.4	40.8	39.8
May	47.8	47.8	47.4
June	54.5	53.5	53.2
July	56.0	55.7	54.9
August	55.9	55.2	53.7
September	50.8	50.9	49.0
Annual	42.5	42.4	40.0

The minimum temperature recorded at Annex Creek from 1917 to 1957 was −18° F. (in February 1917), and there were minimums of −10° F. or lower in about a quarter of the years. As judged from the few monthly records for the mining camps near Juneau, minimum temperatures at least 14° lower than at Annex Creek may be expected at some mountain localities along the mainland between Petersburg and Juneau.

GLACIERS AND SNOW ACCUMULATION

The heavy snowfall in the mountains and the relatively cool, cloudy summers account for numerous glaciers which are prominent features in the mountains of southeastern Alaska. Cirque glaciers and glacierets are commonly located along the ridges between altitudes of about 3,000 feet to 4,000 feet in the stream basins discussed herein. There are some small valley glaciers in the Long River, Crater Creek, and Dorothy Creek basins, a few of which extend down to an altitude of about 1,500 feet. In the Speel River basin (exclusive of the Long River basin) larger and higher areas of snow accumulations account for several sizable valley glaciers, 2 of which extend down to an altitude of about 500 feet.

Topographic maps of the Geological Survey show the extent of glaciers in the Port Snettisham and Taku Inlet areas (as interpreted from aerial photographs of 1948). Maps of the Thomas Bay area are not adequate for such determinations there. The glacier areas in 1948 are tabulated as follows for five basins in which glaciers cover more than a few percent of the total area.

Drainage	Total area (square miles)	Glacier area	
		Square miles	Percentage of total area
Sweetheart Creek at gage	36.3	3.0	8
Long Lake outlet	30.2	8.2	27
Speel River at damsite	226.	83.6	37
Crater Lake outlet	11.4	3.3	28
Dorothy Creek at gage	15.2	3.6	24

Some perennial snow maintains the glaciers, but it is probable that in wet, cool years much of it is temporarily stored on and near the glaciers to appear subsequently as snowmelt in drier, warmer years. The equalizing effect of the snow and ice storage is shown qualitatively by the characteristics of annual runoff from several of the basins in relation to the characteristics of annual precipitation at Juneau and Petersburg. These are tabulated below.

Drainage	Water years	Variability of annual runoff		Variability of annual precipitation at Juneau	
		Range (percent of mean)	Standard deviation (percent of mean)	Range (percent of mean)	Standard deviation (percent of mean)
Cascade Creek near Petersburg	1927, [1] 1947–57	+8 to −14	6	+26 to −26	16
Cascade Creek near Petersburg	1918–28, 1947–56	+28 to −19	11	+22 to −28	18
Sweetheart Creek near Juneau	1916–32, 1949–56	+23 to −19	11	+25 to −27	15
Long River near Juneau	1916–24, 1928–32, 1949–56	+20 to −15	10	+26 to −26	13
Dorothy Creek near Juneau	1930–41, 1943, 1945–56	+21 to −25	13	+27 to −28	15
Carlson Creek at damsite	1917–20, 1947–57	+25 to −27	14	+22 to −29	14
Sheep Creek at damsite near Juneau	1917–20, 1947–57	+21 to −20	13	+22 to −29	14

[1] Petersburg is much closer than Juneau to Cascade Creek. In this period the range of annual precipitation at Petersburg was + 19 percent to — 27 percent, with a standard deviation of 13 percent.

If the annual runoff were not affected by natural storage, its variability in percentage of the mean would be approximately the same as that of the precipitation that caused the runoff, since evapotranspiration is small relative to the precipitation. The precipitation recorded at Juneau serves as an index to the areal precipitation and evidently is closely representative of the variability of precipitation on the nearby Carlson Creek basin, as shown by the close correspondence of the runoff and precipitation characteristics. Natural storage probably is small both in the Carlson Creek and Sheep Creek basins. Since the other basins are more distant from Juneau, the differences between the runoff characteristics in those basins and the precipitation characteristics at Juneau may be affected to a greater extent by random variations in the pattern of areal precipitation. The somewhat consistent nature of the differences, however, indicates that natural storage had an appreciable effect—reducing the range of runoff and the standard deviation by at least several percent. In all except the Carlson Creek and Sheep Creek basins, ground-water storage probably is negligible in relation to snow and ice storage.

The effect of natural storage is very apparent in some years of extreme precipitation. Thus in water year 1949, precipitation was substantially above normal at Petersburg and Juneau, yet the runoff of Cascade Creek and Dorothy Creek was substantially below normal. The basin characteristics evidently are favorable for retention of part of the heavier snow packs through the summer. Furthermore, the summer of 1949 was exceptionally cool, a circumstance that apparently resulted in an abnormal carryover from the heavy snow pack of the previous winter. On the other hand, runoff in the Sheep Creek basin (and probably in the Carlson Creek basin) was the greatest of the periods of record in 1949, as was precipitation at Juneau for the same periods. The Sheep Creek basin and the adjacent Carlson Creek basin are at lower altitudes than the Cascade Creek and Dorothy Creek basins, and apparently even in wet years there is relatively little perennial snow. The correlation between the annual runoff from the Sheep Creek and Carlson Creek basins and the annual precipitation at Juneau is fairly close throughout the limited periods of record.

Although snow carryover tends to reduce the amount of artificial storage needed for a given degree of control by its equalizing effect on annual runoff, the seasonal distribution of runoff also is a determining factor. As shown in figure 2, for example, the storage requirements for control at Lake Dorothy are relatively large in spite of the considerable amount of perennial snow in the basin. The bulk of the estimated seasonal runoff at Lake Dorothy is concentrated in a shorter period than at any of the other sites, and the range of monthly runoff above and below the average monthly runoff is greater.

In addition to changes in snow storage there may be annual as well as long-term changes in the volume of ice in the glaciers. Such changes, however, probably are equivalent to only a very small part of the annual runoff. Even rather large changes in the glaciers over a period of years probably would have little effect on the average annual runoff. The overall size of the Nisqually Glacier on Mount Rainier, Wash., for example, was about 3 square miles in 1912, which is comparable to the area of the glaciers in the Long River basin. A comparison of maps of 1912 and 1952 quoted in a report of the U.S. National Park Service (1954, p. 5) indicated that the net wastage of the Nisqually Glacier in that 40-year period averaged about 3.7 million cubic yards per year, which is approximately 2,300 acre-feet per year. Conditions are not similar in the Long River basin, but even if wastage or accumulation were 5 times that amount it would represent less than 4 percent of the average annual runoff.

The two large valley glaciers of the Speel River basin are shown on a map of the Alaska-Canada boundary prepared by the International Boundary Commission from surveys of 1906 to 1909, and also on the recent quadrangle maps compiled from aerial photographs of 1948. The termini of these glaciers are shown at about the same location on both maps, indicating that there probably was not a major difference in the volume of the glaciers in 1909 and 1948.

STREAM REGULATION

The runoff from the basins between Petersburg and Juneau is largely concentrated in the 6-month period May to October and originates from snowmelt and rainfall. On the average, about 91 percent of the runoff occurs from the drainage area above Lake Dorothy, which is above an altitude of 2,400 feet, and about 86 percent from the areas above Swan Lake on Cascade Creek, Long Lake on the Long River, and Crater Lake on Crater Creek, all of which are largely above an altitude of 1,000 feet. On Carlson Creek about 84 percent of the runoff occurs between May and October and on Sheep Creek and Sweetheart Creek about 79 percent. The runoff at the other sites probably has a seasonal distribution within the same range.

It would be possible to develop a considerable part of the potential power during this runoff period, either from natural flow alone or from natural flow equalized with relatively little storage. Such power, however, would have a very limited market unless used in connection with fuel-electric standby power. Four small hydroelectric plants near Juneau have been operated with natural flow and with supplemental power from steam-electric and diesel-electric units, although in 1959 only one was active. (See p. 21.) Generation of substantial amounts of power in this way probably would not be practicable in the foreseeable future since fuel-electric power is relatively costly in southeastern Alaska.

The power possibilities of the sites, therefore, were estimated only on the basis of regulated flow and with substantially complete control of the runoff where suitable reservoir sites are available.

The amount of storage capacity required for different degrees of control was determined from reservoir operation schedules for uniform monthly and annual releases. The amount required for control without any wastage over a period of many years is considerably affected by the infrequent occurrence of very wet years, and the extra storage capacity needed for complete capture of the runoff in such years is disproportionate to the gain in controlled flow. For example, a capacity of 125,000 acre-feet would have been required for complete control of the runoff of Dorothy Creek at Lake Dorothy during 25 water years of record, but a capacity of only 84,000 acre-feet would have provided for control of 98 percent of the runoff.

At some sites where reservoirs may be created by dams, the incremental cost of storage may not justify utilization of more than about 90 percent of the mean flow, as was pointed out by the Federal Power Commission and U.S. Forest Service (1947, p. 36). It was determined that in general the storage required for complete control of streams in southeastern Alaska is about twice that required to regulate 90 percent of the mean flow. At sites where relatively cheap storage can be developed by draw-down of natural lakes, it may be found desirable to provide for complete or nearly complete control of the runoff.

On the basis of streamflow records through 1956, the storage needed for complete control at the sites varies from about 80 to 150 percent of the mean annual runoff, and that needed for 90 percent utilization varies from 40 to 70 percent. At some sites the storage needed for complete control is roughly 3 times that needed for regulation to 90 percent of the mean flow. The capacities are listed for 100-percent and 90-percent utilization for the sites where such degrees of development appear to be practicable. The variation of storage requirements for regulation from 80 percent to 100 percent of the mean flow is illustrated in figure 2 for a few of the sites. For a given full-reservoir level, regulation to somewhat less than the mean flow may correspond to the maximum development of potential power because of the reduction in drawdown and consequent increase in head. The optimum degree of development at each site would be determined by the intended use of the power and by cost studies.

The storage requirements in percentage of the mean annual runoff differ among the several sites partly because of differences in basin characteristics and to a considerable extent because of differences in the distribution of runoff during the varied periods of records and estimates which were used in the reservoir operation schedules. Future periods may include more critical years or series of years, so that the requirements may be somewhat underestimated especially for complete control. The estimates can be very inaccurate if based on relatively short or nonrepresentative streamflow records. (See discussion of the Sweetheart Creek site.)

Lakes formed by glacial action constitute favorable storage sites on eight of the listed streams between Petersburg and Juneau. Of these, all except Turner Lake are high enough so that storage could be developed by drawdown through tunnels

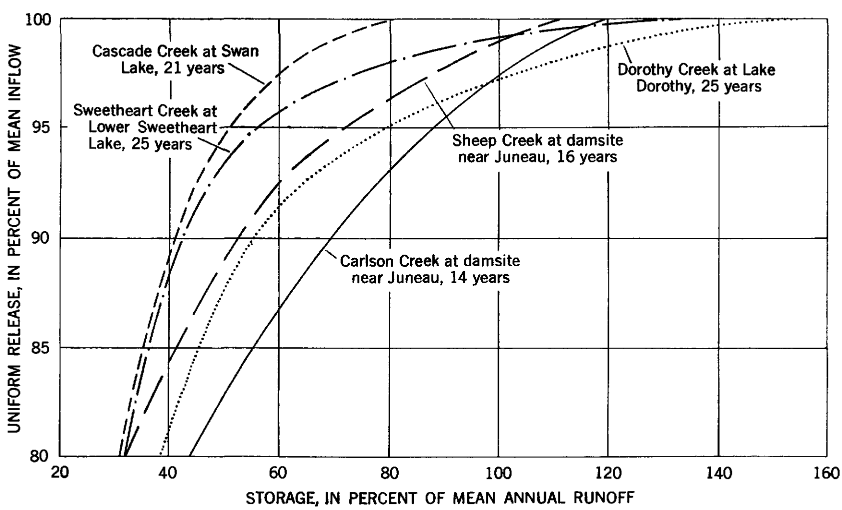

FIGURE 2.—Storage requirements at selected Alaskan sites for indicated degrees of regulation during various periods.

tapping the lakes below their natural surfaces without sacrificing a large part of the power head. Turner Lake is at an altitude of only 73 feet, and impoundment of water by damming the outlet, with consequent gain in power head, would be the only practicable method of development. Dams could be constructed at or near the outlets of all the lakes, and, except at Turner Lake and at Lower Sweetheart Lake where the topography is unfavorable for drawdown, a combination of damming and drawdown might be considered. The distance for conveyance of water from the lakes to powerhouses at tidewater ranges from about ½ mile at the Turner Creek site to 3 miles at the Scenery Creek site.

On the Speel River and on Carlson and Sheep Creeks, storage would have to be developed by construction of dams at favorable places on the channels, supplemented at the Speel River site by an auxiliary dam at a saddle on the divide between the Speel River basin and the head of Speel Arm. The distance for conveyance of water from the reservoir sites to powerhouses at tidewater ranges from about ½ mile at the Speel River site to 1½ miles at the Carlson Creek site.

DEVELOPED POWERSITES

The only waterpower sites that have been developed for significant amounts of power in or near the Petersburg-Juneau area are a group of 7 near Juneau, 1 near Petersburg, and 1 on the Speel Arm of Port Snettisham, at which development has long been discontinued. The brief descriptions of these sites that follow are mainly from reports of the Federal Power Commission and U.S. Forest Service (1947) and the U.S. Army Corps of Engineers, (1952). In 1959, power was being developed at only four of the sites, but plants at other sites near Juneau could be put into service if needed.

CRYSTAL LAKE

The reservoir of the Crystal Lake plant is at the lake, about 15 miles southeast of Petersburg. After enlargement of the plant in 1956 and 1957, storage capacity of 4,300 acre-feet was developed by means of a rockfill dam across the channel downstream from the natural outlet of the lake. This raises the surface 28 feet to an altitude of 1,296 feet at spillway level. Water is conveyed about 5,000 feet by pipe to a powerhouse near Blind Slough, an arm of Wrangell Narrows. There are 2 generators, each of 400 kw capacity, and 1 generator of 1,600 kw capacity, all driven by impulse wheels. A transmission line to Petersburg interconnects the hydroelectric plant with a diesel-electric unit having a power capacity of 1,250 kw.

The plant has been operated since 1925 by the Petersburg Municipal Light and Power Co. under a license issued to the town of Petersburg by the Federal Power Commission for Project No. 201.

TEASE LAKE

The Tease Lake plant was on the stream draining the lake, and its powerhouse was near the mouth of this stream on the east shore of Speel Arm. Water was conveyed to the powerhouse from a low timber dam below the outlet of Tease Lake by means of 2,600 feet of flume and 2,460 feet of penstock. The head of the penstock was at an altitude of about 990 feet. Power was developed by 2 impulse wheels of 1,000 and 350 horsepower which were directly connected to machinery of a pulpmill.

The plant was operated intermittently from 1921 to 1923 under a license issued by the Federal Power Commission to the Speel River Project, Inc., and the Alaska Pulp and Paper Co. for Project No. 4. The plant was abandoned in 1931 and the license was revoked in 1935.

ANNEX CREEK

The powerhouse of the Annex Creek plant is near the northwest shore of Taku Inlet, about 1 mile southwest of the upper Annex Lake and about 4,000 feet northeast of the mouth of Annex Creek. Storage is developed at the lake by means of a timber dam, first constructed in 1916 and replaced in 1936, and a tunnel tapping the lake about 135 feet below the natural surface. The present storage capacity is 23,360 acre-feet. Water is conveyed to the powerhouse through about 1,420 feet of tunnel and 7,100 feet of pipe. The mean net head is 755 feet. Power is developed by 2 impulse wheels driving generators with a combined capacity of 3,500 kva (kilovolt-ampere), listed as 2,800 kw in the report of the Corps of Engineers.

The plant is operated by the Alaska Juneau Gold Mining Co. under a joint permit of the Department of Agriculture and the Department of the Interior. The energy is transmitted 15 miles to Juneau where most of it was formerly used in mining and milling. Since 1944, when mining was stopped, the energy has been available for sale to the Alaska Electric Light and Power Co. for distribution in the Juneau area. The power system of the Alaska Juneau Gold Mining Co. includes a steamplant of 8,000-kw capacity at Juneau.

SHEEP CREEK

The present powerhouse of the Sheep Creek plant is located near the shore of Gastineau Channel, about 3 miles southeast of Juneau. According to Hoyt (1910, p. 157) a small amount of power was being developed on Sheep Creek as early as 1908. A plant was constructed by the Oxford Mining Co. in 1910 to utilize natural flow under a head of 270 feet. This was replaced by a larger development of the Alaska Treadwell Gold Mining Co. in 1914, and the plant later was purchased by the Alaska Juneau Gold Mining Co., the present owner. Water was conveyed about a mile from a low diversion dam at an altitude of 620 feet to the powerhouse by way of a flume, a pipe, a short tunnel, and a penstock. Electric power was generated in 3 units driven by impulse wheels, 2 of 1,000-kw capacity each and 1 of 225-kw capacity. The energy was transmitted to the central fuel-electric station at Juneau. The plant was inactive for several years prior to 1959, and some of the facilities are in disrepair.

GOLD CREEK

The powerplant on Gold Creek is located at Juneau. Some of the natural flow of the creek is diverted at an altitude of 248 feet and conveyed 5,100 feet by flume and penstock to a powerhouse near tidewater in Juneau. This houses 2 generators each of 500 kva capacity, and 1 generator of 1,000 kva capacity, all driven by impulse wheels. The aggregate capacity of the plant was listed as 1,600 kw by the Corps of Engineers (1952).

The plant is owned by the Alaska Electric Light and Power Co. and is connected with the system of the Alaska Juneau Gold Mining Co., and also with 2 diesel-electric units, each of 1,250-kw capacity, which are operated by the power company.

Power was being developed on Gold Creek as early as 1908, according to a compilation by Hoyt (1910, p. 157).

SALMON CREEK

The powerplant on Salmon Creek consists of 2 units operated in connection with a reservoir created by a 170-foot dam which was constructed in 1915. The storage capacity is 19,000 acre-feet, and the altitude of the full-reservoir surface is 1,188 feet. Water is conveyed about 4,480 feet from the reservoir by a steel conduit to a powerhouse on Salmon Creek at an altitude of about 450 feet. This houses 2 generators, each rated at 1,400 kw, driven by impulse wheels. Water is diverted from the tailrace of this powerhouse and conveyed by means of a flume and penstock 11,500 feet to a powerhouse near the tidewater of Gastineau Channel, 2 miles northwest of Juneau. This houses two 1,400-kw generators, each driven by an impulse turbine.

The Salmon Creek plant is operated by the Alaska Juneau Gold Mining Co. under a joint permit of the Department of Agriculture and the Department of the Interior. Most of the power is sold to the Alaska Electric Light and Power Co.

NUGGET CREEK

Nugget Creek is a tributary of the Mendenhall River and is about 10 miles northwest of Juneau. The plant, now inactive, consists of a diversion dam at an altitude of about 550 feet on Nugget Creek near the east side of Mendenhall Glacier, and a conduit to convey the water about 1¼ miles to a powerhouse at an altitude of about 50 feet on the east side of the Mendenhall River valley. The power was generated in 2 units driven by impulse wheels, with capacities of 1,000 kw and 2,350 kva. The plant capacity was limited to about 2,350 kw because of inadequate penstock capacity.

The plant was constructed in 1914 and was operated by the Alaska Juneau Gold Mining Co. under a permit issued by the Forest Service. It is connected to the central station at Juneau by 15 miles of transmission line. The plant was in disrepair in 1959.

TREADWELL DITCH

Treadwell Ditch collected water from seven small creeks on Douglas Island near Juneau. Branches of the ditch conveyed water to the head of one penstock at an altitude of about 560 feet and to another at an altitude of about 460 feet for power projects called No. 1 and No. 2, respectively. Development of power was started in 1882 and was continued until 1918 in 2 powerhouses located near the town of Douglas, which is on Gastineau Channel only 2 miles from Juneau. The waterpower of both plants was used directly for driving the machinery of mines and mills of the Alaska Treadwell Gold Mining Co. and associated companies. Operation of powerhouse No. 2 was discontinued in 1918, and in 1922 a generator was installed in powerhouse No. 1 and the plant was connected by 5 miles of transmission line to the central station of the Alaska Juneau Gold Mining

Co. The installed capacity was listed as 1,044 kw by the U.S. Army Corps of Engineers, (1952). The plant was inactive and in disrepair in 1959.

UNDEVELOPED POWERSITES

FACTORS THAT WOULD AFFECT THE DESIGN AND OPERATION OF POWERPLANTS

Snow avalanches are common, and rockslides have occurred in places in the mountains of southeastern Alaska. These are a potential source of danger to structures such as surface penstocks, powerhouses, and transmission-line towers located on or below steep mountainsides.

The occasional high winds at the mountain passes and along the inlets would have to be taken into account in the design and location of transmission lines. Icing of transmission lines at the higher altitudes also might be a troublesome factor. In the operation of the powerline from Annex Creek to Juneau it has been found desirable to heat the cables with periodic overloads to avoid accumulation of ice. This line crosses a ridge at an altitude of about 3,400 feet.

Ice would form on the surfaces of reservoirs during winter months, and at higher lake sites ice would persist as late as July and even early August in some years. The effect of ice on dams and outlet structures would have to be considered but probably would not present an unusual problem.

The streams at all of the storage sites carry some sediment at high stages, mainly from glacial debris. In several of the streams the suspended sediment is rock flour, which gives the water a milky appearance. Part of this is deposited in the lakes and part is carried through in suspension. It seems unlikely that the usual sediment loads at storage sites on these streams are great enough to cause rapid impairment of the storage capacity, or of gates, conduits, and turbines. An exception is the Speel River, which carries large quantities of heavy sediment, including sand and gravel, in suspension or as bed load. The possible effect of this sediment is discussed further under the section concerning the Speel River reservoir site.

Except for Turner Creek at Turner Lake outlet, fishways probably would not have to be considered at any of the dam sites, since the streams are generally too precipitous for fish migration. Turner Lake is at a low altitude, near tidewater, and salmon have been observed at its outlet. A fishway would have to be provided if a dam should be constructed at the outlet, but since the lake level probably would not be raised more than about 55 feet, this would not be a major problem.

In some waterpower developments, particularly where storage is limited, forecasts of seasonal runoff are useful in the establishment of operation schedules for the most effective use of the water. The forecasts commonly are based on snow surveys and the expected range of precipitation in the snow-runoff period. If the precipitation that occurs after the snow surveys has little effect on the runoff, the forecasts may be very reliable. In southeastern Alaska, however, precipitation that occurs during the period from June to September averages about 30 percent of the annual amount and may account for a substantial part of the runoff. Another relatively unpredictable factor is the natural storage as snow and ice, which tends to persist throughout wet, cool years and melt in dry, warm years.

