LODE MINING IN THE JUNEAU AND KETCHIKAN DISTRICTS.

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INTRODUCTION.

During the last few years gold mining has been increasingly difficult to conduct as a profitable enterprise. The advances in cost of labor and commodities of all kinds have worked a special hardship upon the gold-mining industry, for the standard and unchanging value of gold has rendered it impossible to offset the high prices by increasing the market value of the product, as in other industries. Low-grade gold properties that were formerly worked on a small margin of profit by means of large-scale operations are now either scarcely earning their operating expenses, or are being worked at an actual loss for the sake of enabling the operators to hold their organizations together. Properties of somewhat higher grade are likewise adversely affected, for even for them gold mining has become much less profitable. This condition is reflected in southeastern Alaska by a general policy of retrenchment in mining operations on the part of owners and operators of gold mines. Moreover, present economic conditions have had a very hurtful influence, both economic and psychologic, upon the development of new gold mines.

In the Juneau gold belt the Alaska-Gastineau, Alaska-Juneau, and Treadwell properties were operated in 1919, and prospecting and development work were carried on at the Jualin mine, Berners Bay; at the property of the Admiralty-Alaska Gold Mining Co., at Funter Bay; at the Red Wing group of claims, at the head of Windham Bay; and at the copper property of the Endicott-Alaska Mining & Milling Co., at William Henry Bay. The Peterson mine, at Pearl Harbor, was also worked on a small scale during the summer. Elsewhere in this district mining and prospecting were practically at a standstill.

In the Ketchikan district mining was confined largely to Prince of Wales Island. The Rush & Brown copper mine and the Salt Chuck copper-palladium mine, on Kasaan Peninsula, were operated throughout the year, and the Dunton gold mine, near Hollis, was worked intermittently. Prospecting and development work were continued at the molybdenite property of the Treadwell Co., near Shakan.

JUNEAU DISTRICT.

MAINLAND.

PERSEVERANCE MINE.

The Perseverance mine of the Alaska Gastineau Mining Co., about 4 miles east of Juneau, was operated in 1919 on a basis ranging from 150,000 to 200,000 tons of ore a month, whereas the rated capacity of the mill is 10,000 tons a day. About 460 men were employed. The ore is being taken chiefly from levels 8, 9, 10, and 11. New construction and mine-development work have been greatly restricted, partly because of large increases in operating expenses and scarcity of labor, but also because development work is already considerably ahead of mining operations.

This project is a striking example of the hardship wrought upon the gold-mining industry by the increased cost of labor and supplies. According to data published in a paper by the manager of the Alaska-Gastineau Mining Co.,[1] the cost of supplies of all kinds advanced 35 per cent over the prewar cost in 1917 and 70 per cent in 1918, and it is believed by the writer that the advance reached 100 per cent in 1919. Wages increased 7 per cent in 1917 over the 1916 standard, 25 per cent in 1918, and, it is believed, at least 40 per cent in 1919. The cost of operation has therefore increased steadily during the last three years. The average cost of ore delivered to the mill over a period of four years is shown in the same paper to be about 48 cents a ton, and in view of the increasing costs in the last three years it is fair to judge that the present cost is considerably above this figure. To this must be added milling, shipping, smelting, and administrative charges, which will probably amount to 80 per cent of the cost of ore production. Data on the production of the Perseverance mine, published in monthly statements in the Engineering and Mining Journal, show that the net value per ton during 1919 ranged from 60 to 75 cents and averaged perhaps 70 cents.

ALASKA-JUNEAU MINE.

The Alaska-Juneau mine was operated continuously during 1919, employing about 225 men in the mine and mill. The new 8,000-ton mill, which was completed in 1917 and tried out in 1917 and 1918, was found to be less than 50 per cent efficient, and in 1919 much attention was given to improvements in milling practice. The flow sheet of the mill has been changed materially, and alterations have been made in the milling machinery. The chief improvements have been the introduction of hand picking of the ore as it comes from the

[1] Jackson, G. T., Mining methods of Alaska Gastineau Mining Co.: Am. Inst. Min. and Met. Eng. Trans., 1919, pp. 1547-1570.

12-inch grizzlies, the introduction of the old stamp mill into the flow sheet, and the rebuilding of the tube mills. The first change was necessary to prevent the handling of an excessive amount of waste; the second to avoid overloading the ball mills; and the third to correct poor construction in the tube mills. Milling difficulties are gradually being overcome by these changes.

The lode system at the Alaska-Juneau mine is cut by the Silver Bow fault, which strikes about east and offsets the ore body horizontally 1,000 feet, dividing it into a north and a south ore body. The ore between these two ore bodies lying along the fault is in the nature of fault-plane drag and is irregular in distribution. Present operations are being devoted mainly to cleaning up the old 400 stope, between the two main ore bodies, and to active development of the north ore body. The main haulage tunnel on the north ore body has been extended within 250 feet of the boundaries of the Alaska-Ebner property, and the 420 stope is being actively opened. It is planned to open a 430 stope and successive stopes to the northwest along the north ore body to the limits of the property. In addition, a main haulage way and three level tunnels have been driven in the south ore body, which will ultimately be developed as extensively