METHODS FOR APPRAISAL OF POWER

The power possibilities of all of the sites except the Speel River are discussed only on the assumption that considerable storage would be provided for annual-use or holdover regulation. Storage capacity on the Speel River can be provided by damming the stream, but sedimentation of the reservoir may be rapid. The useful life of the project could be extended by design and operation in a coordinated system so that stabilization of the seasonal power would be provided by the Long River and Crater Creek plants. In that event much of the Speel River storage capacity could be reserved for sedimentation.

Potential power was computed on assumption that the flow could be utilized through the mean gross head for generation of electric power at an overall plant efficiency of 80 percent. In kilowatts this is given by the equation $P = 0.068\ Q\ H$, where Q is the flow in cubic feet per second (cfs), and H is the mean gross head in feet. Unless otherwise specified the mean gross head was taken as the height from the tailrace (or nozzle elevation with impulse wheels) to the reservoir level corresponding to half of the usable contents.

SITES IN THOMAS BAY AREA

MAPS

A plan and profile of Scenery Creek and Scenery Lake and a map of the damsite at the outlet of Scenery Lake were published by the Geological Survey in 1950. The creek and lake plan is on a scale of 1:24,000 and the contour interval is 20 feet. The map of the damsite is on a scale of 1:4,800 and the contour interval is 10 feet.

A map entitled "Cascade Creek and vicinity, Alaska, Dam Sites" was compiled from aerial photographs and from planetable surveys of 1949 and 1950, and published by the Geological Survey in 1952. This is on a scale of 1:24,000 and has a contour interval of 40 feet. It shows the topography of a strip extending a few miles inland from Thomas Bay, in which the powersites on Delta Creek, Cascade Creek, and Scenery Creek are located. Maps of damsites at the outlets of Swan Lake and Scenery Lake are on scales of 1:2,400 and 1:4,800, respectively. The topography of Scenery Lake as shown on this map does not agree exactly with that shown on the map of 1950, which was based entirely on planetable surveys.

Maps of the Alaska Reconnaissance Topographic Series, Petersburg and Sumdum, Alaska-Canada, published by the Geological Survey in 1952, have a scale of 1:250,000 and contour intervals of 200, 250, and 1,000 feet. These show the basins of the powersites, the system of waterways, and the general topography of a large area in the vicinity.

A planimetric map of the Tongass National Forest published by the Forest Service in 1951 on a scale of 1 inch equals 12 miles shows all of southeastern Alaska.

Soundings in Thomas Bay and Frederick Sound are shown on Chart 8210 of the U.S. Coast and Geodetic Survey. The scale is 1:40,000 and the soundings are in fathoms.

LOCAL GEOGRAPHY AND TOPOGRAPHY

Delta Creek, Cascade Creek, and Scenery Creek are on the mainland east of Thomas Bay. The nearest town is Petersburg, about 15 miles southwest of Thomas Bay, on Mitkof Island. The population of Petersburg was 1,605 in the 1950 census, and the principal activity is fishing and related services. Mitkof Island is separated from the mainland by Frederick Sound, which at the narrowest is about 3½ miles wide.

The headwaters of the 3 creeks are at altitudes above 4,000 feet, and peaks near the eastern boundaries of the Scenery Creek and Cascade Creek basins are higher than 6,000 feet.

Drainage is from east to west, and along the course of each creek there are lakes which constitute good storage sites: Ruth Lake on Delta Creek, Swan Lake on Cascade Creek, and Scenery Lake on Scenery Creek. (See fig. 3.) In addition a pool called

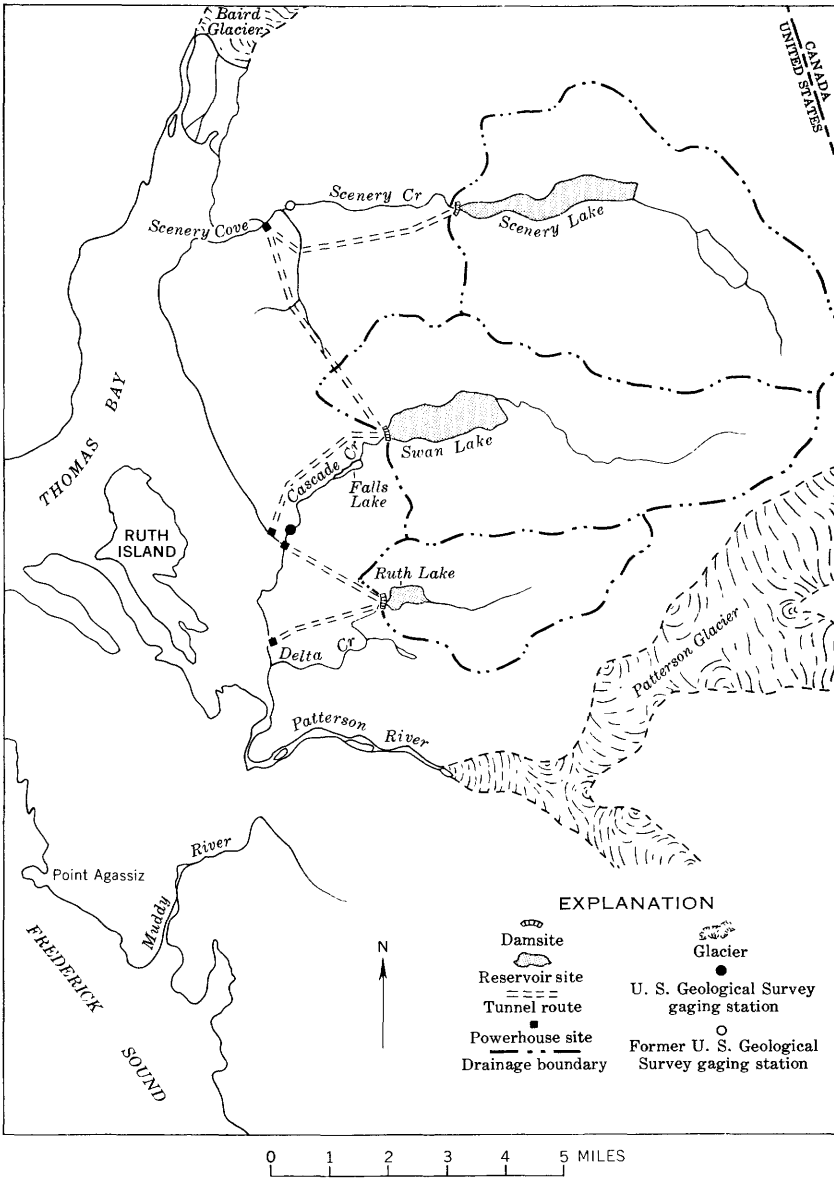

FIGURE 3.—Map of powersites in the Thomas Bay Area, Alaska.

Falls Lake extends half a mile along Cascade Creek, a mile downstream from Swan Lake. Photographs of Ruth Lake and Scenery Lake are shown in figures 4 and 5. Swan Lake is in similar rugged terrain.

FIGURE 4.—Aerial view northward across Ruth Lake and divide between Delta and Cascade Creek basins. Thomas Bay in left background.

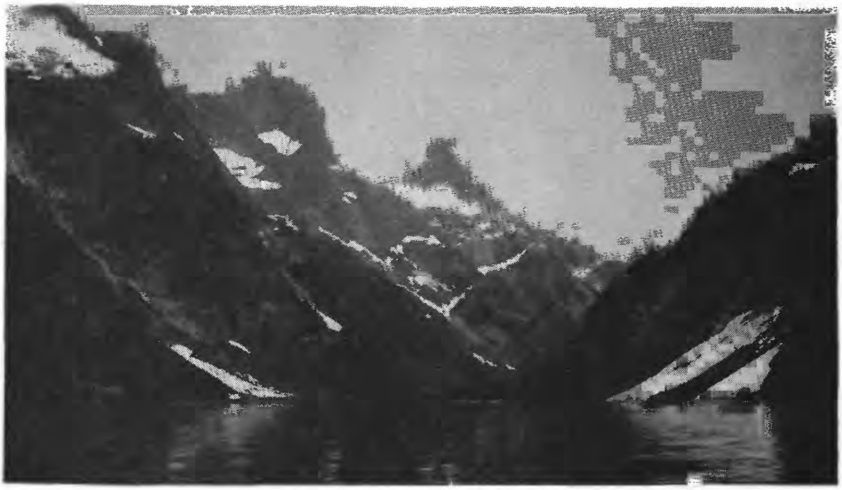

FIGURE 5.—View eastward toward upper end of Scenery Lake.

Chart 8210 of the U.S. Coast and Geodetic Survey shows that Thomas Bay is as much as 600 feet deep and that large tugs or barges could reach the mouths of each of the three creeks. Transport of equipment and material from the shore to inland points for construction of powerplants might require tramways.

WATER SUPPLY

RECORDS OF STREAMFLOW

A gaging station designated "Cascade Creek near Petersburg," located near the mouth of the creek, was operated from October 1917 to November 1928 and from October 1946 to date. The drainage area is 23.0 square miles. The average discharge for the 21 water years of complete record was 244 cfs, corresponding to an average annual runoff of 177,000 acre-feet. Monthly and annual figures of runoff through September 1956 as rounded from records are listed in table 2

TABLE 2.—*Monthly and annual runoff, in thousands of acre-feet, Cascade Creek near Petersburg, Alaska*

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Annual
1918	36.2	39.1	4.5	4.0	1.5	1.2	3.0	12.0	28.7	32.7	40.3	23.8	227.0
1919	23.1	11.0	5.6	9.9	1.5	1.7	4.4	9.5	19.2	29.3	35.1	29.0	179.3
1920	20.5	6.1	4.5	4.8	3.4	2.0	2.0	6.1	26.2	33.8	41.6	19.8	170.8
1921	9.7	7.6	2.1	2.0	2.3	2.5	2.0	12.3	30.3	26.6	22.7	24.0	144.1
1922	34.8	7.4	9.0	3.1	1.4	1.2	3.9	11.1	18.4	29.1	30.9	23.5	173.8
1923	15.5	15.1	4.0	1.7	2.3	3.4	5.4	15.2	30.4	27.7	31.2	33.0	184.9
1924	23.7	14.2	4.8	2.2	1.4	2.8	3.9	18.0	35.3	32.5	31.8	40.7	211.3
1925	22.0	12.1	5.2	1.1	1.1	1.5	2.0	20.5	29.0	38.3	27.7	18.7	179.2
1926	12.9	10.9	21.3	24.9	4.1	8.6	16.2	17.7	24.4	25.3	20.0	13.7	200.0
1927	23.9	9.6	8.3	3.3	1.1	1.9	1.9	10.1	32.8	29.6	25.8	31.5	179.8
1928	18.4	5.0	2.0	8.7	2.8	4.1	4.3	22.4	34.0	36.2	27.2	25.2	190.3
1947	11.6	13.5	2.3	2.6	2.3	11.5	9.7	20.1	30.3	23.9	22.7	31.3	181.8
1948	11.6	9.5	4.4	5.3	2.3	1.6	1.5	21.4	29.5	24.8	22.0	28.8	162.7
1949	13.3	8.7	3.0	2.8	1.4	2.1	3.6	17.8	26.5	30.4	28.3	27.1	165.0
1950	23.1	22.2	3.8	1.5	1.1	1.4	1.6	10.1	30.8	31.0	23.9	25.5	176.0
1951	8.6	5.1	3.0	2.6	1.4	1.8	2.7	17.9	34.7	29.9	20.4	17.0	145.1
1952	15.0	6.7	4.1	2.0	1.9	1.8	2.8	15.9	26.0	37.8	28.6	31.0	173.6
1953	29.1	9.1	3.9	2.0	1.7	1.8	2.6	21.5	27.3	23.9	25.3	22.9	171.1
1954	24.2	7.9	4.7	3.1	11.0	2.1	1.8	12.1	27.1	24.0	17.3	19.7	155.0
1955	15.9	13.3	9.2	4.1	2.5	2.2	3.0	8.4	25.2	34.1	33.7	26.1	177.7
1956	13.2	8.2	2.5	1.4	1.2	1.0	2.1	22.1	25.2	33.3	40.7	17.9	168.8
Mean	19.3	11.5	5.3	4.4	2.4	2.8	3.8	15.3	28.2	30.2	28.4	25.2	177.0

A gaging station designated "Scenery Creek near Petersburg," near the mouth of the creek, was operated from September 1949 to November 1952, when the station was destroyed by falling trees in a windstorm. The drainage area at the former station is 30.0 square miles. Monthly and annual figures of runoff in thousands of acre-feet, as rounded from the records for the 3 water years of complete record are given below.
water years of complete record, are given below.

Month	1950	1951	1952	Month	1950	1951	1952
Oct.	28.8	12.6	19.3	May	16.9	21.6	19.6
Nov.	28.2	6.7	8.3	June	33.0	37.6	27.8
Dec.	4.9	3.7	4.4	July	35.0	33.8	42.9
Jan.	2.2	3.4	2.6	Aug.	29.2	22.9	32.7
Feb.	1.4	1.8	2.8	Sept.	33.8	22.3	34.5
Mar.	1.8	2.3	3.5				
Apr.	2.7	5.4	6.6	Annual	217.9	174.0	205.0

The monthly and annual records through September 1956, and daily discharge records for Cascade Creek from October 1946 to September 1956 and for Scenery Creek from September 1949 to September 1952 have been published by the U.S. Geological Survey (1957, 1958a, 1958b).

RUNOFF AT RUTH LAKE OUTLET

No streamflow records have been obtained for Delta Creek except for 10 discharge measurements at the mouth of the creek at times of relatively low flow between 1950 and 1956. Seven of these were made at times when the recorded flow of nearby Cascade was fairly steady and hence may give a rough indication of the relative amount of runoff from the two basins during periods of low flow. The average of the low-flow measurements is 35 percent of the corresponding flow of Cascade Creek whereas the drainage area is 45 percent that of Cascade Creek. This discrepancy may reflect a difference in seasonal distribution of runoff near the mouths of the creeks rather than a difference in annual runoff per unit area. The 2 lowest measurements on Delta Creek, 2.79 cfs (Feb. 3, 1955), and 6.51 cfs (Nov. 29, 1950) were only 18 percent of the comparable flows of Cascade Creek.

The storage site on Delta Creek at Ruth Lake has a drainage area of 7.9 square miles, or 42 percent of that at the outlet of Swan Lake on Cascade Creek. The Delta Creek and Cascade Creek basins are adjacent and have somewhat similar topography and aspect, although the headwaters of Delta Creek are not quite as high as those of Cascade Creek. It is probable that the runoff per unit area is roughly the same in the two basins. The water supply at the Ruth Lake outlet was estimated to be 40 percent of that at the Swan Lake outlet, or slightly less than the drainage-area ratio. This corresponds to a mean discharge of 81 cfs. The seasonal and annual distribution of the runoff was assumed to be the same at the two lakes in the estimation of storage requirements at Ruth Lake, although the discharge measurements on Delta Creek show that the runoff at Ruth Lake probably is somewhat more concentrated than that at Swan Lake.

RUNOFF AT SWAN LAKE OUTLET

The storage site on Cascade Creek at Swan Lake has a drainage area of 18.9 square miles, or 82 percent of that at the gaging station. Since the area above the lake ranges between higher altitudes than the area below the lake, it undoubtedly receives proportionately more snowfall and less rainfall. The runoff therefore must be proportionately greater in summer months and less in winter months than at the gage. For the purpose of determining storage requirements, the following estimated distribution in percent of runoff at the gaging station, was used.

Oct	.90	Jan	.50	Apr	.50	July	.90
Nov	.85	Feb	.50	May	.75	Aug	.90
Dec	.75	Mar	.50	June	.85	Sept	.90

Reservoir operation schedules were computed from the end of the high-water season, November 1917, through 250 months of record in the 21 water years of complete record, 1918 through 1956. Although there is a gap from 1928 to 1946, the records were considered as being a consecutive series representative of a possible future series. The average estimated discharge is 203 cfs at the outlet of Swan Lake, or 84 percent of the average discharge recorded at the gage for the months of the operation schedule.

RUNOFF AT SCENERY LAKE OUTLET

The period of streamflow record for Scenery Creek, water years 1950–52, is too brief to give a measure of the reliable water supplies. During that period the runoff per unit area was 7 percent less than from the area above the Cascade Creek gage, and was less in each of the 3 water years. It is assumed that the runoff per unit area above the two storage sites tends to have a similar difference over long periods of wet and dry years.

The storage site on Scenery Creek at Scenery Lake has a drainage area of 21.1 square miles, or about 11 percent more than the area above Swan Lake on Cascade Creek. Since the unit runoff probably is less, it was assumed that the total runoff at each of the 2 lakes is the same, corresponding to a mean discharge of 203 cfs. It was also assumed that the seasonal and annual distribution of the runoff is the same.

DELTA CREEK POWERSITE

RESERVOIR SITE

A reservoir could be formed on Delta Creek by a dam near the outlet of Ruth Lake at its western end. This lake is 2 miles east of Thomas Bay, at an altitude of 1,353 feet. It is half a mile long and is bounded by steep mountainsides except at the upper end, where a delta has formed. The slope on the south side of Ruth Lake is heavily timbered, but that on the north side, is extremely steep and supports very little timber. The lake has an area of only 55 acres and a volume of only about 2,500 acre-feet.

The sides of a V-shaped canyon downstream from the lake outlet are topographically suitable as abutments for a dam to a height of several hundred feet above the lake. At a point about 200 feet downstream from the outlet the right bank is practically vertical to a height of 60 feet above the stream. The creek channel is roughly 30 feet wide between the steep canyon sides. The damsite has not been mapped except as a part of the area shown on the Geological Survey topographic map "Cascade Creek and Vicinity." As nearly as can be determined from this map the canyon is about 380 feet wide 230 feet above the stream, and 500 feet wide 340 feet above the stream. The steep canyon sides extend upward for several hundred feet to knolls at an altitude of about 1,800 feet on both sides.

Since the subsurface capacity of Ruth Lake is small in relation to that needed for substantial control of the runoff, development by drawdown would not be practicable. Reservoir areas and capacities for a range above and below the lake surface are shown below.

Altitude (feet)	Area (acres)	Capacity (acre-feet)	
		Below lake surface	Above lake surface
1,280	15	2,400	
1,300	26	2,000	
1,320	35	1,400	
1,340	44	600	
1,353 [1]	55	0	0
1,400	94		3,500
1,440	113		7,600
1,480	137		12,600
1,520	165		18,600
1,560	190		25,700
1,600	222		33,900
1,640			[2] 43,000
1,660			[2] 48,000

[1] Lake surface.
[2] Estimated by extrapolation.

Rock is exposed on both sides of the canyon, and Miller (1955, p. 39) reported that it is satisfactory as a foundation for either a masonry or rock-fill dam.

On the assumption that the storage requirements are proportionately the same as at Swan Lake (see p. 35) 48,000 acre-feet of capacity would have been needed for complete control of Delta Creek in the same 21 years of runoff recorded for Cascade Creek. This could be obtained by raising the lake surface 307 feet, with a dam about 340 feet above stream level at the damsite. Regulation for uniform release equal to 90 percent of the mean flow, or 73 cfs, might be more practicable. This would require a storage capacity of 24,000 acre-feet, which could be obtained by raising the lake surface only 197 feet with a dam about 230 feet above the stream level at the damsite.

Since the terrain is very rugged, transport of materials from Thomas Bay would be relatively costly. The bulk of the material for a rock-fill dam could be quarried at the site, and this type therefore might be cheaper than a masonry dam.

If a side-channel spillway should be constructed, as might be appropriate for a rock-fill dam, the possibility of blockage or damage from slides should be considered. There were no signs of fresh slides at the time of the geologic examination in 1951, and since there are breaks in the slopes at the knolls directly above the site, the possibility may be remote.

PLANS OF DEVELOPMENT

Water could be conveyed from Ruth Lake to a powerhouse on Thomas Bay by means of a tunnel and penstock. There are at least 2 possible routes, each requiring about 1½ miles of tunnel and ½ mile of penstock. One is north of Delta Creek and bears southwestward from Ruth Lake to a powerhouse site at or near the mouth of Delta Creek. The other bears northwestward from the lake to a powerhouse site at or near the mouth of Cascade Creek.

The second route was suggested by the Federal Power Commission and U.S. Forest Service (1947, p. 64) because a strip along Thomas Bay extending a mile south of Cascade Creek was considered to be a satisfactory site for a mill and town.

If an investigation shows that industrial sites south of Thomas Bay are preferable, as seems likely, it might be advantageous to locate the Delta Creek powerhouse near the mouth of Delta Creek to minimize the distance for transmission of power and conveyance of water to the factory. It would be possible also to convey reservoir releases still farther south from Ruth Lake by means of about 2.1 miles of tunnel and penstock to a powerhouse at the Patterson River. This river is a glacial stream that has formed a wide delta at the southern end of Thomas Bay.

CASCADE CREEK POWERSITE

RESERVOIR SITE

A reservoir could be created on Cascade Creek by construction of a dam near the outlet of Swan Lake at its western end, by a tunnel to provide for drawdown of the lake, or by a combination of the two methods. Swan Lake is 2.5 miles east of Thomas Bay at an altitude of 1,514 feet. It is 2 miles long and is bounded by steep mountainsides, except at the upper end. The slopes around the lake are timbered.

A narrow canyon downstream from the lake outlet constitutes a very good dam site. (See fig. 6). At the narrowest section of the canyon, 500 feet downstream from the lake outlet, the width at stream level is about 90 feet, and at 150 feet above stream level it is 390 feet.

Miller (1955, p. 31–32) reported that the bedrock is diorite and is a suitable foundation for either a masonry or rock-fill dam.

The topography also is favorable for development of storage capacity by tapping the lake with a tunnel outlet. Sufficient capacity for complete control of the runoff could be obtained either by drawdown alone or by damming alone. Reservoir areas and capacities for a range above and below the lake surface are listed on page 36.

Schedules of reservoir operation were established for uniform monthly releases equal to 100 percent of the mean discharge, 203 cfs, and 90 percent of the mean discharge, 183 cfs. These schedules would have required 121,000 and 60,000 acre-feet of usable capacity, respectively.

FIGURE 6.—View of Swan Lake outlet and damsite area.

Altitude (feet)	Area (acres)	Capacity (acre-feet)	
		Below lake surface	Above lake surface
1,250		[1] 121,000	
1,300	389	101,700	
1,320	410	93,700	
1,340	424	85,400	
1,360	441	76,800	
1,380	455	67,800	
1,400	469	58,600	
1,420	485	49,100	
1,440	498	39,300	
1,460	517	29,100	
1,480	532	18,600	
1,500	552	7,800	
1,514 [2]	570	0	0
1,520	579		3,400
1,560	730		29,600
1,600	867		61,500
1,640	946		97,800
1,680	1,020		137,100
1,720	1,130		180,100

[1] Estimated by extrapolation.
[2] Lake surface.

Since the terrain between the lake and Thomas Bay is very rugged, the transport of construction materials from Thomas Bay would be relatively costly. This circumstance might be a determining factor in the design of the dam or in the choice between damming and drawdown. The bulk of the materials for a rock-fill dam is adjacent to the site.

If a dam should be constructed it would be necessary to provide a spillway adequate to pass the maximum discharge that might occur. For a side-channel spillway, a type appropriate for a rock-fill dam, consideration should be given to the possibility of blockage or damage by slides. This hazard probably would be greatest during the spring or early summer when snowslides might bring down masses of brush, trees, and rocks. Miller reported that the right, north side of the canyon should be reasonably free from slides.

The maximum stream discharges probably are due to heavy rainfall combined with some snow and ice melt in the fall, which would be the period of maximum reservoir content. The maximum recorded discharge at the Cascade Creek gage was 3,280 cfs in September 1947, possibly corresponding to about 2,800 cfs at the Swan Lake outlet.

PLANS OF DEVELOPMENT

Water could be conveyed from Swan Lake in a westerly direction to a powerhouse a quarter of a mile northwest of the mouth of Cascade Creek. This would be about the shortest route for development of the head down to a suitable site at tidewater. The waterway would consist of 2.2 miles of tunnel and 0.6 mile of penstock. (The penstock length could be halved by location of the powerhouse farther to the northwest, but the terrain there may be unsuitable except for an underground installation since it is extremely steep.) It would be possible also to convey the water northwestward to the mouth of Scenery Creek, but this route is about 1 mile longer, requiring about 3½ miles of tunnel and ¾ mile of penstock. The main advantage of this site is that a common powerhouse could be used for both the Cascade Creek and Scenery Creek units. The main disadvantage is that the point of power generation would be more distant from the area of probable use and powerlines would have to cross very rugged terrain between Scenery Creek and Cascade Creek.

In an alternative plan suggested by the Federal Power Commission and U.S. Forest Service (1947, p. 64) the head would be developed only from Falls Lake to Thomas Bay. A 50-foot dam would be constructed at the outlet of Falls Lake, raising its level to an altitude of 1,207 feet. Water could be conveyed from this forebay to the powerhouse site northwest of Cascade Creek through only about 1 mile of tunnel and ½ mile of penstock for development of 1,190 feet of head. Storage could be developed at Swan Lake for complete regulation entirely by drawdown through half a mile of tunnel emptying into Cascade Creek above Falls Lake. The overall length of waterway would be roughly 70 percent of that required for conveyance directly from Swan Lake to Thomas Bay, and 86 percent of the mean head below the reservoir would be developed.

Miller (1955, p. 35) reported that a tunnel along the north side of the Cascade Creek valley to the site near the mouth of Cascade Creek would be in diorite throughout its length. His examination indicated that a tunnel along the route to Scenery Creek probably would be in diorite, but some calcareous gneiss might be included.

SCENERY CREEK POWERSITE

RESERVOIR SITE

Storage capacity could be developed at Scenery Lake by construction of a dam near the lake outlet at its western end, by drawdown, or by a combination of the two methods. The lake is at an altitude of 957 feet and is 3 miles east of Scenery Cove, an inlet of Thomas Bay. The lake extends about 2½ miles farther east between steep mountainsides. A smaller, unnamed lake is in the creek valley about a mile upstream. Timber grows on a flat area in the valley at the head of Scenery Lake and on the adjacent mountainsides in scattered stands broken by precipitous areas of bare rock. Evidence of snowslides is noticeable at several places around the lake.

Locations for a dam were considered at a point about 50 feet below the lake outlet and at about 350 feet downstream where a knoll constitutes a favorable abutment on the right, north bank (see fig. 7.) If the lake level were raised more than about 70 feet, an auxiliary dam would be required across a saddle between the knoll and a hillside to the north. The distance across the saddle is 350 feet at a level 100 feet above the lake. The base of a dam at the center line of the downstream site probably would be somewhat lower than at the centerline of the upstream site, but the section for the main dam is narrower. Scenery Creek drops about 30 feet in a waterfall at the lake

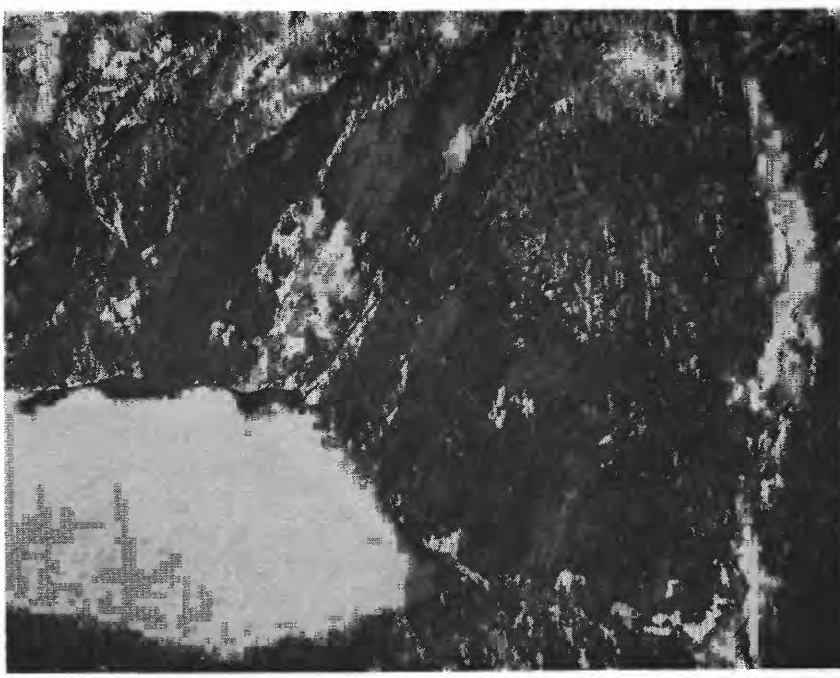

FIGURE 7.—Aerial view of Scenery Lake outlet. The damsite area is between the lake and the drain at the right edge of the picture.

outlet, which is a narrow V-shaped notch. The altitude of the stream at the centerline of the downstream site is 920 feet, or 37 feet below the lake surface.

Storage capacity of 60,000 acre-feet for regulation to 90 percent of the mean flow could be developed by raising the lake surface 89 feet to an altitude of 1,046 feet. The width of the canyon at the centerline of the downstream site is only 275 feet at this level, and the width of the saddle is 250 feet. The width at the upstream site at the same level is 900 feet. Storage capacity of 121,000 acre-feet for complete control could be created by raising the lake surface 157 feet to an altitude of 1,114 feet, but this would require a dam extending at least a thousand feet across the valley at either location.

Miller (1955, p. 21) reported that the bedrock at both damsites is satisfactory for foundation and abutments. He classified it as gneiss on the left side and across the channel, and as diorite farther to the north. The knoll at the lower dam axis separating the main and auxiliary dam sections was described as relatively impervious and suitable to serve as a natural dam.

The areas and capacities for a range above and below the lake surface are shown in the table below. Underwater contours on the map "Cascade Creek and Vicinity" were defined only above an altitude of 900 feet but soundings made at 5

Altitude (feet)	Area (acres)	Capacity (acre-feet)	
		Below lake surface	Above lake surface
800		[1] 69,000	
820		[1] 62,000	
840		[1] 54,000	
860		[1] 46,000	
880		[1] 38,000	
900	473	28,800	
920	496	19,100	
940	518	9,000	
957 [2]	544	0	0
960	570		1,600
980	634		13,600
1,000	685		26,800
1,020	739		41,000
1,040	781		56,200
1,060	[3] 814		72,100
1,080			[1] 89,000
1,114			[1] 121,000

[1] Estimated by extrapolation.
[2] Lake surface.
[3] Estimated in incomplete area of map "Cascade Creek and Vicinity."

sections across the lake showed that the underwater slopes are reasonably uniform down to an altitude of 800 feet, and the estimates for the range between 900 and 800 feet were made accordingly. The lake bottom flattens abruptly at altitudes between 800 and 750 feet so that drawdown much below the 800-foot level would tap relatively little storage. The lake bottom at a section a quarter of a mile east of the outlet is level at an altitude of 800 feet for much of its width. A usable capacity of 60,000 acre-feet could be developed by drawdown to an altitude of 824 feet if the lake can be tapped by a tunnel at a level that is low enough to provide a water seal.

The storage requirements were assumed to be the same as at Swan Lake. These were computed as 121,000 acre-feet for a uniform monthly release of 203 cfs and 60,000 acre-feet for uniform release of 90 percent of this amount, or 183 cfs. The larger capacity could not be developed entirely by drawdown, and it probably would be relatively costly if developed entirely by damming.

Access to Scenery Lake for transport of heavy equipment and materials would be relatively difficult because of steep, rugged terrain extending about 0.6 mile west of the lake. Scenery Creek drops 560 feet through a crooked canyon in this area. An access road probably could be constructed without unusual difficulty from Scenery Cove about 2½ miles eastward to an altitude of about 400 feet in the Scenery Creek canyon. Tramways of some kind might be the most feasible means of transport from this point up to the lake outlet.

The right, north, side of the canyon at the damsite extends up only about 300 feet higher than the lake surface to a divide between Scenery Creek and a tributary, and thus should be relatively free from slides. This side would be a better location for a side-channel spillway than at the left abutment, which is below a steeper and higher slope (see fig. 7). Alternatively, it might be desirable to construct a concrete overflow structure in the saddle as a spillway for a nonoverflow dam in the channel section at the lower damsite. In connection with a main dam at that location, an excavated spillway through the saddle area could be used for reservoirs having a maximum pool level lower than an altitude of about 1,030 feet.

The peak discharge at the Scenery Creek gage ranged from about 150 percent to 200 percent of that at the Cascade Creek gage during 7 comparable rises from 1950 to 1952, although the drainage area is only 30 percent larger and the annual runoff per unit area is less than that of Cascade Creek. The relatively large peak flows on Scenery Creek evidently are due to relatively large areas at medium and low altitude where precipitation may occur as rain rather than snow. For example, only 3 percent of the Cascade Creek basin is below an altitude of 1,200 feet, as compared with about 15 percent in the Scenery Creek basin. There is a somewhat similar difference in range of altitude above the storage sites on the two streams, so it is likely that peak discharges at Scenery Lake are greater than at Swan Lake.

PLANS OF DEVELOPMENT

Water could be conveyed from Scenery Lake in a westerly direction either to a powerhouse near the head of Scenery Cove or to one upstream in the Scenery Creek canyon for a lesser degree of development. Scenery Creek drops 680 feet, or 70 percent of the total fall to tidewater, within about 1¼ miles of the lake. A waterway to Scenery Cove along the south side of the canyon would consist of about 3¼ miles of tunnel and about ¼ mile of penstock. A waterway to a powerhouse site 680 feet lower than the lake would consist of only about 1¼ miles of tunnel and a quarter of a mile of penstock.

The U.S. Army Corps of Engineers (1952, p. 120) considered the possibility of conveying water from Scenery Lake to a powerhouse site at the mouth of Cascade Creek. This would avoid the difficult problem of power transmission over the rugged terrain between Scenery Creek and Cascade Creek, but the distance for conveyance of water would be almost doubled, and it was concluded that a powerhouse site on Scenery Creek would be preferable.

The route to Scenery Cove crosses the South Fork of Scenery Creek, a precipitous stream draining the mountain slope just southeast of the mouth of Scenery Creek. It would be possible to capture natural flows of this creek by diversion into a shaft inlet at an altitude on the creek above the hydraulic gradient of the Scenery Lake tunnel. The drainage area that could be tapped in this way is 3.0 square miles or 14 percent of that above the outlet of Scenery Lake.

Miller (1955, p. 26) reported that a tunnel from Scenery Lake along the south side of the Scenery Creek valley would be in gneiss for a short distance west of the lake and in diorite for the remainder of the route to Scenery Cove.

POTENTIAL POWER OF SITES IN THOMAS BAY AREA

The potential power of each of the 3 sites was estimated on the assumption that the head would be developed from the reservoirs down to the nozzles of impulse wheels set 17 feet above mean sea level—a few feet higher than the expected high-tide level. The power possibilities and related data are summarized as follows for 2 degrees of regulation.

	Delta Creek		Cascade Creek		Scenery Creek	
Controlled flow...percent of mean flow	100	90	100	90	100	90
Storage capacity...acre-ft	48,000	24,000	121,000	60,000	121,000	60,000
Operating range alt (ft)	1,660 1,353	1,550 1,353	1,600 1,396	1,562 1,458	1,046 824	1,004 898
Controlled flow...cfs	81	73	203	183	203	183
Mean head...ft	1,533	1,459	1,497	1,497	940	940
Continuous power...kw	8,440	7,240	20,700	18,600	13,000	11,700

The plan of storage development for Delta Creek illustrated in this tabulation is by a dam at the outlet of Ruth Lake (since drawdown is impracticable). The plan for Cascade Creek and Scenery Creek is by combined damming and drawdown, with storage capacity equally divided above and below the natural lake level, a division that is only one of many that might be considered. The potential power and some related data, with damming alone and drawdown alone, are summarized below for comparison.

	Cascade Creek		Scenery Creek	
Controlled flow...percent of mean flow	100	90	100	90
Controlled flow...cfs	203	183	203	183
Operating range with dam...alt (ft)	1,664 1,514	1,598 1,514	1,114 957	1,046 957
Operating range with drawdown...alt (ft)	1,514 1,250	1,514 1,398	(1)	957 824
Continuous power with dam...kw	21,900	19,200	14,200	12,300
Continuous power with drawdown...kw	19,100	17,900	(1)	11,000

1 Storage available by drawdown is insufficient for this degree of regulation.

The estimates for Scenery Creek in the foregoing tabulations were made without allowance for the possible use of the natural flow of the South Fork of Scenery Creek. If the runoff per unit area of the South Fork basin is the same as that of the Scenery Lake basin, its mean flow at the possible point of capture is 14 percent of the inflow to Scenery Lake. The continuous power could be increased somewhat accordingly by overall regulation from Scenery Lake, although this would require increased storage and waterway capacity.

The cost of storage at Swan Lake and Scenery Lake by damming or by combined damming and drawdown probably would be substantially more than by drawdown alone. The cost of drawdown above that for conveyance from dams or higher levels in the lakes would be due mainly to increases in length of the tunnels for tapping the lakes at depth. The increases would be relatively small because the underwater slopes are steep. Any saving in storage cost by drawdown, however, would have to be weighed against the reduction in power due to the reduction in available head.

LOCATIONS AT WHICH POWER COULD BE USED

An area of at least 10 square miles lies below an altitude of 200 feet between the shores of Frederick Sound near Point Agassiz and the Patterson River at the southern end of Thomas Bay. Much of it is topographically suitable for an industrial site. Point Agassiz is within a transmission range of about 6 miles from Delta Creek, 8 miles from Cascade Creek, and 14 miles from Scenery Creek.

A transmission line from Cascade Creek and Delta Creek could be located near the east shore of Thomas Bay to a crossing of the Patterson River, thence southwestward to Point Agassiz. A possible though unfavorable route between Scenery Creek and Cascade Creek is near the east shore of Thomas Bay along a very steep mountainside, which is subject to rock and snowslides as shown on some photographs of the area and on Chart 8210 of the U.S. Coast and Geodetic Survey. The U.S. Army Corps of Engineers (1952, p. 120) judged that an alternative route along a ridge roughly a mile inland would be preferable. It is across very rugged terrain at an altitude of about 3,000 feet, but the route would be free from slides. Transmission from Scenery Creek also would be possible by an underwater crossing of Thomas Bay to the land west of Scenery Cove, thence southward to another underwater crossing to Ruth Island, and overland across Ruth Island and the peninsula south of it to point Agassiz. Although this 15-mile route bypasses most of the rugged terrain, it is separate from the Cascade Creek-Point Agassiz route and would require about 3 miles of submarine cable for transmission.

The suitability of an area for industrial purposes must be considered in relation to sources of pure water, particularly since many processes require fairly large quantities of water. For example, the requirements for a mill producing 400 tons of woodpulp per day, a somewhat typical size, may be on the order of 40 cfs. A dependable supply of about twice this amount would be available from regulated water of Delta Creek, and even more from Cascade Creek or Scenery Creek. Water could be piped from Delta Creek or Cascade Creek to the Point Agassiz area over a route similar to that for transmission of power, at the sacrifice of some of the power head. Alternatively, supplies possibly could be obtained from ground water in the valleys of the Patterson River and the Muddy River, both of which are glacial streams near Point Agassiz. (Investigation of the ground-water possibilities was suggested by C. D. Cederstrom, Geological Survey, after an aerial reconnaissance in 1952.)

A strip of land extending along the shore of Thomas Bay from Cascade Creek southward was mentioned by the Federal Power Commission and U.S. Forest Service (1947, p. 64) as a possible industrial site. It has an area of about 100 acres below an altitude of 200 feet. An apparent disadvantage of the site is its cramped nature and its location below a steep mountainside. A triangular area of moderate relief just south of the mouth of Delta Creek, about 2 miles south of Cascade Creek, lies between the Patterson River delta and a ridge separating the Delta Creek and Patterson River basins. It has an area of about 350 acres between altitudes of 40 feet and 200 feet. Both areas are close to the Cascade Creek and Delta Creek powersites and to sources of water from one or the other creek. The area south of Delta Creek may be preferable because of its moderate relief and lesser slide hazard.

The U.S. Army Corps of Engineers, (1952, p. 121 and 132a) considered transmission of power from the Cascade Creek and Scenery Creek sites to the Point Agassiz area, or to load centers at Petersburg and Wrangell. The transmission distance to Petersburg is about 20 miles from Cascade Creek, including about 4 miles of underwater crossing at Frederick Sound. The transmission distance to Wrangell is about 60 miles, including about 1½ miles of underwater crossing at Eastern Passage near Wrangell. Much of the route would be over very rugged terrain on the mainland southeast of Thomas Bay. The cost of energy delivered at Petersburg and Wrangell was estimated to be about 150 and 170 percent respectively of the cost at Cascade Creek, with all the power transmitted to one or other of those towns. The transmission cost evidently would be a serious handicap to development of the power for use very far from the Thomas Bay area.

SITES AT GILBERT BAY AND SPEEL ARM OF PORT SNETTISHAM AREA

MAPS

Surveys of Upper Sweetheart Lake, Lower Sweetheart Lake, and Sweetheart Creek were made by the Geological Survey in 1958 and published in 1960 ("Plan and Damsite, Lower and Upper Sweetheart Lakes, Alaska.") A flat area of several square miles southeast of the mouth of Sweetheart Creek which may be suitable for an industrial site is also included. The maps are on scale 1:24,000 and have a contour interval of 20 feet. Maps of damsites below the outlets of the 2 lakes are on a scale of 1:2,400, with a contour interval of 10 feet.

A map of the damsite area at the outlet of Tease Lake has been prepared by the Forest Service from surveys of the Speel River Project, Inc., one of the licensees of the former waterpower development there which was operated as Federal Power Project No. 4. The map is on a scale of 1 inch equals 100 feet, with a contour interval of 10 feet. The topography is shown to about 80 feet above the lake level. The damsite map is part of a map entitled "Crater, Long and Tease Lakes Projects near Juneau, Alaska." Photostat copies are available from the regional office of the Forest Service at Juneau.

A map entitled "Plan, Long Lake, Crater Lake and Vicinity near Juneau, Alaska, Dam Sites" was published by the Geological Survey in 1952. The scale of the map is 1:24,000 and the contour interval is 20 feet. Contours are shown to about 200 feet above and 200 feet below the lake surfaces. The damsite maps are on scales of 1:1,200; 1:2,400; and 1:4,800, with a contour interval of 10 feet on land and under water. These maps are of the sites at the outlets of Crater Lake and Long Lake, a site on the Speel River, and a saddle where an auxiliary dam would be required.

The powersites and their related drainage basins are shown on Geological Survey topographic maps of the quadrangles Sumdum D–5 and D–6 and Taku River A–5, A–6, B–5, and B–6, Alaska; and on Sheet 7 of the map of the international boundary between the United States and Canada. The maps of the Sumdum and Taku River quadrangles were compiled by the Geological Survey in 1948 and 1951 on a scale of 1:63,360, with a contour interval of 100 feet. The international map was published by the International Boundary Commission in 1923 on a scale of 1:250,000, with a contour interval of 250 feet.

Maps showing the waterways and terrain between Speel Arm and Juneau include those for the quadrangles Juneau (Alaska–Canada), Sitka, Sumdum, and Taku River, Alaska, all on a scale of 1:250,000, with contour intervals of 200 to 1,000 feet. Some of this region also is shown on the quadrangle maps Juneau (A–1) and (B–1), on a scale of 1:63,360, and Juneau (B–2), on a scale of 1:62,500; and on a special topographic map "Juneau and Vicinity," on a scale of 1:24,000.

Soundings in Taku Inlet, Gastineau Channel and a part of Stephens Passage are shown on Chart 8235 of the U.S. Coast and Geodetic Survey. Soundings in Gilbert Bay, Speel Arm, Port Snettisham, and Stephens Passage near Snettisham are shown on Chart 8227. Both charts are published on a scale of 1:40,000, and the soundings are in fathoms.

LOCAL GEOGRAPHY AND TOPOGRAPHY

Port Snettisham is a fiord extending northeastward from Stephens Passage and terminating in a few miles of narrower section called Speel Arm. The Speel River flows into Speel Arm from the northeast through tidal flats of its delta. Stephens Passage joins Taku Inlet and Gastineau Channel 15 miles northwest of Port Snettisham.

Juneau, the nearest city, is on Gastineau Channel, about 25 miles northwest of Port Snettisham. The population of Juneau was recorded as 5,956 in the 1950 census. The principal activities are operation of the territorial government, commercial fishing, and furnishing transportation and other services to outlying communities, and to tourists. The rugged mountains and large glaciers in the immediate vicinity of Juneau are outstanding attractions. Gold mining formerly was a very important industry but is has been inactive since 1944.

Four of the powersites—Tease Lake, the Speel River, the Long River (a tributary of the Speel River), and Crater Creek—are grouped close to the head of Speel Arm. The other one, Sweetheart Creek, is 14 miles south of this group at the end of a southern extension of Port Snettisham called Gilbert Bay. (See fig. 8.) It is about 35 miles from Juneau by water.

The drainage basins of the four powersites are in mountainous terrain, with divides above altitudes of several thousand feet. About an eighth of the Speel River basin lies in Canada, and

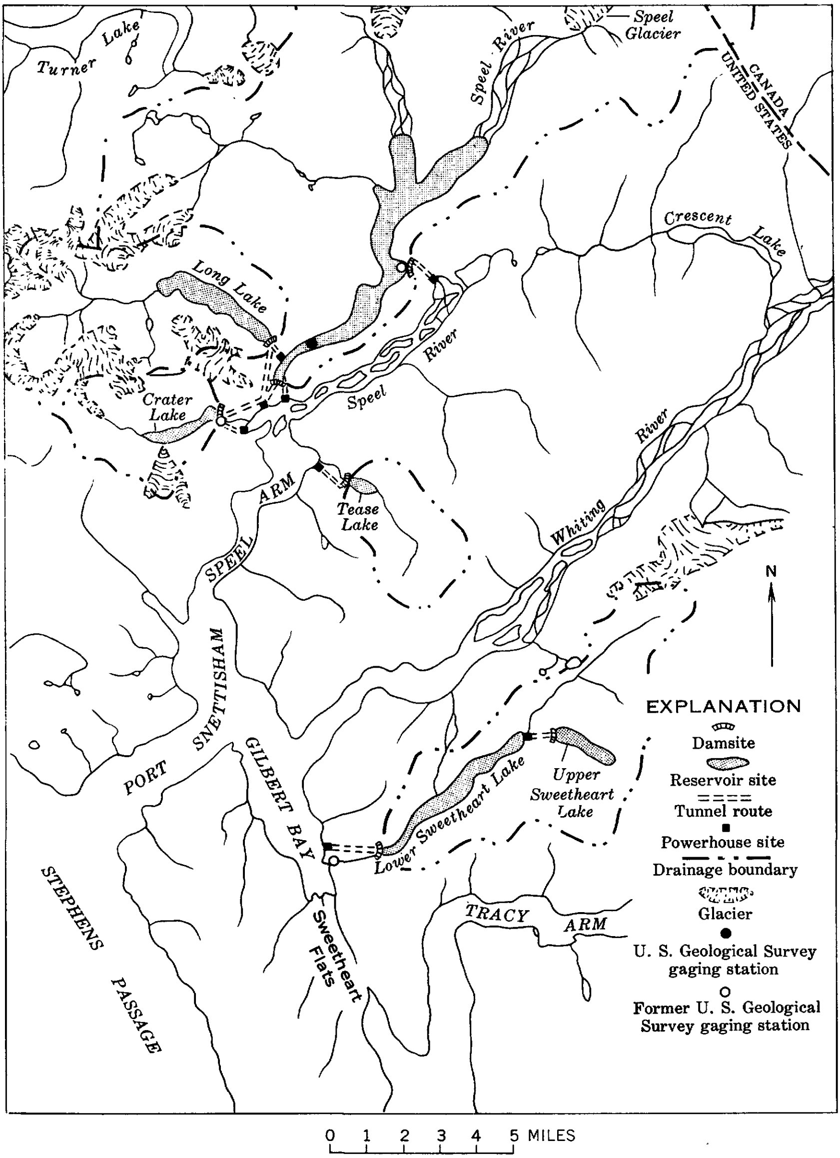

FIGURE 8.—Map of powersites in the Port Snettisham area, Alaska.

that portion is largely covered with snowfields extending to altitudes above 6,000 feet. At present [1959] there are no settlements in the stream basins or nearby.

There are several mine tunnels on the south side of Port Snettisham between its entrance and Gilbert Bay near the abandoned hamlet of Snettisham. A large deposit of magnetite ore is located nearby.

Deep water extends to near the heads of Speel Arm and Gilbert Bay. The Forest Service (written communication 1957) reported that conditions for anchorage and construction of port facilities in Gilbert Bay are favorable. The mountainsides adjacent to the delta of the Speel River and the head of Speel Arm are very steep, and special methods may be required for transport of materials from landing piers to the nearby powersites.

WATER SUPPLY

RECORDS OF STREAMFLOW

Gaging stations have been maintained on Sweetheart Creek, the Speel River, the Long River and Crater Creek as shown below.

Figures of monthly and annual runoff for Sweetheart Creek near Juneau, Long River near Juneau, and Crater Creek near

Gaging station	Drainage area (square miles)	Period of records [1]
Sweetheart Creek near Juneau [2]	[3] 36.3	Aug. 1915 – Mar. 1917. June 1918 – Sept. 1927.
Tease Lake outlet at Port Snettisham [4]	10.9	April – Oct. 1913.
Long Lake Outlet near Juneau.	30.2	Feb. 1913 – Oct. 1915.
Long River near Juneau	32.5	Oct. 1915 – Sept. 1924. Oct. – Dec. 1926. June 1927 – May 1933. Oct. 1951 – Sept. 1956.
Speel River near Juneau	226	July 1916 – Sept. 1918.
Crater Creek near Juneau	11.4	Feb. 1913 – Dec. 1920. June – Aug. 1921. Oct. – Dec. 1922. June – Sept. 1923. June – Sept. 1924. June 1927 – Dec. 1932.

[1] Through Sept. 1956. Except for the Tease Lake outlet the available monthly and annual records through Sept. 30, 1956, and daily discharge records for Long River near Juneau from Oct. 1951 to Sept. 1956 have been published by the U.S. Geological Survey (1957, 1958a, b).
[2] Published as "Sweetheart Falls Creek near Juneau."
[3] Revised.
[4] The record is of questionable accuracy.

Juneau are listed in tables 3, 4, and 5, respectively. These were rounded from published records and include some estimates for years of missing record.

RUNOFF AT UPPER AND LOWER SWEETHEART LAKE

The average discharge of Sweetheart Creek for the 10 water years of complete record, 1916 and 1919–27, was 335 cfs. The record was extended by estimating the monthly runoff in the 1917–18, 1928–32 and 1949–56 water years from records of the Long River near Juneau and relationships between the monthly runoff of Sweetheart Creek and the Long River in a period of overlapping records (see table 3). The average discharge for the 25 years of records and estimates is 345 cfs. The extended record provides a better estimate of the extremes of runoff to be expected, and thus provides a better basis than the 10-year record for estimating requirements for control of Sweetheart Creek.

Upper Sweetheart Lake, a potential storage site on a tributary stream, has a drainage area of 3.65 square miles at relatively high altitude. Its water supply was assumed to be about 10 percent of that at the gaging station, or 35 cfs, in accordance with the drainage-area ratio. The monthly and annual distribution of runoff was assumed to be the same as at the gage.

TABLE 3.—*Monthly and annual runoff, in thousands of acre-feet, Sweetheart Creek near Juneau, Alaska* [1]

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Annual
1916	25.3	10.0	6.2	2.4	2.2	2.6	9.3	22.6	46.8	30.8	35.8	37.8	231.8
1917	38.2	11.5	5.4	3.5	7.0	3.0	4.4	22.7	39.2	38.0	42.0	33.0	247.9
1918	35.3	38.5	6.3	6.3	2.2	1.4	4.6	20.2	44.8	38.3	41.0	36.8	275.7
1919	23.1	23.4	11.9	15.7	3.0	2.6	8.8	21.0	31.8	37.7	35.5	35.9	250.4
1920	30.1	9.2	8.4	14.0	5.4	2.4	3.0	14.6	37.0	34.9	39.4	24.9	223.3
1921	21.5	16.4	3.3	3.9	5.3	3.9	6.8	24.3	37.5	29.5	26.3	25.3	204.0
1922	36.8	9.7	18.0	5.6	1.7	1.5	6.8	25.8	40.3	35.3	33.9	31.2	246.6
1923	21.3	24.0	7.1	3.6	5.2	8.2	13.7	29.2	37.2	29.7	22.3	42.2	243.7
1924	30.4	29.0	12.5	4.1	2.3	4.6	6.8	36.0	49.3	47.6	36.0	48.9	307.5
1925	28.2	17.1	10.0	2.4	1.7	2.8	5.0	29.3	41.2	39.2	22.9	25.2	225.0
1926	18.7	21.0	30.2	35.3	8.0	16.2	25.1	22.3	26.8	21.2	18.5	14.2	257.5
1927	30.1	18.6	13.7	6.6	2.1	4.8	5.8	24.3	45.6	29.6	21.0	35.2	237.4
1928	18.7	7.4	3.3	12.0	7.5	6.5	14.3	37.6	46.0	41.1	28.9	29.6	252.9
1929	28.4	21.3	20.7	12.7	2.3	5.7	5.4	23.6	46.8	33.8	27.2	26.9	254.8
1930	58.4	28.3	9.6	1.3	2.4	3.3	8.9	21.5	40.1	34.4	35.2	29.3	272.7
1931	29.6	32.6	21.8	9.9	14.0	2.8	8.2	33.2	54.4	36.4	35.6	29.3	307.8
1932	37.3	10.6	5.6	3.6	3.0	3.3	7.1	24.2	42.6	31.3	28.6	34.8	232.0
1949	28.6	23.2	8.1	6.4	2.3	3.0	6.0	33.0	43.0	33.6	32.7	32.3	252.2
1950	30.3	67.0	7.8	2.5	1.6	1.8	2.6	25.4	43.5	35.7	26.5	35.2	279.9
1951	17.2	6.0	2.9	3.6	2.3	2.6	4.8	29.2	54.5	40.0	23.0	26.4	212.5
1952	16.8	7.6	6.1	2.4	2.1	2.6	9.8	29.8	41.5	40.0	31.2	39.6	229.5
1953	61.0	26.0	8.0	3.8	3.5	2.6	5.5	38.8	53.2	35.6	33.3	31.4	302.7
1954	49.0	8.3	9.3	4.6	15.2	3.3	3.3	22.0	42.5	31.2	20.6	32.9	242.2
1955	25.2	27.4	24.3	5.7	2.8	3.3	4.4	19.4	37.8	39.6	37.4	30.2	257.5
1956	18.3	12.3	3.7	1.9	1.6	2.2	4.6	33.2	33.4	39.0	44.2	23.8	218.2
Mean	30.3	20.3	10.6	7.0	4.3	3.9	7.4	26.5	42.3	35.3	31.2	31.7	250.6

[1] Data for April 1917–May 1918, October 1927–September 1932, and October 1948–September 1956 were estimated.

TABLE 4.—*Monthly and annual runoff, in thousands of acre-feet, Long River near Juneau, Alaska*

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Annual
1916	32.4	8.1	6.0	3.1	2.8	3.1	7.7	15.6	51.4	52.6	65.8	61.9	310
1917	37.2	8.6	5.3	5.4	7.2	3.2	4.0	20.6	41.4	61.2	79.3	54.9	328
1918	40.1	39.3	5.8	6.0	2.3	1.6	4.2	18.4	44.3	65.8	75.0	63.1	366
1919	31.0	20.4	11.1	12.9	3.0	3.1	7.4	19.0	32.4	53.1	64.6	59.5	318
1920	32.3	11.4	7.9	11.1	5.4	2.8	3.1	14.4	34.5	56.4	73.8	38.1	291
1921	23.4	15.6	3.7	4.2	5.3	4.2	6.6	23.9	42.5	52.3	52.7	42.1	276
1922	42.3	12.4	17.1	5.6	1.7	1.5	6.9	24.9	42.0	56.1	64.6	49.3	324
1923	29.3	31.1	6.4	3.8	4.7	7.2	11.0	26.8	43.1	57.2	59.8	67.8	348
1924	34.6	31.0	13.6	4.8	2.9	5.5	8.0	35.4	54.1	71.9	64.6	64.3	391
1928	21.3	7.5	3.1	11.4	7.9	7.4	13.0	34.1	48.5	66.4	54.5	49.4	324
1929	32.3	21.7	19.4	12.1	2.4	6.5	4.9	21.4	49.2	54.4	51.4	44.9	321
1930	66.4	28.9	8.9	1.2	2.5	3.7	8.1	19.5	42.4	55.3	66.4	48.8	352
1931	33.7	33.3	20.2	9.4	14.7	3.2	7.4	30.1	57.2	58.7	67.0	48.9	384
1932	42.4	10.8	5.2	3.4	3.2	3.7	6.4	22.0	45.0	50.5	53.9	58.0	304
1949 [1]	32.5	23.7	7.5	6.1	2.4	3.4	5.4	30.0	45.5	54.2	61.5	53.6	326
1950 [1]	34.4	68.5	7.2	2.4	1.7	2 0	2.4	23.0	46.0	57.5	50.0	58.5	354
1951 [1]	19.5	6.1	2.7	3.4	2.4	3.0	4.4	26.5	57.5	64.3	43.1	43.9	277
1952	19.1	7.7	5.6	2.3	2.2	3.0	8.9	27.0	43.6	64.2	58.9	65.7	303
1953	69.1	26.5	7.4	3.6	3.7	3.0	5.0	35.2	56.1	57.2	62.6	52.4	382
1954	55.9	8.5	8.6	4.4	15.3	3.7	3.0	19.8	44.8	50.2	38.8	54.1	307
1955	28.6	28.0	22.5	5.4	3.0	3.7	4.0	17.6	39.9	63.7	70.4	50.3	337
1956	20.8	12.6	3.4	1.8	1.7	2.5	4.2	30.1	35.2	62.8	83.2	39.7	298
Mean	35.3	21.0	9.0	5.6	4.5	3.7	6.1	24.3	45.3	58.4	61.9	53.1	328

[1] Data for the 1949–51 water years are estimated.

TABLE 5.—*Monthly and annual runoff, in thousands of acre-feet, Crater Creek near Juneau, Alaska* [1]

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Annual
1914	16.0	6.4	2.4	1.3	2.5	2.3	3.1	8.8	16.2	31.8	25.1	15.8	131.7
1915	19.2	6.2	1.5	2.2	1.0	2.7	4.4	14.4	24.6	30.6	28.8	23.1	158.7
1916	11.4	2.7	2.0	1.1	1.0	1.2	2.6	5.5	22.0	22.8	28.5	28.0	128.8
1917	16.6	3.0	2.0	2.2	2.5	1.4	1.4	8.7	18.1	27.1	33.1	21.5	137.6
1918	15.4	14.9	2.2	2.0	.9	.8	1.2	7.9	20.6	29.6	36.3	24.5	156.3
1919	12.4	7.9	4.0	4.2	.8	.7	2.8	7.3	12.9	25.6	31.4	25.0	135.0
1920	12.9	4.0	2.8	6.2	2.0	1.0	1.2	3.3	10.5	25.0	32.7	15.6	117.2
1928	8.3	2.9	1.5	5.4	1.8	2.5	2.5	11.9	22.7	32.5	23.2	20.4	135.6
1929	11.9	6.7	5.0	4.7	1.1	3.0	1.7	5.6	22.7	25.8	24.8	20.6	133.6
1930	28.5	13.2	3.7	.3	.5	.9	2.0	6.4	18.3	25.8	29.8	21.4	150.8
1931	13.8	15.2	9.0	4.2	5.7	1.4	2.7	13.0	23.9	25.6	29.1	21.5	165.1
1932	20.5	4.3	1.7	1.2	1.2	.9	2.0	6.5	16.9	22.3	22.5	25.5	125.5
1949	13.5	8.0	.9	1.4	.3	1.4	1.2	9.5	17.0	23.0	25.0	22.0	123.2
1950	14.0	28.0	1.3	.3	.4	.8	1.4	6.0	17.5	24.0	21.0	24.0	138.7
1951	8.0	1.1	.9	.4	.5	.7	1.1	7.5	22.0	27.0	18.0	18.0	105.2
1952	12.0	3.2	1.0	.3	1.0	1.0	1.8	6.8	14.0	25.0	24.0	27.0	117.1
1953	27.0	13.0	2.4	.3	1.3	1.4	1.9	9.0	19.0	25.0	27.0	21.0	148.3
1954	19.0	7.5	2.3	.7	7.5	1.5	1.1	5.5	16.0	20.0	17.0	19.0	117.1
1955	11.0	9.0	5.5	2.0	1.0	1.4	1.5	5.0	13.0	27.0	27.0	20.0	123.4
1956	9.5	4.0	.5	.4	.3	.9	1.5	9.0	13.0	25.0	36.0	19.0	119.1
Mean	15.0	8.1	2.6	2.0	1.7	1.4	2.0	7.9	18.0	26.0	27.0	21.6	133.4

[1] Data for the 1949–56 water years are estimated.

The actual amount of runoff probably is somewhat greater and more concentrated in months of snow melting.

Lower Sweetheart Lake, a potential storage site on Sweetheart Creek, has a drainage area of 35.2 square miles, or 97 percent of that at the gage. Its water supply was estimated accordingly as 334 cfs.

RUNOFF AT TEASE LAKE OUTLET

The record of monthly discharge near the outlet of Tease Lake from April to October 1913 was listed by the Federal Power Commission and U.S. Forest Service (1947, p. 119). This presumably was furnished by an applicant to the Forest Service for a power permit, and is of questionable accuracy because of gaps in the record and crude methods of measurement. The runoff as listed for the period of record was 171,000 acre-feet (partly estimated). The period overlaps that of records for the Long Lake and Crater Lake outlets, the drainage basins of which are about 6 miles northwest and west of Tease Lake, across Speel Arm. The average runoff relations that existed for the period of overlap, and the longer records on Crater Creek and the Long River, were used to estimate the average discharge at Tease Lake as about 165 cfs. The same relation used with longer records and estimates through September 1956 leads to an estimate of about 155 cfs.

The average discharge at Tease Lake as estimated from the ratios of its drainage basin to those of Sweetheart Creek, the Long River, and Crater Creek, and the records and estimates for those streams, is respectively 104 cfs, 152 cfs, and 176 cfs. The Tease Lake area is centrally located between the Sweetheart Creek and Long River basins.

The mean annual precipitation at Speel River during the period of record was about 142 inches, which may correspond to a runoff of about 130 inches, or an average discharge of 105 cfs from an area equivalent to the Tease Lake drainage basin. The Speel River station was a mile northwest of Tease Lake near sea level. Although heavier precipitation would be expected in the mountains of the lake basin, which extend to altitudes above 4,000 feet, there are only a few small glacierets. This lack shows that the precipitation may be substantially less than in the Long River basin where glaciers are prevalent at similar altitudes. It is estimated accordingly that the discharge per unit area in the Tease Lake area is intermediate to that in the Sweetheart Creek and Long River basins, and that the average discharge is about 125 cfs.

RUNOFF AT LONG LAKE OUTLET

The period of record at the Long Lake outlet is too brief to provide a measure of reliable water supplies. The gaging station there was replaced in 1915 by one on the river 1 mile downstream from Long Lake because measuring conditions at the lake are unsatisfactory. The record for this station, Long River near Juneau, covers 19 complete water years in the period from 1916 to 1956. The mean discharge during the years of record, 457 cfs, probably was not much different than during the 41 years, 1916–56. However, the records do not cover 3 water years, 1949–51, which were within a relatively dry period of exceptional length. Since this may be considered a critical period for storage regulation, estimates of monthly runoff were made for the 3 years of missing record. These were based on the recorded monthly runoff of nearby Dorothy Creek, and monthly relationships for the period of overlapping records, 1952–56. The computed mean discharge for the 22 years is 454 cfs.

The water supply at the Long Lake outlet was assumed to be 422 cfs, or 93 percent of that at the gage, in accordance with the drainage-area ratio.

RUNOFF AT SPEEL RIVER DAMSITE

The gaging station on the Speel River was in the immediate vicinity of the only practicable damsite, half a mile downstream from the mouth of the Long River. The record covered 2 complete water years, 1917–18, and is only of fair accuracy. As shown by the records for the Long River, runoff during those years probably was near or above average.

The monthly runoff of the Speel River exclusive of runoff of the Long River near Juneau was estimated for the dry period, 1949–56, from the Long River record and the average relationship that existed during 27 months of overlapping records, 1916–18. This provides an estimate of the runoff that would be available for control at the Speel River site after utilization of the Long River runoff, nearly all of which may be diverted from the basin for power generation.

The average-relation curve was based on scanty data; the relationship may vary seasonally and annually because of varied conditions for natural storage; and the Long River figures for the water years 1949 to 1951 are estimates themselves, so the simulated record for the Speel River can be only a crude representation of the historical runoff. It is intended to provide a basis for estimating the regulated streamflow that can be obtained with a given amount of storage capacity in a future dry period of roughly similar characteristics. The adjusted records and the estimates are shown in table 6. The computed mean discharge for the 10 water years 1917–18 and 1949–56 is 2,080 cfs.

TABLE 6.—*Monthly and annual runoff, in thousands of acre-feet, Speel River near Juneau, exclusive of Long River near Juneau, Alaska*[1]

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Annual
1916	......	......	......	......	......	......	......	......	......	280	367	308	....
1917	141	37	20	16	21	7	16	84	171	288	444	250	1,495
1918	220	172	25	17	8	7	17	78	192	321	380	362	1,799
1949	120	85	28	24	8	12	22	150	220	230	280	230	1,409
1950	130	330	28	8	5	7	8	100	230	260	210	260	1,576
1951	63	224	10	12	9	10	18	120	280	310	160	160	1,176
1952	80	30	18	7	7	10	35	120	200	320	290	330	1,447
1953	350	120	24	12	13	10	18	160	280	250	300	230	1,767
1954	270	32	32	16	66	13	10	84	210	240	180	270	1,423
1955	130	120	98	20	10	13	14	73	180	320	370	240	1,588
1956	88	50	12	6	6	8	15	140	160	310	450	180	1,425

[1] Data for the 1949–56 water years are estimated.

RUNOFF AT CRATER LAKE OUTLET

The record at Crater Lake outlet (published as "Crater Creek near Juneau") covers 12 complete water years between 1913 and 1932. Estimates of monthly runoff were made for the 1949–1956 water years from the records for nearby Dorothy Creek and relations between monthly figures for the period of overlapping records, 1930–33 (see table 5). In very cold months, as measured by temperature records at Juneau, the relations are abnormal, and the estimates were made accordingly. In such months the flow of Crater Creek has dropped to a low of 0.5 that of Dorothy Creek from an average of about 1.35.

SWEETHEART CREEK POWERSITE

RESERVOIR SITES

Upper Sweetheart Lake is about 8 miles east of Gilbert Bay and 0.8 mile east of the head of Lower Sweetheart Lake on an unnamed tributary. Sufficient storage capacity for substantial control of the runoff could be created by construction of a dam near the lake outlet, by drawdown, or by a combination of the two methods.

The lake is at an altitude of 1,865 feet and is 1,321 feet higher than Lower Sweetheart Lake. It extends southeast from its outlet for more than 1 mile between steep, barren mountainsides to a delta at the upper end. The steep slopes continue underwater to a depth of at least 150 feet. The surface area of the lake is 295 acres.

Rock mantled with very little soil forms an irregular barrier across the valley at the lower end of the lake. The outlet creek flows in a passage through this barrier, which constitutes a good site for a dam of moderate height. The right abutment of the creek section is limited in height by a ridge northwest of the creek, the top of which is at an altitude of about 1,920 feet at the dam site, or 60 feet above the creek. The left abutment is similarly limited by a knoll at about the same level, separated by a saddle from higher ground to the southeast. The saddle could be used as a natural spillway with crest level at an altitude of 1,913 feet. The width across the damsite at this level is 250 feet, and the storage capacity above the natural lake surface is 16,500 acre-feet.

About the same capacity could be created entirely by drawdown of 65 feet to an altitude of 1,800 feet. This could be accomplished by tapping the lake with a tunnel at a point about 500 feet southeast of the outlet.

Reservoir areas and capacities for a range above and below the surface of Upper Sweetheart Lake are listed below.

Altitude (feet)	Area (acres)	Capacity (acre-feet)	
		Below lake surface	Above lake surface
1,760	204	25,000	
1,780	216	20,800	
1,800	231	16,300	
1,820	244	11,600	
1,840	253	6,600	
1,865 [1]	295	0	0
1,880	337		4,700
1,900	368		11,800
1,920	385		19,300
1,940	413		27,300
1,960	435		35,800
1,980	468		44,800

[1] Lake level.

Storage capacity equal to the estimated average annual runoff of 25,000 acre-feet would provide for complete or nearly complete control on a schedule of uniform releases. This could be provided by a dam at the outlet raising the lake level to an altitude of 1,934 feet, but the topography is not favorable for a structure of that height. The capacity could be provided more readily by drawdown to an altitude of 1,760 feet.

A storage capacity of only about 12,000 acre-feet would provide for a uniform release equal to 90 percent of the average inflow. This could be created with a 36-foot dam at the outlet or by drawdown of 47 feet.

This site is farther from tidewater than any of the others considered in this report. If a reservoir is created at Lower

Sweetheart Lake, the best means of access probably would be by water from the lower to the upper end of the reservoir and thence by an access road or tramway to Upper Sweetheart Lake.

Lower Sweetheart Lake is at an altitude of 544 feet and its outlet is about 2 miles east of Gilbert Bay. The lake extends about 5 miles northeast from the outlet and lies in a narrow valley. There is a constriction about ⅔ mile from the outlet and another about 1 mile from the upper end where depths are only a few feet. (See fig. 9.) The lake is several hundred feet deep in its central part, but a tunnel extending nearly a mile beyond the outlet would be needed to tap this part at depth. Creation of storage by damming would be preferable not only because of the lesser requirement for waterway but also because it would result in a substantial increase instead of a reduction in the limited head.

FIGURE 9.—Aerial view of Lower Sweetheart Lake. The outlet is just beyond the field of view in center of foreground. (U.S. Forest Service photograph; June 22, 1929.)

Sweetheart Creek flows westward from the lake in a V-shaped canyon featured by many cliffs along the sides. The narrowest section is about 300 feet downstream from the outlet, where the width at creek level at an altitude of 539 feet, is less than 40 feet and at an altitude of 700 feet is only 350 feet.

So far as is known a geologic examination of the damsite has not been made. The rocks near the east side of Gilbert Bay are classified by Buddington and Chapin (1929) as mostly phyllite and, locally, slate. Dort (1924, p. 77) referred to the rock along a suggested tunnel route from the damsite to Gilbert Bay as slate, with nearly vertical cleavage planes crossing the east-west route.

The reservoir areas and potential capacities for a range above the surface of Lower Sweetheart Lake are given below.

Altitude (feet)	Area (acres)	Capacity (acre-feet)	Altitude (feet)	Area (acres)	Capacity (acre-feet)
544	1,250	0	640	1,680	144,000
560	1,380	21,200	660	1,720	178,000
580	1,450	49,400	680	1,770	213,000
600	1,550	79,400	700	1,850	249,000
620	1,630	111,000			

Storage requirements for regulation to a uniform monthly and annual release were determined both for the 10 water years of complete record, considered as a consecutive series, and for 25 years of records and estimates. These show that 146,000 acre-feet would have been sufficient for complete control in the 10-year period but that about 220,000 acre-feet would have been needed in the 25-year period. This could be provided with a dam about 140 feet high which would raise the reservoir level to an altitude of 684 feet. A capacity of 102,000 acre-feet would have been sufficient to provide for a uniform release equal to 90 percent of the mean inflow. This could be provided by a dam about 71 feet high, which would raise the reservoir level to an altitude of 615 feet but would reduce the mean head available above sea level about 6 percent so that the uniform power generation would be only about 85 percent of that available with full control. At this site it seems likely that the value of the incremental power would outweigh the incremental plant cost for complete control, and it might even be advantageous to construct a dam higher than needed for the required storage in order to provide additional head. For example, the gain in mean head and potential power by raising the full reservoir level from 685 feet to 750 feet would be 11 percent.

During the course of surveys in July and August, 1958, it was observed that the creek flowing into the upper end of the lake was clear except at times of heavy rain runoff, and that Sweetheart Creek below the lake was clear at all times. The lake constitutes a sediment catchment of ample volume, all of which would be available as dead storage in a reservoir created by a dam.

The topography at the damsite is favorable for an arch dam, but a rock-fill structure might be preferable if suitable rock could be quarried locally, as seems probable. Transport of heavy equipment and materials to the site would be relatively difficult because of the rugged terrain. Facilities for transport might consist of several miles of access road constructed from tidewater to the rim of the canyon above the damsite, and a tramway down the canyon side.

The maximum discharge of Sweetheart Creek during the period of record was 2,880 cfs, or about 80 cfs per square mile. Maximum discharges of 150 cfs per square mile or more have occurred in 3 of 20 years on the Long River near Juneau from a drainage area comparable in size to that of Sweetheart Creek. The frequency of such discharges on Sweetheart Creek may be similar. A spillway of a special type, such as a side channel or side channel and tunnel, probably would be considered at this site and would be essential with a rock-fill dam.

PLANS OF DEVELOPMENT

Water could be conveyed westward from Upper Sweetheart Lake to a powerhouse located near the upper end of the reservoir site at Lower Sweetheart Lake. If Upper Sweetheart Lake were tapped at an altitude of about 1,750 feet for development of storage, the waterway would consist of about 1,000 feet of tunnel connecting with about 2,000 feet of penstock to the powerhouse.

Water could be conveyed from Lower Sweetheart Lake 2 miles to a powerhouse at Gilbert Bay. Dort (1924, p. 79) suggested an area 2,000 feet north of the mouth of Sweetheart Creek at the edge of Gilbert Bay for a powerhouse site and described the rock foundation as excellent. The waterway would consist of about 1¾ miles of tunnel and ¼ mile of penstock.

TEASE LAKE POWERSITE

RESERVOIR SITE

Tease Lake is 1 mile from the eastern shore of Speel Arm at an altitude of 1,006 feet. The Federal Power Commission and

U.S. Forest Service (1947, p. 66) estimated that construction of an 80-foot dam and drawdown of the lake surface 100 feet would provide a storage capacity of 22,000 acre-feet. An accurate topographic map was not available for this determination. As shown by the topographic map of the Taku River (A–5) quadrangle, the valley upstream from the lake ranges from about ¼ to ½ mile wide for nearly 2 miles and is below an altitude of 1,100 feet. Low-level observations from an airplane in 1958 showed that the valley floor is flat and that a considerable part of it is marshy. It is estimated accordingly that there is potential storage capacity of at least 25,000 acre-feet between the present lake surface and an altitude of 1,080 feet.

A photograph of the lake from its upper end shows that steep slopes on the sides extend to the shoreline on the south side and probably on the north side as well. Soundings have not been made, but the underwater volume must be relatively small since the surface area is only about 120 acres (as measured to the hillsides).

A dam could be constructed across the outlet channel about 350 feet downstream from the lake. The width of the valley at an altitude of 1,080 feet is 540 feet.

The Federal Power Commission and U.S. Forest Service (1947, p. 66) reported that quartz diorite is exposed at several places across this section, and that there is loose rock in places that could be incorporated in a rock-fill dam without much stripping.

A storage capacity of 25,000 acre-feet is 28 percent of the estimated mean annual runoff of about 90,000 acre-feet. This probably would be sufficient to provide for a uniform release equal to about 80 percent of the mean discharge, or 100 cfs.

PLANS OF DEVELOPMENT

Water could be conveyed from the reservoir by means of about 0.9 mile of tunnel and 0.3 mile of penstock to a powerhouse located on the shore of Speel Arm a few hundred feet south of the mouth of the creek discharging from Tease Lake. Alternatively, a surface conduit could be located near the 1,000-foot level for about two-thirds of a mile below the dam, connecting with about half a mile of penstock to the same powerhouse site.

LONG RIVER POWERSITE

RESERVOIR SITE

A large amount of storage capacity could be developed at Long Lake by construction of a dam at the lake outlet, by drawdown, or by a combination of the two methods. The outlet, which is at the southeastern end of the lake, is at an altitude of 814 feet and is only 1½ miles from the tidal flats at the mouth of the Speel River. The lake extends about 4 miles to the northwest between steep mountainsides. The Long River valley upstream from the lake is covered with glacial debris to an average width of about 2,000 feet for about 3 miles.

The Long River drains the lake in 2 channels around a rock island for 200 feet, and it falls 500 feet in a cascade extending 1,500 feet southeast of the head of the island (see fig. 10). The river then flows eastward on a flatter gradient about 4 miles to the Speel River. About half of this reach is through a sizable body of water called Indian Lake, which is at an altitude of 177 feet.

The hillsides at the outlet section are topographically suitable as abutments for a dam to an altitude of at least 900 feet, where the width of the valley is 700 feet. The width at stream level between the steep hillsides is 250 feet, including the rock island which extends generally about 10 feet above the stream and is 150 feet wide. The channel in a distance of 200 feet from

FIGURE 10.—Aerial view of Long Lake and the cascade on the Long River below the island at the damsite. (U.S. Forest Service photograph; June 22, 1929.)

the head of the island drops 70 feet, and in a distance of 450 feet it drops 140 feet. The rock on the right bank slopes sharply downstream below a narrow ridge at the outlet section and the lake bottom drops sharply upstream so that the terrain is generally unfavorable as a base for a high gravity dam. It appears to be more suitable for an arch dam or a buttressed dam.

Miller (1956, p. 30) reported that the rock in the region of the lake outlet is quartz diorite, and that, because of fractures, considerable excavation and grouting might be required to prevent leakage. Alternatively it may be found that a higher dam farther downstream would be preferable, if the fractures at the outlet section extend to considerable depth, although the downstream topography is not as favorable for abutments.

The potential storage capacity at Long Lake and the corresponding surface areas for a range of altitudes above and below the lake surface are shown below.

Storage requirements for regulation were determined from operation schedules for the 22 years of recorded and estimated runoff at the Long River gaging station. These were converted to requirements at the lake outlet by application of the drainage-area ratio, 93 percent. It was found that 255,000 acre-feet of

Altitude (feet)	Area (acres)	Capacity (acre-feet)	
		Below lake surface	Above lake surface
600	844	231,000	
620	901	213,000	
640	940	195,000	
660	982	176,000	
680	1,020	156,000	
700	1,070	135,000	
720	1,110	113,000	
740	1,140	90,600	
760	1,190	67,200	
780	1,230	43,100	
800	1,280	18,100	
814 [1]	1,320	0	0
820	1,440		9,000
840	1,640		39,800
860	1,830		74,400
880	1,980		112,000
900	2,090		153,000
920	2,190		196,000
940	[2] 2,370		241,000
960	[2] 2,450		290,000

[1] Lake surface.
[2] Estimated in incomplete area of map.

usable capacity would have been needed to provide a uniform monthly release equal to the mean discharge, 422 cfs; and that 140,000 acre-feet woud have been needed for a uniform monthly release of 380 cfs or 90 percent of the mean discharge.

For access to the lake, a road might be constructed from the Speel River estuary about 1½ miles to a point near Long River at an altitude between 200 and 300 feet. Because of the steep slope it would be difficult to extend this up to the lake, and a short tramway might be preferable. Sand and gravel at the upstream end of the lake may be the best source of concrete aggregate, and, if so, transport by water probably would be considered since the construction of a road on the steep mountainsides would be extremely difficult.

If a dam were constructed at the Long Lake outlet, sufficient spillway capacity would be required for the maximum discharge that might occur. During the periods 1916–33 and 1952–56, the maximum recorded discharge at the gaging station 1 mile downstream from Long Lake was 6,000 cfs, in September 1927. This corresponds to the unit rate of 185 cfs per square mile.

PLANS OF DEVELOPMENT

Several alternative plans are possible, depending on whether the Long River site should be developed alone or in combination with the Speel River and Crater Creek sites.

Water could be conveyed from the Long Lake reservoir about 9,700 feet southward by way of a tunnel and penstock to a powerhouse at the edge of the tidal flats of the Speel River estuary. The powerhouse site is about a quarter of a mile west of the mouth of Glacier Creek. It was pointed out in plans described by the Federal Power Commission and U.S. Forest Service (1947, p. 68) that the powerhouse could be used commonly for the Long Lake, Crater Lake and Speel River units. The waterway from Long Lake reservoir would require 8,000 feet of tunnel and 1,700 feet of penstock. The mountainsides above the powerhouse site extend up to an altitude of nearly 5,000 feet in a distance of 2 miles, and there is a glacier on the upper part of the slope. It seems possible that snow avalanches might constitute a hazard in this region, and if so the penstock and power house might have to be constructed underground.

SPEEL RIVER POWERSITE

RESERVOIR SITE

The Speel River enters a narrow canyon half a mile downstream from the mouth of Long River, and about 8 miles upstream from the head of Speel Arm. The canyon reach, which is about half a mile long, includes the only favorable damsite on the river. Both upstream and downstream from the canyon reach the stream flows on a wide deposit of glacial materials.

The canyon sides are favorable for the abutments of a dam at a section a few hundred feet downstream from the head of the gorge where the width is 700 feet at an altitude of 300 feet, and about 1,300 feet at an altitude of 450 feet. At medium-low stages the river at this section flows in a channel that is less than 50 feet wide between steep rock sides and is at an altitude of 160 feet. There is an overflow channel about 150 feet wide along the left side of the canyon, separated from the low-water channel by a narrow rock ridge.

A dam to an altitude of 245 feet would back water up the Speel River valley roughly 6 miles, and up the Long River basin roughly 5 miles to a saddle between the basin and Speel Arm. At this place, called the Saddle damsite, an auxiliary dam would be required for flowage to a higher altitude. The saddle consists of a wide deposit of alluvium and glacial materials of unknown depth, under a cover of muskeg moss. The surface has somewhat uniform slopes on each side of the low point of the saddle up to an altitude of 300 feet, where the width is 1,200 feet. Rock is exposed in places on steeper slopes above this altitude. The width of the valley is 1,960 feet at an altitude of 450 feet. Just southwest of the saddle in the drainage area of Glacier Creek there is a sharp drop of 80 to 100 feet in a distance of 100 to 150 feet. On the other side there is a small body of water called First Lake, 200 feet northeast of the saddle, at a surface altitude of 234 feet. First Lake and Second Lake are in a short valley tributary to the Long River. The location and design of a dam might be determined somewhat by these topographic features on both sides of the saddle, particularly if bedrock is at considerable depth.

Miller (1956, p. 40) reported that the rock at Speel River damsite is of varying composition but apparently is suitable for the foundation of a masonry dam at least 160 feet in height. At the Saddle damsite it was not clear whether the abrupt slope southwest of the saddle represents a section of the valley fill or a rock formation covered with a layer of alluvium and glacial deposits. Miller classified the rock at the damsite as quartz diorite, overlain in the saddle section with alluvium or glacial fill to a depth that may be as much as 50 feet.

The potential capacity of a reservoir at the Speel River site can be determined only roughly from the available maps, which are on a scale of 1:63,360 and have a contour interval of 100 feet. The capacities and corresponding surface areas thus determined are shown below.

Altitude (feet)	Area (acres)	Capacity (acre-feet)	Altitude (feet)	Area (acres)	Capacity (acre-feet)
165	0	0	350	[1] 4,993	600,000
200	2,375	42,000	400	5,794	869,000
250	[1] 3,284	183,000	460	....	[2] 1,240,000
300	4,192	370,000			

[1] Interpolated.
[2] Estimated by extrapolation.

Water could be diverted from the reservoir at a point near the Saddle damsite, which is only 2,800 feet from the Speel River estuary. The outlet works could be located below the present surface of First Lake, and with a little excavation at the outlet of the lake the reservoir could be drawn down to an altitude of 235 feet, or about the present lake altitude. Alternatively, it would be possible to locate the outlet works at Second Lake, which is 3,900 feet from the Speel River estuary. The reservoir then could be drawn down to an altitude of about 200 feet.

With a diversion near the Saddle dam the Long River arm of the reservoir would be effective as a settling basin between the Speel River valley and the outlet works. The potential capacity of this arm of the reservoir between the surface of Indian Lake, at an altitude of 177 feet, and a crest altitude of 300 feet is about 88,000 acre-feet. Only 35,000 acre-feet would be usable capacity above an altitude of 235 feet, and 53,000 acre-feet would be dead storage above the altitude of Indian Lake. The underwater volume of Indian Lake, which has a surface area of 520 acres, probably is substantial, and this also would be effective as a catchment for sediment.

Operation schedules for the Speel River component of runoff show that a usable storage capacity of 1,100,000 acre-feet would have been required to provide for a uniform monthly release of 2,050 cfs from 1949 to 1956, or complete control of the estimated runoff exclusive of the Long River. This capacity would be available in a reservoir by drawdown from a maximum altitude of about 460 feet to 235 feet. A capacity of 730,000 acre-feet would have been required to provide for a uniform monthly release of 1,845 cfs or 90 percent of the mean flow from 1949 to 1956. It would be topographically feasible to construct dams of the required height at the Speel River and Saddle damsites, but they would be of considerable size.

It may be found that a much lesser degree of development would be preferable. For illustration of one possibility, a maximum flowage line was assumed at an altitude of 300 feet, approximately the same as in a plan for regulation proposed by the Federal Power Commission and U.S. Forest Service (1947, p. 67). A usable capacity of 234,000 acre-feet would be available by drawdown to an altitude of 235 feet, and this could have provided for a uniform monthly draft of 870 cfs from 1949 to 1956.

Any reservoir on the Speel River would trap relatively large amounts of sediment of glacial origin which is carried in suspension and as bedload. Miller (1956, p. 43) pointed out that sedimentation might seriously reduce the useful life of the reservoir. He observed that sand and gravel bars along the braided channel shift rapidly at times of high flow. Much of this material would be deposited in the upper end of a reservoir above the level of dead storage, causing a progressive reduction in the usable capacity from the outset.

Investigation may show that enough reserve capacity for sediment can be created so that the runoff could be substantially controlled over a long period. Alternatively it may be possible and desirable to operate a smaller Speel River unit essentially as a run-of-the-river plant, with only short-time regulation. Such a plan might be considered if enough storage can be economically provided in nearby reservoirs at Long Lake and Crater Lake for overall power regulation in a coordinated system of the three units.

A spillway would be required either at the Speel River or at the Saddle damsite with capacity sufficient to pass the maximum discharge that might occur. During the period of record, 1916 to 1918, the maximum discharge was estimated as 35,600 cfs. A discharge of that amount would be difficult to control on the ½-mile slope between the Saddle damsite and the Speel River estuary since there is no natural channel of substantial size. Furthermore it would be undesirable to pass the excess water over the Saddle dam because this would favor the transport of sediments into the Long River arm of the reservoir at times of maximum sediment load. For these reasons it would seem preferable to locate the spillway at the main dam on the Speel River.

PLANS OF DEVELOPMENT

Water could be conveyed by way of a tunnel and penstock from the Speel River damsite for utilization through whatever head is concentrated in the reservoir and about 120 feet that is available in the ½-mile reach of canyon downstream. This plan has two disadvantages: the Long River arm of the reservoir would not be effective for trapping sediment, and the powerhouse site is in a relatively isolated location.

A dam to a height of 75 feet or more at the Speel River site would back water up the Long River valley, covering First Lake near the Saddle damsite. Water could be conveyed southeastward from that point through about half a mile of tunnel and a short penstock for utilization down to the edge of the Speel River estuary. The shortest route is to a point about half a mile northeast of the mouth of Glacier Creek. Alternatively, water could be conveyed southwestward about 1 mile to the site west of the mouth of Glacier Creek which has been proposed for a common powerhouse of the Speel River, Long River, and Crater Creek units. Since relatively large waterways would be required for substantial utilization of Speel River water, the advantage of a common powerhouse might be largely offset by the increased distance for conveyance.

Miller (1956, pl. 3) reported that the rock is quartz diorite along each of the three possible tunnel routes.

CRATER CREEK POWERSITE

RESERVOIR SITE

Crater Lake at its outlet is only ¾ mile from the Speel River estuary and is at an altitude of 1,022 feet. A considerable amount of storage capacity could be developed there by construction of a dam at the outlet, by drawdown, or by a combination of the two methods. The lake extends about 2 miles southwest from its outlet between steep mountainsides. It is drained by Crater Creek, which flows eastward in a series of cascades about 1 mile to the Speel River estuary. (See fig. 11.)

The sides of the canyon just downstream from the outlet are topographically suitable as abutments for a dam to at least 200 feet above the lake surface. The width of the canyon at that altitude is about 500 feet. The creek drops 50 feet in a distance of 200 feet from the lake outlet, and 30 feet of that drop is within the first 50 feet of distance. The rock on the north side of the creek also slopes sharply downstream from a narrow ridge at the outlet section. Because of these topographic features

FIGURE 11.—Aerial view of damsite at the outlet of Crater Lake, showing Speel Arm in background. The mouth of Crater Creek is left of and inshore from the wooded area at left center.

the site may be more suitable for an arch dam or buttressed dam than the gravity type.

Miller (1956, p. 23) found that the rock at the damsite is quartz diorite broken by vertical joints or fractures transverse to the direction of streamflow.

The potential storage capacities and corresponding surface areas for a range of altitudes above and below the lake surface at Crater Lake are shown below.

Storage requirements for regulation were determined from reservoir schedules for the 20 years of recorded and estimated runoff, considered as a consecutive series. These show that 142,000 acre-feet of capacity would have been required to provide uniform monthly releases equal to the mean discharge, 184 cfs; and that 71,000 acre-feet would have been required for a uniform monthly release of 165 cfs, or 90 percent of the mean discharge.

A capacity of 142,000 acre-feet could be developed entirely by damming. It could possibly be developed entirely by drawdown through an estimated range of some 400 feet, but the increased plant requirements and the large reduction in head make this plan seem impracticable. A capacity of 71,000 acre-feet could be developed entirely by damming or entirely by drawdown.

Construction of an access road from the Speel River estuary to Crater Lake would be very difficult, and investigation may

Altitude (feet)	Area (acres)	Capacity (acre-feet)	
		Below lake surface	Above lake surface
800	320	89,100	
820	338	82,500	
840	353	75,600	
860	363	68,400	
880	376	61,000	
900	392	53,400	
920	410	45,300	
940	423	37,000	
960	436	28,400	
980	447	19,600	
1,000	465	10,500	
1,022 [1]	503	0	0
1,040	570		9,600
1,060	633		21,700
1,080	675		34,800
1,100	723		48,800
1,120	764		63,600
1,140	792		79,200
1,160	818		95,300
1,180	847		112,000
1,200	885		129,000

[1] Lake surface.

show that a tramway would be needed for transport of construction equipment and materials. Sand and gravel suitable for concrete aggregate may be available in the creek valley at the upper end of the lake but, as at Long Lake, transport to the damsite would be impracticable except by water.

The required spillway capacity at the Crater Creek dam would be in excess of 3,100 cfs, a maximum which was recorded in September 1927. This corresponds to the relatively high unit rate of 260 cfs per square mile.

PLANS OF DEVELOPMENT

Water could be conveyed from Crater Lake 4,200 feet southeastward on the shortest route to a powerhouse site at tidewater. This is at a point 2,000 feet southwest of the mouth of Crater Creek and 2,000 feet northeast of a cove at the head of the Speel Arm. About equal lengths of tunnel and penstock would be required for drawdown to an altitude of about 850 feet.

Alternatively, water could be conveyed eastward to the site for a common powerhouse through about 1¼ miles of tunnel and ¼ mile of penstock. (Conveyance to this site from Long Lake, the Speel River reservoir, and Crater Lake would require an aggregate of more than 4 miles of waterway, whereas less than

2 miles would be required for conveyance to 3 individual powerhouses.)

Miller (1956, p. 26) reported that both tunnel routes would intersect joint systems in the quartz diorite.

LONG RIVER, SPEEL RIVER, AND CRATER CREEK SITES, COORDINATED DEVELOPMENT

The potential power available 100 percent of the time at the Long River, Speel River, and Crater Creek powersites is about 86,000 kw with development by combined damming and drawdown at the lakes, and with substantially complete control of the runoff in periods like 1949 to 1956. The power available 100 percent of the time with control of 90 percent of the runoff in such periods is about 72,000 kw. More than half of these totals are due to the Speel River site where two large dams would be required for either degree of regulation.

If provision for such regulation proves to be impracticable it still would be possible to utilize a considerable part of the Speel River flow in a system of the three plants designed for coordinated operation. For example, the Speel River reservoir might be constructed to a maximum altitude of 300 feet and operated only for short-time regulation with nearly all of the capacity reserved for sedimentation. With usable capacities of 250,000 acre-feet and 150,000 acre-feet at Long Lake and Crater Lake, respectively, the 3 plants could have been operated for a continuous generation of 58,000 kw. This was determined by an operation schedule through the dry 1952 water year, with the maximum draft on the Speel River reservoir limited to 3,000 cfs, and with all of the load carried by the Speel River powerhouse in months when the inflow equaled or exceeded that amount. A total plant capacity of 100,000 kw would have been required to carry an average load of 58,000 kw, but most of the excess capacity would have been available for daily peaking.

POTENTIAL POWER OF SITES NEAR GILBERT BAY AND SPEEL ARM OF PORT SNETTISHAM

The potential power of the upper unit of the Sweetheart Creek site and of the Tease Lake and Crater Creek sites was estimated on the assumption that the head below the mean reservoir levels would be developed down to the levels of impulse wheels. At the Sweetheart Creek site this was assumed to be at an altitude of 700 feet, or a little above the assumed maximum flowage line of a reservoir that might be created at Lower Sweetheart Lake.

At the other sites the wheel level was assumed to be at an altitude of 17 feet, a few feet above the level of the highest expected tide.

The available heads at the lower unit of the Sweetheart Creek site and at the Long River and Speel River sites are less than a thousand feet, and thus development by means of reaction turbines and draft tubes would be appropriate. At these sites it was assumed that the head would be developed from the mean reservoir levels to the average level of tailwater. This was taken to be mean sea level at the Sweetheart Creek site and 8 feet above mean sea level at the other sites, where the tailwater level may be determined by the level of mudflats in the Speel River estuary.

In one of several possible schemes, the potential power of the Long River might be developed in two stages, with the tailwater of the first stage at the prospective Speel River reservoir. In that event the overall head would be reduced by drawdown in that reservoir. The potential power of the Long River site as listed in following tables corresponds only to full use of the available head without the reduction that would result from routing the water through the prospective Speel River reservoir.

If the storage for full control at Upper Sweetheart Lake were developed entirely by drawdown, the mean head would be 1,116 feet, the operating range 1,865 feet to 1,760 feet, and the continuous power about 2,600 kw. Drawdown of Lower Sweetheart Lake and Tease Lake was not considered.

	Upper Sweetheart Lake		Lower Sweetheart Lake		Tease Lake
Controlled flow...percent of mean flow	100	90	100	90	80
Controlled flow...cfs	35	31	334	301	100
Mean head...ft	1,202	1,184	619	582	[1] 1,033
Storage capacity...acre-ft	25,000	12,000	220,000	102,000	[1] 28,000
[2]Height of dam...ft	69	36	140	71	74
Operating range...alt (ft)	1,865–1,934	1,865–1,901	544–684	544–615	1,006–1,080
Continous power...kw	2,860	2,500	14,100	11,900	7,000

[1] Estimated.

[2] Above lake level.

Potential power and related data for the Long River, Speel River, and Crater Creek sites is shown below. The storage is provided by damming and drawdown except on the Speel River.

	Long River		Speel River		Crater Creek	
Controlled flow... percent of mean flow....	100	90	100	90	100	90
Controlled flow...cfs...	422	380	2,050	1,845	184	165
Mean head...ft........	[1] 806	[1] 806	360	322	[1] 1,005	[1] 1,005
Storage capacity... acre-ft..............	255,000	140,000	1,100,000	730,000	142,000	71,000
Height of dam...ft.....	[2] 74	[2] 44	[3] 300	[3] 240	[2] 108	[2] 60
Operating range... alt (ft)..............	888 707	858 758	460 235	400 235	1,130 853	1,082 853
Continous power...kw..	23,100	20,800	50,200	40,400	12,600	11,300

[1] With the storage equally divided above and below the lake surface.
[2] Above lake level.
[3] Height of main dam above stream level.

The potential power and related data on the Long River and Crater Creek with storage developed by damming alone and by drawdown alone are summarized below for comparison.

	Long River		Crater Creek	
Controlled flow...percent of mean flow.....	100	90	100	90
Controlled flow cfs........................	422	380	184	165
Height of dam [1]...ft....................	133	80	190	108
Operating range with dam...alt (ft)........	947 814	894 814	1,212 1,022	1,130 1,022
Operating range with drawdown...alt (ft)...	814 575	814 695	([2])	1,022 853
Continuous power with dam...kw..........	25,300	22,000	14,000	12,000
Continuous power with drawdown...kw....	20,100	19,400	([2])	10,400

[1] Above lake level.
[2] Drawdown considered impracticable.

LOCATIONS AT WHICH POWER COULD BE USED

A suitable industrial site for use of power from the Sweetheart Creek site and the sites near Speel Arm may be a flat area 1 mile from the mouth of Sweetheart Creek, extending about 3½ miles southeast between Gilbert Bay and Tracy Arm. At present [1959] this is entirely undeveloped. Power from the sites at Speel Arm could be transmitted to this area over a distance of about 18 miles including a ¾-mile span across the Speel Arm and a ¾-mile span across the Whiting River.

The neck of land is about ¾ mile wide and slopes gradually from an altitude of 100 feet near Tracy Arm to the tidal flat of Gilbert Bay. About a third of it at the end near Gilbert Bay is marshy. The U.S. Forest Service (1957) made a field examination and found that much of the area appears suitable for location of a sizable industry, but recommended that geologic and other examinations be made before it is seriously considered for development.

Some water is available from natural flows of streams draining from the mountainsides on each side across the flat area, and some possibly could be obtained from ground water. A large supply of dependable water could be obtained if a reservoir is created at Lower Sweetheart Lake. Some storage there for a water supply probably would be essential to a sizable industrial development on Sweetheart Flats. Water could be diverted from Sweetheart Creek below the reservoir or from the waterway of a powerplant, sacrificing some of the potential power.

A plan of development for Long Lake and Crater Lake was suggested by Dort (1924, p. 81–88) in which a common powerhouse would be located a quarter of a mile west of the mouth of Glacier Creek. Land adjacent to this place was described as suitable for an industrial site. A tract of at least 50 acres within 2,000 feet of the mouth of Glacier Creek appears to be topographically suitable for location of structures. All of this area is below an altitude of 200 feet and most of it is below an altitude of 100 feet. Supplies of industrial water could be obtained by diversion from the penstocks above the powerhouse at sacrifice of some of the potential power.

Some disadvantages of the location are that the Speel River estuary is separated by mudflats from the deep water of Speel Arm, that terrain suitable for expansion of industries and settlements is very limited, and that there may be a possibility of slides from the nearby mountainsides.

In 1926 an applicant to the Federal Power Commission proposed transmission of power from Long Lake and Crater Lake to the vicinity of Juneau. The transmission system would have included a submarine cable across Taku Inlet and would have served in part for transmission of power from the Lake Dorothy site, the development of which also was proposed by the applicant. A location for crossing Taku Inlet, as suggested by the U.S. Army Corps of Engineers (1952, p. 133) and the U.S. Bureau of Reclamation (1955, p. 39), is near the mouth of Dorothy Creek where the width is less than 2 miles. If the transmission line were located near the waterways for the entire distance, the length of the route from the Long River site to Juneau would be about 51 miles. This could be reduced about 10 miles by a shortcut accross the mountainous peninsula between Port Snettisham and Slocum Inlet of Stephens Passage.

A powerplant at the Tease Lake site could be interconnected with plants at the Long River, Speel River, and Crater Creek sites by means of roughly 4 miles of transmission line including a ½-mile span across the Speel River. The lower unit of the Sweetheart Creek site could be interconnected with the Speel Arm plants by about 11 miles of transmission line joining the proposed Juneau line on the west side of Port Snettisham, 5 miles southwest of Crater Creek. This would include ¾-mile spans across both the Whiting River and Port Snettisham, and the overall distance for transmission to Juneau would be about 7 miles more than from the Long River site.

Juneau is located in part on steep slopes below a mountainside, but it has the considerable advantage of an existing community with harbor facilities and other utilities. Suitable terrain for expansion is available on the mainland a few miles northwest of the municipal area, or on nearby Douglas Island.

The domestic water supply of Juneau is obtained in part by diversion of some of the natural flow of Gold Creek. The average discharge of the stream is 104 cfs, but conditions are not favorable for development of storage for regulation. Nearby Salmon Creek has a drainage area and runoff that are about the same as that of Gold Creek. Part of the flow is controlled for power purposes at the reservoir of the Alaska Juneau Gold Mining Co. It would be possible to use regulated flow for an industrial water supply by diversion above the lower unit of the Salmon Creek powerplant.

Lemon Creek, which is about 2 miles northwest of Salmon Creek and about 4 miles northwest of Juneau, also might be considered for water supplies in connection with power development. Two sites on this creek were described by the Federal Power Commission and U.S. Forest Service (1947, p. 74) at which storage could be created for partial control of the stream. Streamflow records collected from 1951 to 1956 and precipitation records at Juneau show that the long-term mean discharge may be about 140 cfs. An applicant to the Federal Power Commission in 1955 proposed development of both storage sites for power purposes, with the tailwater of the lower unit at an altitude of 30 feet. An area of several hundred acres lies between that level and the tidal mudflats of Gastineau Channel. The proposed use of the power was for operation of a prospective newsprint mill or pulp mill to be located on the northwestern end of Douglas Island where there is a good harbor.

Water supplies could be obtained on Douglas Island from runoff of creeks, but the winter flow would be small. Supplemental supplies would have to be obtained from ground water on the island if enough is available, or from regulated sources on the mainland, to provide a substantial and dependable supply of industrial water.

SITES IN TAKU INLET AND GASTINEAU CHANNEL AREA

MAPS

A map entitled "Plan and Profile, Sheep Creek and Carlson Creek near Juneau, Alaska, Miscellaneous Dam Sites" was published by the Geological Survey in 1953. The scale of the plan map is 1:24,000 and the contour intervals are 20 and 40 feet. Maps of damsites on Carlson, Sheep, and Turner Creeks, are on a larger scale with a contour interval of 10 feet.

The powersites and their related drainage areas are shown on the topographic maps of the Juneau A–1, B–1, and B–2 quadrangles; Taku River A–6 and B–6 quadrangles; and the Taku River and Juneau quadrangles of the Reconnaissance Topographic Series. Except for the reconnaissance series, these maps were compiled by the Geological Survey from 1949 to 1952 on a scale of 1:63,360 and with contour interval of 100 feet. The reconnaissance maps were published by the Geological Survey in 1953 on a scale of 1:250,000 and with contour intervals of 200, 250 and 500 feet. They show the system of waterways and topography of a large area in the general vicinity of Juneau. In addition to the maps of the regular topographic series there is a special topographic map entitled "Juneau and Vicinity" which includes the area at Juneau, the Sheep Creek basin, and a part of the Carlson Creek basin. The scale is 1:24,000 and the contour interval is 40 feet.

A map of the Dorothy Creek basin prepared for the Bureau of Reclamation has been compiled on a scale of 1:7,200 and with a contour interval of 20 feet. Copies are available for examination in files of the Bureau of Reclamation or of the Geological Survey.

A map of a damsite on Carlson Creek at Mile 2.3 (distance from the mouth of the stream measured along mapped channel) was prepared by the Alaska Gastineau Mining Co. in 1920. The original scale was 1 inch equals 40 feet or 1:480, with a contour interval of 40 feet. Photostatic copies are available for examination in files of the Forest Service or of the Geological Survey.

Soundings in Taku Inlet, Gastineau Channel, and a part of Stephens Passage are shown on Chart 8235 of the U.S. Coast and Geodetic Survey. The chart is on a scale of 1:40,000, and the soundings are in fathoms.

LOCAL GEOGRAPHY AND TOPOGRAPHY

Taku Inlet extends northward from the northern end of Stephens Passage about 17 miles to the Taku River estuary. Most of the Taku River is in Canada, and there are no apparent power possibilities on the 20-mile reach of river channel in Alaska.

FIGURE 12.—Aerial view of mountains between Port Snettisham and Taku Inlet along a possible transmission-line route. Gastineau Channel and Taku Inlet in background. (U.S. Forest Service photograph; June 22, 1929.)

FIGURE 13.—Aerial view of Taku Inlet. The rock cliff at right center is just beyond the mouth of Dorothy Creek, and the Taku tidal glacier is visible beyond the cliff.

Steep mountainsides extends down to Taku Inlet except at the mouths of tributaries and at Norris Glacier and Taku Glacier, which flow from the northeast into the inlet near its upper end (see figs. 12, 13). Along the Taku River upstream there are strips of flat land below an altitude of 200 feet that aggregate more than 20 square miles. A land survey has been made of a part of this terrain, and there has been some recreational development and a few homestead entries. Access is dependent on boats or barges of shallow draft.

If there should ever be settlement or industrial activity along the Taku River justifying power development, powersites on Boundary Creek and Yehring Creek might be considered. Boundary Creek joins the Taku River from the north, just downstream from the international boundary, at a river altitude of about 70 feet; and Yehring Creek joins the river from the south about 6 miles farther downstream. The power possibilities have been discussed by the Federal Power Commission and U.S. Forest Service (1947, p. 70) on the basis of a reconnaissance of damsites on Boundary Creek and photographs and preliminary maps of Yehring Creek. The average potential was estimated to be 9,000 hp (equivalent to 6,710 kw) on Boundary Creek and 14,500 hp (equivalent to 10,800 kw) on Yehring Creek, but the possibilities for storage regulation are limited.

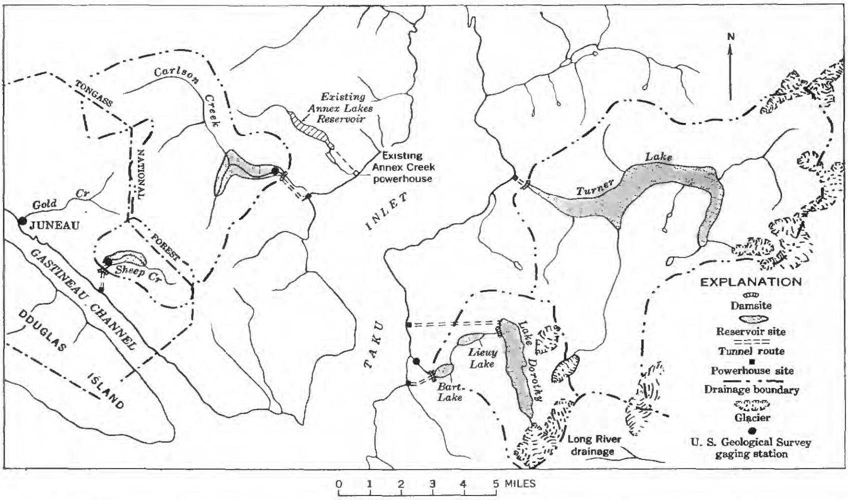

FIGURE 14.—Map of powersites in the Taku Inlet and Gastineau Channel area, Alaska.

Three of the four powersites discussed in this section are on streams tributary to Taku Inlet; Dorothy Creek and Turner Creek are on the east side and Carlson Creek on the west side. The other site is on Sheep Creek, which is tributary to Gastineau Channel about 3 miles southeast of Juneau and about 6 miles northwest of the mouth of Taku Inlet. (See fig. 14.)

All the stream basins are in mountainous terrain, with altitudes ranging up to 4,000 feet or more, but that of Dorothy Creek has a notable concentration of area at relatively high altitude. Lake Dorothy, at an altitude of 2,421 feet, could be developed for control of nearly 80 percent of the runoff of the entire basin.

There is a road from Juneau to the mouth of Sheep Creek along Gastineau Channel but because of the steep terrain, extension of this road to the mouth of Carlson Creek some 16 miles for access to the powersite would be costly. Construction of a road from Sheep Creek around the head of Taku Inlet would be entirely out of the question, not only because of the distance along steep mountainsides but also because the route crosses the two large glaciers and the wide estuary of the Taku River. Dorothy Creek and Turner Creek are within about 25 miles of Juneau by water.

Except on Sheep Creek there has been no substantial development or settlement in the stream basins of the four powersites. A hydroelectric plant on Sheep Creek is described in the section "Developed Power." Existing structures in the upper part of the Sheep Creek basin include mine buildings, aerial trams, and a transmission line.

The powerhouse of the Annex Creek hydroelectric plant described in the section "Developed Power" is about 2 miles northeast of Carlson Creek. Energy from this plant is transmitted 15 miles to Juneau by a line that crosses part of the Carlson Creek and adjacent Sheep Creek basins.

WATER SUPPLY

RECORDS OF STREAMFLOW

Gaging stations have been maintained on Dorothy, Turner, Carlson, Sheep, and Gold Creeks as shown below. The records for Gold Creek were used for comparative purposes.

Gaging station	Drainage area (square miles)	Period of record [1]
Dorothy Creek near Juneau	15.2	Oct. 1929 – Oct. 1941. Sept. 1942 – Dec. 1943. June 1944 – Sept. 1956.
Turner Creek at Taku Inlet	53.1	May 1908 – Mar. 1909.
Carlson Creek at Sunny Cove, near Juneau	.... 22.3 24.3	Jan. 1914 – Sept. 1914. Oct. 1915 – Dec. 1915. July 1916 – Dec. 1920. July 1951 – Sept. 1956.
Sheep Creek near Juneau	.... 4.30	Jan. 1911 – Dec. 1913. Aug. 1916 – Dec. 1920. Oct. 1946 – Sept. 1956.
Gold Creek at Juneau	9.76 10.3 9.76	Aug. 1916 – Dec. 1920. Oct. 1946 – Sept. 1948. Oct. 1949 – Sept. 1956.

[1] To September 1956.

Except for those of Turner Creek, the monthly and annual records through September 1956, and daily discharge records for Dorothy Creek from October 1945 through September 1956, and for Sheep Creek from October 1946 through September 1956 have been published by the Geological Survey (1957, 1958a, b). The monthly record for Turner Creek was published by the Federal Power Commission and U.S. Forest Service (1947, p. 125) as of unknown accuracy. The record was obtained by the Alaska Treadwell Mining Co. in its investigation of the powersite.

Recorded figures of monthly runoff from the brief Turner Lake record are listed herein under the section on the runoff at Turner Lake outlet. Some monthly runoff figures for Dorothy Creek, as rounded from the records, and some estimates for the Sheep Creek and Carlson Creek damsites are given in tables 7–9.

TABLE 7.—*Monthly and annual runoff, in thousands of acre-feet, Dorothy Creek near Juneau, Alaska*

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Annual
1930	21.0	9.0	4.0	0.7	0.7	1.3	2.9	4.6	11.7	20.3	22.9	16.8	115.9
1931	12.0	11.5	6.2	2.9	3.9	1.4	2.0	7.2	19.6	19.1	22.2	17.9	125.9
1932	12.9	3.8	1.0	1.1	.8	.8	1.6	4.3	14.9	17.8	17.3	16.3	92.6
1933	13.2	2.5	1.4	1.2	.9	.6	1.3	5.3	8.9	15.4	16.5	10.9	78.1
1934	10.4	9.4	2.0	.6	.7	.9	1.2	3.7	14.9	17.0	25.0	14.9	100.7
1935	13.2	4.9	3.3	1.0	.6	1.1	1.1	3.3	9.8	24.3	18.8	12.1	93.5
1936	12.4	3.4	5.1	1.1	.7	1.2	2.1	6.7	18.9	18.4	16.7	21.2	107.9
1937	28.0	16.9	7.0	1.5	.8	1.4	1.6	4.1	17.7	15.4	18.4	20.2	133.0
1938	23.6	5.1	3.0	2.6	2.1	4.2	1.3	7.7	12.2	17.2	15.1	23.3	117.4
1939	14.3	4.4	3.4	2.0	1.3	1.1	1.4	4.5	13.4	21.0	26.8	15.3	108.9
1940	15.9	8.4	4.6	1.6	1.9	1.0	2.2	7.1	12.9	19.7	24.8	18.8	118.9
1941	13.7	4.2	2.0	1.1	1.3	1.4	3.2	5.8	15.0	19.9	13.3	8.8	89.7
1943	15.5	3.2	1.9	2.3	1.1	2.5	3.7	5.8	13.5	23 6	20.8	22.8	116.7
1945	19.7	8.3	5.2	1.2	.8	1.5	1.6	7.2	14.5	20.3	16.1	18.4	114.8
1946	24.5	2.8	1.2	.9	.8	1.1	1.1	8.6	16.8	16.3	20.4	13.7	108.2
1947	11.9	7.7	1.6	1.4	1.0	5.3	2.8	7.3	16.6	16.3	14.9	22.8	109.6
1948	13.0	5.3	3.9	2.2	1.1	1.0	.8	8.2	19.1	18.7	16.8	23.0	113.1
1949	10.0	7.3	2.3	1.9	.8	1.1	1.7	7.1	12.3	16.7	18.9	16.5	96.6
1950	10.6	21.1	2.2	.8	.6	.7	.8	4.5	12.9	17.7	15.4	18.0	105.3
1951	6.0	1.9	.9	1.1	.8	1.0	1.4	5.6	16.7	19.8	13.3	13.5	82.0
1952	8.9	2.7	1.4	1.1	1.0	.9	1.3	5.0	10.7	18.8	17.8	19.9	89.5
1953	20.1	9.4	2.0	1.2	1.1	1.3	1.4	7.2	14.8	19.5	20.5	16.9	115.4
1954	14.5	5.5	1.9	1.6	3.6	1.6	1.0	4.0	11.8	14.8	12.2	14.4	86.9
1955	8.3	6.8	4.4	1.7	1.0	1.2	1.2	3.8	9.9	20.0	20.9	15.0	94.2
1956	7.2	3.2	1.3	.7	.6	.9	1.2	6.8	10.2	18.6	27.1	14.3	92.1
Mean	14.4	6.7	2.9	1.4	1.2	1.5	1.7	5.8	14.0	18.7	18.9	17.0	104.3

TABLE 8.—*Monthly and annual runoff, in thousands of acre-feet, Carlson Creek at damsite near Juneau, Alaska*

[1917–20, from records for a drainage area of 22.3 square miles; 1947–51, estimated from records of adjacent basins (to June 1951); 1951–56, estimated for a drainage area of 22.3 square miles from records for 24.3 square miles]

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Annual
1917	28.0	7.3	3.6	3.1	4.4	2.5	3.6	23.0	41.9	52.1	51.5	35.8	256.8
1918	29.9	28.9	3.9	4.1	1.0	.7	2.7	17.3	46.4	46.9	45.4	37.7	264.9
1919	22.1	16.1	7.7	8.4	1.6	1.2	5.7	20.1	34.6	42.3	38.1	36.7	234.6
1920	25.3	7.7	6.5	6.8	2.4	1.1	1.5	14.8	43.1	42.2	45.1	24.6	221.1
1947	28.6	33.2	3.1	3.1	1.7	22.8	15.0	28.8	35.9	29.9	28.1	45.0	275.2
1948	23.4	22.6	8.2	6.8	2.5	1.3	1.5	36.8	31.6	35.4	19.1	38.4	227.6
1949	28.5	29.0	3.4	3.0	1.6	3.6	6.9	26.0	54.0	50.0	48.5	28.5	283.0
1950	34.2	32.8	3.8	1.5	1.0	1.0	1.3	17.2	33.6	34.0	20.6	25.8	206.8
1951	12.3	5.3	1.8	1.5	1.0	1.0	4.0	30.2	42.0	29.6	17.2	15.4	161.3
1952	14.9	6.4	2.8	1.0	.8	1.5	5.1	20.8	37.9	41.5	32.0	39.6	204.3
1953	43.0	19.2	6.8	2.1	1.5	.7	5.6	28.6	39.8	29.8	28.0	27.9	233.0
1954	39.1	6.3	6.9	2.4	9.6	1.8	1.6	18.2	36.0	31.6	15.9	24.4	193.8
1955	20.2	20.2	16.6	4.2	2.4	1.9	2.5	15.4	35.6	46.1	47.4	29.4	241.9
1956	15.5	8.7	1.6	1.2	1.2	1.0	3.0	30.4	30.5	34.2	43.2	20.8	191.3
Mean	26.1	17.4	5.5	3.5	2.3	3.0	4.3	23.4	38.8	39.0	34.3	30.7	228.3

RUNOFF AT LAKE DOROTHY, LIEUY LAKE, AND BART LAKE

Dorothy Creek heads at an altitude of 2,421 feet in Lake Dorothy, which is the major storage site of the basin and could be used for complete control of the runoff at the lake. The drainage area is 11.0 square miles or approximately 72 percent of that at

TABLE 9.—*Monthly and annual runoff, in thousands of acre-feet, Sheep Creek at damsite near Juneau, Alaska*

[1911–20, rounded from the gaging station records which for that period approximately represent the runoff at the damsite; after 1920, estimates of the runoff at the damsite based in records for upstream points]

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Annual
1911	......	......	......	0.60	0.48	0.42	0.30	2.70	5.50	5.70	4.60	2.40	....
1912	3.80	1.20	2.10	.59	1.15	.73	1.20	5.73	4.30	2.95	2.87	2.87	29.49
1913	2.70	1.21	1.80	.73	1.01	.95	1.93	4.05	4.05	5.20	4.05	3.60	31.28
1917	5.16	1.92	.91	.35	1.09	.57	.55	3.69	5.37	6.11	5.93	5.02	36.67
1918	5.52	6.37	1.13	.63	.38	.26	.35	3.91	6.13	4.26	5.31	4.55	38.80
1919	4.01	3.74	2.32	1.82	.44	.30	1.51	3.78	5.16	5.92	4.69	5.46	39.15
1920	5.34	1.68	1.08	2.06	.89	.60	.46	2.93	6.90	5.26	5.16	3.31	35.67
1947	4.67	4.81	.79	.77	.47	2.72	2.80	5.92	5.67	4.28	3.84	8.67	45.41
1948	5.15	4.99	1.66	1.30	.74	.40	.26	6.00	5.37	6.25	3.39	6.55	42.06
1949	4.98	5.92	.85	.78	.44	.88	1.59	5.73	8.05	6.28	6.07	4.17	45.74
1950	5.66	5.49	1.16	.49	.31	.30	.42	3.52	4.46	4.75	3.39	4.26	34.21
1951	2.56	1.39	.59	.60	.28	.29	1.18	5.86	7.41	4.56	2.82	2.37	29.91
1952	2.28	1.81	1.08	.50	.39	.42	1.02	5.28	6.96	6.13	4.21	6.52	36.60
1953	6.21	4.23	1.52	.82	.67	.45	1.51	6.16	5.70	4.81	4.51	4.72	41.31
1954	6.42	1.74	1.62	.91	1.15	.52	.42	3.14	4.96	4.22	2.07	2.76	29.93
1955	3.72	3.61	3.16	1.13	.71	.62	.62	2.88	5.77	5.31	6.48	4.17	38.18
1956	3.27	1.75	.55	.32	.27	.27	.49	6.33	4.56	4.13	6.07	3.45	31.46
Mean	4.47	3.24	1.40	.85	.64	.63	.98	4.56	5.67	5.06	4.38	4.40	36.62

the gaging station. Because of the high altitude, the area above the lake undoubtedly has proportionately greater runoff than the average for the basin and proportionately more summer runoff and less winter runoff. The U.S. Bureau of Reclamation (1955, p. 28) estimated a monthly distribution which seems reasonable and is used herein. It is roughly consistent with three measurements of the Geological Survey made during the high-water season of 1954 at Lake Dorothy outlet, each of which showed more than 90 percent of the corresponding flow at the gaging station. The estimated runoff at the Lake Dorothy outlet, in percent of runoff at the Dorothy Creek gaging station, is shown below.

Oct.	.85	Jan.	.35	April	.35	July	.85
Nov.	.75	Feb.	.35	May	.60	Aug.	.85
Dec.	.50	Mar.	.35	June	.80	Sept.	.85

The mean discharge at the gaging station was 144 cfs during the 25 water years of record between 1929 and 1956. The mean discharge at Lake Dorothy outlet for runoff in accordance with the estimated monthly relationships was 112 cfs or about 78 percent of that at the gage.

There are two small lakes along the course of Dorothy Creek downstream from Lake Dorothy; Lieuy Lake, formerly called Lake Veronica, and Bart Lake, formerly called Lake Mary. Their altitudes are 1,706 feet and 996 feet respectively, as determined for the special map of the Dorothy Creek basin. The Federal Power Commission and U.S. Forest Service (1947, p. 69) pointed out that each of these lakes could be used as diversion points for utilization of intervening runoff below Lake Dorothy. The drainage area between Lake Dorothy and Lieuy Lake is 1.4 square miles and that between Lake Dorothy and Bart Lake is 3.7 square miles. These areas are about 13 percent and 34 percent respectively of the area tributary to Lake Dorothy, but since they are at lower altitudes the amounts of runoff are assumed to be only 10 percent and 25 percent of that at Lake Dorothy. The percentages correspond to increments of 11 cfs at Lieuy Lake and 28 cfs at Bart Lake, above the mean discharge at Lake Dorothy.

RUNOFF AT TURNER LAKE OUTLET

The former gaging station on Turner Creek was 600 feet downstream from the outlet of Turner Lake and ½ mile from the mouth of the creek at Taku Inlet. The figures of monthly runoff, rounded from those published by the Federal Power Commission and Forest Service are shown below.

Date	Runoff (thousands of acre-feet)	Date	Runoff (thousands of acre-feet)
1908		*1908*—Con.	
May	15.6	October	40.0
June	43.7	November	17.6
July	49.5	December	15.1
		1909	
August	43.7	January	8.9
September	50.6	February	5.0
		March	6.5
		Total	296.2

The precipitation recorded during the winter of 1907–08 was substantially more than during the winter of 1908–09 at several stations in southern and southeastern Alaska. As nearly as can be judged from these early records the precipitation during the 1907–08 water year was only slightly more than normal. Thus the mean annual runoff at Turner Lake outlet is at least 300,000 acre-feet, corresponding to 106 inches on the drainage area of 53.1 square miles, or to a mean discharge of about 410 cfs. The Dorothy Creek drainage basin of 15.3 square miles is just to the southwest of the Turner Creek basin. The mean discharge of 144 cfs for the 25 years of record between 1929 and 1956 corresponds to 119 inches on that drainage area.

RUNOFF AT CARLSON CREEK DAMSITE

A reservoir could be created along Carlson Creek and its tributary, Sheep Fork, by a dam at Mile 1.8 or alternatively at Mile 2.3. The gaging station on Carlson Creek prior to 1921 was at about Mile 2.0, where the drainage area is 22.3 square miles; and the present station started in July 1951 is at Mile 1.5, where the drainage area is 24.3 square miles. The runoff at the reservoir site is assumed to be the same as the recorded runoff from 1914 to 1920, and the same as the recorded runoff times the drainage-area ratio, 0.92, from July 1951 to September 1956.

The records do not cover the 1950 and 1951 water years which are part of a period of generally subnormal precipitation and runoff extending through 1956. Figures of monthly runoff were estimated for the period from October 1946 to June 1951 and used with the records and adjusted records to provide a more representative sequence for the estimation of storage and power possibilities. Except for the 1949 water year, the estimates were based on the recorded runoff of Gold Creek at Juneau and the average relationship that existed between the adjusted monthly runoff of Carlson Creek and the monthly runoff of Gold Creek for the period of overlapping records, July 1951 to September 1956. The Gold Creek basin is adjacent to the Carlson Creek basin, and the monthly distribution of runoff in the two basins is closely similar. The figures for the 1949 water year, were estimated from monthly runoff of Sheep Creek and the relationships that existed between Sheep Creek and Carlson Creek in periods of overlapping records.

RUNOFF AT SHEEP CREEK DAMSITE

The only reservoir site on Sheep Creek is a valley extending from a damsite at Mile 1.0 upstream to about Mile 3.0. The drainage area at the damsite is approximately 4.6 square miles, and that at the gaging station about at Mile 1.4 is 4.30 square miles. The intervening drainage area is 7 percent of that at the gage but probably is proportionately less productive than upper parts of the basin.

The records for the period 1916–20, and presumably from 1911 to 1913, were based on measurements made 0.3 mile below the gage, near the damsite, and include some inflow that evidently is largely from water that passes the gage underground. As described by Plafker (1956, p. 15) the floor of the Sheep Creek valley is formed by moderately well sorted sand, granules, pebbles, and cobbles with subordinate amounts of talus. Four comparative sets of discharge measurements, as shown below, give an indication of the magnitude of the bypass flow during months of low flow.

Date	Flow (cfs)	
	At gage	0.3 mile below gage
February 25, 1918	0	5.6
March 20, 1919	0	4.5
April 15, 1920	0	5.7
February 9, 1951	.5	5.9

According to these measurements an average flow of about 5.3 cfs returns to the channel between the gage and the damsite, and must originate largely from the drainage area above the gage, which is 93.5 percent of that at the damsite. A uniform flow of 5.3 cfs throughout the year would correspond to about 12 percent of the mean annual runoff at the gage.

The records for the period 1946–49 were based on measurements made 0.1 mile below the gage, and after 1949 the records are of runoff at the gage. The minimum monthly discharge as recorded in several months at the gage is zero, as compared with a minimum of 4.2 cfs prior to October 1920 when measurements were made near the damsite.

The runoff at the damsite was approximately the same as the runoff recorded before 1921. During the 1947–49 water years, it was assumed that there was a uniform ground-water return between the measuring section and the damsite equivalent to 8 percent of the recorded annual runoff, and a surface-water inflow equal to 4 percent of the recorded runoff during the months May to November. The surface-water inflow was estimated in the same way for the 1950–56 water years, but it was assumed that the ground-water inflow over the longer channel reach from the gaging station to the damsite was equivalent to 12 percent of the annual runoff. The monthly runoff as recorded and estimated for the damsite is listed in table 9.

The runoff as estimated is about 16 percent more at the damsite than at the gage from 1950 to 1956. The ratio of this amount to that measured near the damsite during the 1917 to 1920 water years is 1.62. The ratio of recorded amounts of runoff on nearby Gold Creek in the same two periods was approximately the same, 1.63. This correspondence indicates that the Sheep Creek estimates probably are not greatly in error.

The mean discharge at the Sheep Creek damsite for 16 water years between 1911 and 1956 is estimated as 50.5 cfs.

DOROTHY CREEK POWERSITE

RESERVOIR SITES

Lake Dorothy is 2.7 miles from the tidewater of Taku Inlet by the shortest route, which is from its northern end. The lake extends more than 3 miles southward between steep mountainsides, which are practically bare of vegetation, to a delta of glacial debris at the upper end. The terminus of a glacier is within a few hundred feet of the lake shore at this place. (See fig. 15.)

Dorothy Creek drains Lake Dorothy through an outlet on the west side, 0.4 mile from the north end. The topography of the lake outlet, as taken from the special map of the Dorothy Creek basin, is shown in figure 16. Both sides of the outlet section and the creek bed have been glaciated; consequently very little if any soil or gravel mantles the area.

FIGURE 15.—Aerial view of Lake Dorothy showing glaciers at upper end of lake in lower center. Dorothy Creek flows from the lake down the canyon at left center. Taku tidal glacier in background. (U.S. Forest Service photograph, August 4, 1929.)

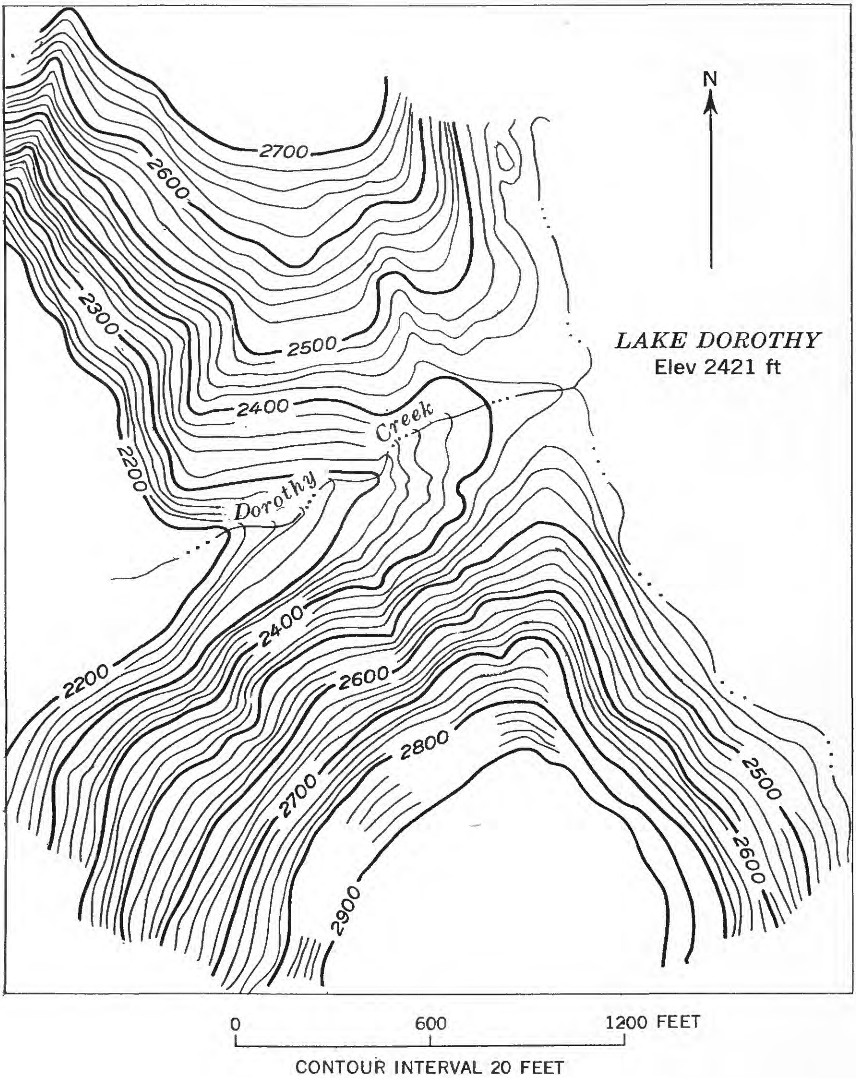

FIGURE 16.—Map of Lake Dorothy damsite.

It would be possible to develop sufficient storage capacity for control of the runoff at Lake Dorothy either entirely by damming or entirely by drawdown through a tunnel outlet. It is probable that all of the capacity would be developed by drawdown, as proposed by the U.S. Bureau of Reclamation (1955, p. 38), since only a relatively small part of the head would be lost, and since access for construction of a dam at the outlet would be very difficult.

The potential capacities and surface areas for a range above and below the lake surface at the Lake Dorothy site are shown below. Areas and capacities below the lake surface were taken from curves determined by the Bureau of Reclamation; those at and above the lake surface from the map of the Dorothy Creek basin.

Altitude (feet)	Area (acres)	Capacity (acre-feet)	
		Below lake surface	Above lake surface
2,240	642	142,500	
2,260	670	129,500	
2,280	697	116,000	
2,300	727	101,500	
2,320	760	87,000	
2,340	793	71,000	
2,360	828	55,000	
2,380	864	38,500	
2,400	901	20,500	
2,421 [1]	968	0	0
2,440	1,049		19,200
2,460	1,114		40,800
2,480	1,180		63,700
2,500	1,239		87,900
2,520	1,282		113,100
2,540	1,319		139,100

[1] Lake surface.

Storage requirements for regulation were determined from reservoir schedules based on estimated inflows corresponding to the 25 water years of record between 1929 and 1956. These years were considered as a consecutive series. The schedules show that 125,000 acre-feet of usable capacity would have been required to provide for a uniform monthly release equal to the estimated mean inflow of 112 cfs. A capacity of only 50,000 acre-feet would have provided for a uniform monthly release of 101 cfs, equal to 90 percent of the mean inflow. A capacity of 125,000 acre-feet could be obtained by drawdown of 155 feet to an altitude of 2,266 feet; and a capacity of 50,000 acre-feet could be obtained by drawdown of 55 feet to an altitude of 2,366 feet.

Lieuy Lake is 0.6 mile downstream from Lake Dorothy, and about 1¾ miles from Taku Inlet, separated by extremely steep, rugged terrain. The surface area of the lake is 79 acres. Although it would be topographically feasible to develop several thousand acre-feet of capacity by damming the lake outlet, the dam would be relatively costly because of the inaccessible location. The lake has not been sounded, but the mountainsides surrounding the lake are steep and some storage undoubtedly could be developed by drawdown. However, the possibility of any development seems very doubtful since the cost of a waterway to a powerhouse alone probably would be more than the value of the potential power that could be developed from the small inflow below Lake Dorothy.

Bart Lake is about ½ mile farther downstream and is about 1¼ miles from the mouth of Dorothy Creek at Taku Inlet. The surface area of the lake is 229 acres. It is estimated that the runoff from the drainage area between Lake Dorothy and Bart Lake could be controlled for 90 percent utilization with storage

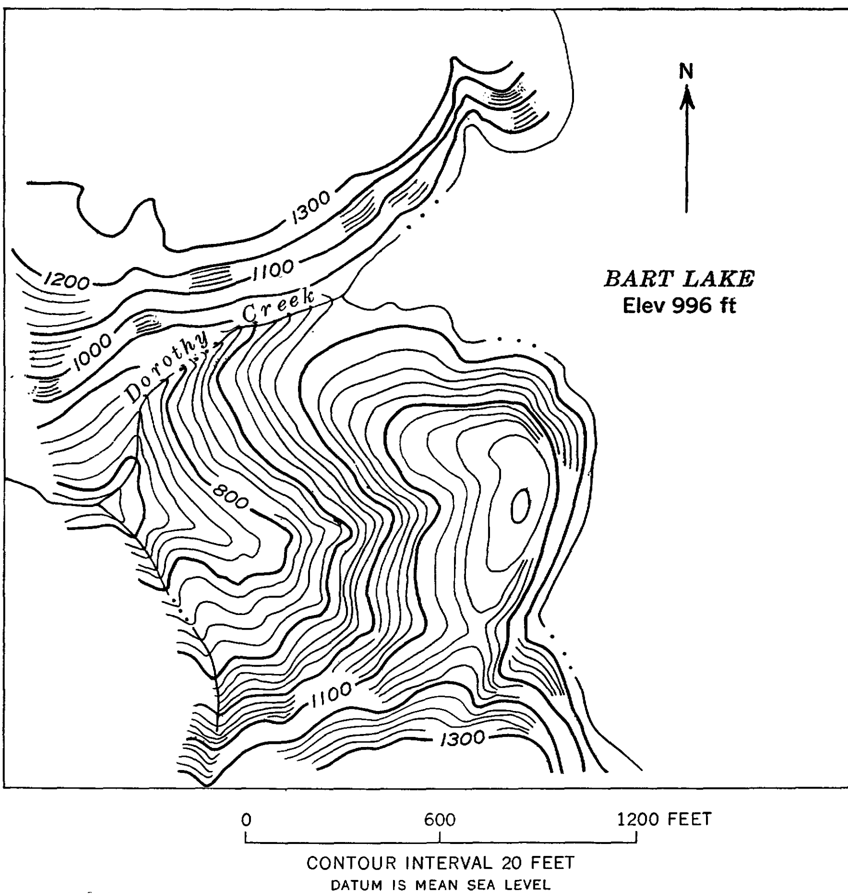

FIGURE 17.—Map of Bart Lake damsite.

capacity of about 13,000 acre-feet. This could be obtained with a dam at the outlet, raising the lake surface 52 feet to an altitude of 1,048 feet. The outlet area is shown in figure 17 as traced from the special map of the Dorothy Creek basin. The reservoir areas and capacities for a range above the lake surface at the Bart Lake site are shown below.

Altitude (feet)	Area (acres)	Capacity (acres-feet)	Altitude (feet)	Area (acres)	Capacity (acres-feet)
996.......	229	0	1,060......	261	16,200
1,000.......	245	950	1,080......	266	21,500
1,020.......	252	5,920	1,100......	273	26,800
1,040.......	257	11,000			

Soundings have not been made but it seems likely that the required capacity also could be obtained by drawdown through a tunnel outlet.

Construction of roads to any of the reservoir sites would be extremely difficult because of the steep, rugged terrain. The U.S. Bureau of Reclamation (1955, p. 36) proposed construction of a cable railway from Taku Inlet to the downstream end of the tunnel route from Lake Dorothy, for construction and operating purposes.

The maximum discharge recorded at the Dorothy Creek gage was 1,780 cfs, November 3, 1949, which corresponds to 117 cfs per square mile. If dams were constructed at the outlets of the lakes, spillway capacities for more than twice this discharge probably would be considered, but if storage were developed entirely by drawdown the natural channels would serve as spillways.

PLANS OF DEVELOPMENT

Water could be conveyed from Lake Dorothy by way of a tunnel and penstock on one of several alternate routes to Taku Inlet. The shortest route, and the one favored by the U.S. Bureau of Reclamation (1955, p. 38), bears almost due west from the northern end of Lake Dorothy. The length of the tunnel would be about 1.6 miles and the length of a surface penstock about 1.2 miles. It would be possible to locate the powerhouse 0.7 mile farther south near the mouth of Dorothy Creek, but the bureau reported that a penstock and powerhouse there would have to be located underground because of the steepness of the terrain.

According to geologic examination of the bureau, the entire tunnel route westward from the lake is in quartz diorite and crosses several fault zones; no unusual difficulty was envisioned, and it was suggested that an unlined tunnel (except through the fault zones) might be considered.

Water could be conveyed from Lieuy Lake to the proposed powerhouse of the Lake Dorothy unit on Taku Inlet for separate development of power from natural flows. This would require about 1¼ miles of tunnel and ½ mile of penstock. A waterway capacity of about 50 cfs would be sufficient for substantial capture of mean daily flows. The potential power corresponding to the estimated mean discharge of 11 cfs and a head of 1,689 feet is 1,260 kw.

Water could be conveyed from Bart Lake northwestward through 1.6 miles of tunnel and 0.3 mile of penstock to the proposed powerhouse of the Lake Dorothy unit for separate development of power from natural or regulated flows. Alternatively, water could be conveyed westward from Bart Lake through about ¾ mile of tunnel and ½ mile of penstock to a powerhouse site at the mouth of an unnamed creek on Taku Inlet about 1 mile south of Dorothy Creek. A waterway capacity of about 150 cfs would be sufficient for substantial capture of mean daily flows from all runoff below Lake Dorothy.

TURNER CREEK POWERSITE

RESERVOIR SITE

A considerable amount of storage capacity could be created in Turner Lake ½ mile upstream from the mouth of Turner Creek by construction of a relatively low dam. The lake extends about 6 miles eastward from its outlet near Taku Inlet, and there is an arm at the upper end extending about 2 miles to the south. Except at the short valley between the lake and Taku Inlet, and at small areas of glacial deposits from the larger tributaries, steep mountainsides extend down to the lake on all sides. The maximum depth of the lake shown in about 6 soundings of 1952 was 682 feet. Since the lake surface is at an altitude of only 73 feet, development of storage by drawdown would not be practicable. (See fig. 18.)

The distance between the mountainsides at the lake outlet is roughly 1,200 feet, but a rock knoll within this reach constitutes a favorable abutment for a dam of moderate height. It is estimated that a dam to an altitude of 160 feet would provide for substantially complete control of the runoff. This would

FIGURE 18.—Aerial view of Turner Lake outlet and tidal mudflat at mouth of Turner Creek on Taku Inlet. Rockslide debris found at the damsite probably came from the area of the large scar on the slope left of the lake outlet.

extend about 1,000 feet across the main outlet section on a curved axis to the knoll, and 300 feet across a saddle west of the knoll. A dam to an altitude of 117 feet would provide sufficient capacity for control of 90 percent of the estimated runoff. This would extend 650 feet across the main section on a curved axis to the rock knoll. The saddle west of the knoll could be excavated for construction of a spillway with a crest at an altitude of 117 feet. The ground surface at the low point of the saddle is at an altitude of 136 feet, and there is a cover of talus estimated to be less than 15 feet thick.

Plafker (1956, p. 35) described the foundation at the main section as granodiorite bedrock concealed by landslide debris, including blocks of large size, except for a part extending about 250 feet east of the knoll which has a cover of soil estimated to be less than 3 feet thick. He considered the foundation rock to be excellently suited for a concrete or rock-fill dam, with treatment perhaps limited to removal of landslide debris and other surficial material.

Plafker pointed out that the landslide debris at the outlet section and along the creek probably came from the mountainside north of the damsite, as evidenced by a large scar, and that a wall might have to be constructed on the north abutment to divert falling rock from the dam.

The approximate reservoir areas and capacities for a range of altitude above the surface of Turner Lake were determined from the map of the Taku River B–6 quadrangle and are shown below.

Altitude (feet)	Area (acres)	Capacity (acres-feet)	Altitude (feet)	Area (acres)	Capacity (acres-feet)
73	3,050	0	200	4,010	467,000
100	3,550	89,000	300	4,480	892,000

The runoff record at Turner Lake is too brief for a determination of the storage capacities needed for control. At many other storage sites in southeastern Alaska, capacity equal to the average annual runoff or less would provide for substantially complete utilization on a schedule of uniform monthly releases, and the capacity required for control of 90 percent of the runoff would be roughly half as much. The estimated mean discharge of 410 cfs at Turner Lake corresponds to an average annual runoff of about 300,000 acre-feet. It is assumed accordingly that the storage capacities required for 100 percent utilization and 90 percent utilization are 300,000 acre-feet and 150,000 acre-feet respectively.

Materials and equipment could be transported by boat along Taku Inlet to the vicinity of Turner Creek, and from the shore to Turner Lake by a short construction road. Tidal flats extend outward from the shore about ½ mile near the mouth of Turner Creek so that access there might be dependent on landing craft of shallow draft at times of high tide. The bulk of materials for a rock-fill dam is available near the damsite.

PLANS OF DEVELOPMENT

Water could be conveyed from the Turner Lake reservoir northwestward through a penstock to a powerhouse site on the left bank of Turner Creek about 600 feet from the lake outlet. This is at the foot of a rapids where the stream altitude is 16 feet. Plafker described the exposed bedrock at the site as an excellent foundation for a powerhouse.

It might be practicable to lower the tailrace at this site by excavation in the creek channel downstream from the rapids. Alternatively, it would be possible to convey the water about

2,000 feet farther downstream to a powerhouse site near the mouth of Turner Creek at the edge of the tidal flats.

CARLSON CREEK POWERSITE

RESERVOIR SITE

The damsite at Mile 2.3, surveyed by the Alaska Gastineau Mining Co., is at the lower end of a valley where the altitude of Carlson Creek is 320 feet. A much narrower site is located in a gorge one-half mile downstream where the creek is at an altitude of 230 feet. A map of the lower site at Mile 1.8 is included with the "Plan and Profile of Sheep Creek and Carlson Creek," which was printed in 1953.

A reservoir with a pool level of 500 feet or higher would extend up the Carlson Creek valley to about Mile 3.2 and an arm from that point would extend up the valley of Sheep Fork more than 1 mile. Plafker (1956, p. 23) interpreted the flat-floored valley upstream from the damsites to be a former glacial lake which was filled with aluvium. There is a very dense growth of alders over much of the valley floor. (See fig. 19.)

It seems unlikely that a reservoir with a pool level higher than

FIGURE 19.—View of Carlson Creek reservoir site from point a quarter of a mile above upper damsite. The Sheep Fork flows from behind ridge at left center.

about 560 feet would be considered. This would require a dam to a height of 330 feet above stream level at Mile 1.8 or to a height of 220 feet at Mile 2.3. The width of the valley at that level is 800 feet at the lower site and 1,400 feet at the upper site.

Plafker (1956, p. 26) reported that the bedrock at the lower damsite, called injection gneiss, is suitable as a foundation for either a concrete or rock-fill dam. He called attention to closely spaced joints parallel to the creek which would have to be sealed with a grout curtain along the dam alinement.

The damsite at Mile 2.3 has not been examined in detail. An unpublished report of the Alaska Gastineau Mining Co., dated 1913 and entitled "Power Possibilities of Carlson Creek," states that exposures of bedrock are rare on the sides of the site and that borings of considerable magnitude might be necessary to determine the depth of bedrock in the bottom. The feasibility of the site was described as uncertain.

The capacities and surface areas of potential reservoirs above both damsites at the Carlson Creek reservoir site are shown below.

Altitude (feet)	Area (acres)	Capacity (acres-feet)	Altitude (feet)	Area (acres)	Capacity (acre-feet)
With dam at lower site					
230	0	0	420	327	18,800
260	1	10	440	365	25,800
280	8	100	460	398	33,400
300	23	410	480	428	41,600
320	33	970	500	463	50,600
340	41	1,710	520	502	60,200
360	160	3,740	540	546	70,700
380	220	7,600	560	595	82,100
400	286	12,700			
With dam at upper site					
320	0	0	460	323	24,400
340	1	10	480	349	31,100
360	114	1,160	500	379	38,400
380	168	3,980	520	413	46,300
400	224	7,900	540	452	55,000
420	259	12,700	560	497	64,400
440	292	18,200			

The storage requirements for complete control were determined from operation schedules for the 14 years of records and estimates, considered as a consecutive series. A usable capacity of 270,000 acre-feet would have been needed for uniform monthly releases equal to the mean discharge of 312 cfs. This could only be obtained by construction of very high dams at either site.

Operation schedules were computed for 2 assumed capacities, 25,000 acre-feet and 50,000 acre-feet, that may be within the range of feasibility. The uniform monthly releases could have been maintained by yearly use of the storage, as shown below.

Release (cfs) for indicated capacity (acre-feet)			Release (cfs) for indicated capacity (acre-feet)		
Water year	25,000	50,000	Water year	25,000	50,000
1917	137	206	1950	111	194
1918	124	206	1951	109	178
1919	164	247	1952	117	186
1920	141	210	1953	138	221
1947	182	306	1954	148	217
1948	150	232	1955	149	253
1949	142	226	1956	109	184

With a capacity of 25,000 acre-feet, the regulated flow available for 100, 90, and 50 percent of the time would have been about 109 cfs, 111 cfs, and 141 cfs respectively. The corresponding flows with a capacity of 50,000 acre-feet would have been 178 cfs, 186 cfs, and 217 cfs.

The only access to the reservoir site at present is by a trail which parallels Annex Creek to the Juneau transmission line. About 2½ miles of the transmission line is located at the reservoir site above the lower damsite and would have to be relocated before construction of a dam.

Plafker (1956, p. 27) reported that the bedrock at the dam site area is satisfactory for crushed aggregate or dimension stone, and that suitable natural aggregate of varied size may be available in sufficient amounts along Carlson Creek at the reservoir site.

The maximum recorded discharge of Carlson Creek was 6,200 cfs, on September 26, 1918. This corresponds to the fairly high rate of 278 cfs per square mile.

PLANS OF DEVELOPMENT

Water could be conveyed from a dam at either site by means of a tunnel and penstock to a powerhouse on Carlson Creek, ½ mile upstream from the mouth. The altitude of the creek at this site is 20 feet. The length by way of a tunnel from the upper site would be 1.4 miles, and from the lower site, 0.9 mile. The length of the penstock would be 0.2 mile by either plan. Alternatively, it would be possible to extend the tunnel about ½ mile and convey water to a powerhouse located at the tidewater of Taku Inlet. Conditions for a powerhouse foundation probably are better at the upstream site where the bedrock was described by Plafker as similar to that at the damsite. The tailwater level at this site could be lowered by excavating the channel of Carlson Creek down to tidewater. It was assumed that it would be practicable to lower the level to that of the higher high-water plane or an altitude of 8 feet, and the power possibilities were estimated accordingly.

Plafker (1956, p. 28) reported that the tunnel route from the lower damsite is in sound bedrock except for two fault zones. The gneiss bedrock was mapped along the sides of the valley upstream beyond the upper damsite.

SHEEP CREEK POWERSITE

RESERVOIR SITE

The reservoir site on Sheep Creek extends from 1 mile to about 3 miles above the mouth of the creek, and is in a broad, U-shaped valley. There is a scattered growth of trees on the alluvium of the valley floor and dense stands of brush and alders on talus slopes at the sides of the valley. (See fig. 20.) A narrow canyon at the

FIGURE 20.—Aerial view of Sheep Creek reservoir site from above the divide between Sheep Creek and Carlson Creek basins. The towers of the Annex Creek-Juneau transmission line are visible in foreground, Gastineau Channel in background.

lower end of the valley constitutes a favorable damsite at a stream altitude of about 620 feet.

The sides of the canyon at the damsite extend up on steep slopes to altitudes above 1,000 feet. A dam probably would not be considered to an altitude higher than 890 feet. The canyon width at that level is about 650 feet.

Plafker (1956, p. 16, 19) reported that bedrock at the damsite is predominantly greenstone tuff, well suited as a foundation for either a concrete or rock-fill dam. The lower slopes at the site are mantled with talus debris estimated to be less than 25 feet thick.

The potential reservoir areas and capacities at the Sheep Creek reservoir site are listed below.

Altitude (feet)	Area (acres)	Capacity (acre-feet)	Altitude (feet)	Area (acres)	Capacity (acre-feet)
617.........	0	0	800........	249	19,000
640.........	5	50	840........	283	29,600
680.........	50	1,170	880........	336	42,000
720.........	118	4,530	920........	387	56,500
760.........	178	10,400			

Schedules of reservoir operation were computed for uniform monthly releases equal to 100 percent of the mean discharge, 50.5 cfs, and 90 percent of the mean discharge, 45.4 cfs. These would have required 42,000 acre-feet and 19,000 acre-feet of capacity respectively.

For flowage above an altitude of 720 feet it would be necessary to seal the Sheep Creek adit of the Alaska-Juneau gold mine, now inactive. Relocation of the Annex Creek-Juneau transmission line would be necessary for a distance of about 1½ miles.

An aerial tram possibly would be used for access to the reservoir site from the end of the road at the mouth of Sheep Creek. There is an existing tram from near the mouth of the creek to a point above the damsite, and another from a point in the reservoir site to mine tunnels on an upper slope of the Sheep Creek basin. There are many mining claims, millsites, and patented mineral land in the reservoir site, all inactive as of 1956.

The maximum discharge recorded at the Sheep Creek gage was 850 cfs, on September 8, 1948. This corresponds to 195 cfs per square mile, not an exceptionally high rate for such a small basin.

PLANS OF DEVELOPMENT

Water could be conveyed from the Sheep Creek reservoir southwestward to a powerhouse at Gastineau Channel by means of a tunnel or pipeline and penstock. The total length of waterway would be approximately 0.7 mile by the shortest route to a site near Thane, or about 0.9 mile to the site of the inactive powerhouse near the mouth of Sheep Creek. Plafker (1956, p. 20) described the slate bedrock at and near the mouth of Sheep Creek as excellent foundation material. He reported that the bedrock along any diversion route is the same as at the damsite, predominantly greenstone tuff.

POTENTIAL POWER OF SITES IN TAKU INLET AND THE GASTINEAU CHANNEL AREA

The potential power at the Dorothy Creek site was estimated on assumption that the head would be developed from the reservoirs down to the nozzles of impulse wheels set 17 feet above mean sea level—a few feet higher than the highest expected tide. At the other sites it was assumed that by means of reaction turbines and draft tubes the head would be developed down to mean tailwater levels—16 feet above mean sea level at the Turner Creek site, 8 feet above mean sea level at the Carlson Creek site, and mean sea level at the Sheep Creek site.

The power possibilities and related data for the Dorothy Creek and Turner Creek sites are summarized below.

	Dorothy Creek				Turner Creek	
	Lake Dorothy		Bart Lake			
Controlled flow...percent of mean flow......	100	90	100	90	100	90
Controlled flow......cfs..	112	101	28	25	410	369
Mean head...........ft..	2,333	2,378	1,031	1,005	101	79
Storage capacity..acre-ft..	125,000	50,000	26,000	13,000	300,000	150,000
Height of dam [1]......ft..	....	......	100	52	87	44
Operating range..alt (ft)..	2,421 2,266	2,421 2,366	1,096 996	1,048 996	160 73	117 73
Continuous power....kw..	17,800	16,300	1,960	1,700	[2] 2,820	1,980

[1] Above lake level.

[2] Continuous power of 3,060 kw could be generated with an operating range of 160 feet to 117 feet, a suitable storage of 150,000 acre-feet, a controlled flow of 359 cfs, and a mean head of 122 feet.

The power possibilities of Carlson Creek were estimated on assumption that it would not be feasible to develop enough storage capacity for more than partial control in any year. The controlled flows of each of the 14 years of the operation schedules constitute a basis for estimating the flows that would be available 100, 90, and 50 percent of the time (Q100, Q90, and Q50 table below), and the corresponding power (P100, P90, and P50). The potential power and related data for the Carlson Creek site are tabulated below for 2 degrees of regulation and with a dam at either the lower or upper site.

Storage capacity (acre-feet)	Mean flow (cfs)			Mean head (feet)	Power (kw)		
	Q100	Q90	Q50		P100	P90	P50
25,000 [1]	109	111	141	440	3,260	3,320	4,220
25,000 [2]	109	111	141	440	3,480	3,550	4,510
50,000 [1]	178	186	217	470	5,860	6,120	7,140
50,000 [2]	178	186	217	470	6,200	6,490	7,550

[1] Lower site.
[2] Upper site.

The potential power and related data for the Sheep Creek site with two degrees of regulation are shown below.

	Controlled flow (percent of mean flow)			Controlled flow (percent of mean flow)	
	100	90		100	90
Controlled flow..cfs..	50.5	45.4	Height of dam [1]......ft..	273	198
Mean head.......ft..	820	770			
Storage capacity.....acre-ft..	42,000	19,000	Operating range.....alt (ft)..	890 700	815 700
			Continuous power.....kw..	2,820	2,380

[1] From stream level to normal pool level.

LOCATIONS AT WHICH POWER COULD BE USED

Power that might be developed at the four sites tributary to Taku Inlet and Gastineau Channel probably would be used in the Juneau area. The length of a possible route for transmission of power to Juneau from the Dorothy Creek site is 15 miles and from the Turner Creek site is about 23 miles. These distances are for overland routes near the shores of Taku Inlet and Gastineau Channel, and a submarine crossing of Taku Inlet near the mouth of Dorothy Creek where the width is about 1¾ miles. Power from the Carlson Creek site could be interconnected with that of the Dorothy Creek and Turner Creek sites by about 6 miles of line along the west side of Taku Inlet, joining the Juneau line near the submarine crossing. Alternatively, it could be transmitted about 13 miles to Juneau along the general route now used for the Annex Creek-Juneau line. Power from the Sheep Creek site could be transmitted along the edge of Gastineau Channel a few miles to Juneau on the same route used from the existing powerhouse.

Locations that might be considered for industrial development in the Juneau area are discussed in the section on powersites in the Gilbert Bay and Speel Arm of Port Snettisham area.

Large areas adjacent to the Taku River are topographically suitable for industrial sites but are not accessible to deepwater vessels. The tract nearest Taku Inlet extends several miles along the east side of the Taku River estuary and has an area of about 4 square miles below an altitude of 100 feet. Supplies of fresh water there would be dependent on the runoff of several small creeks which flow across the tract from the adjacent mountainsides. The overall drainage area is roughly 12 square miles, but there are no apparent possibilities for control of the runoff. The tract is within a transmission range of about 10 miles from the Turner Creek powersite.

An area of about 50 acres near the mouth of Turner Creek is topographically suitable for location of a factory and a small supporting community. It is in the immediate vicinity of sources of water and the Turner Creek powersite but the limited extent of suitable terrain and the lack of a harbor make the possibility of development seem very remote.

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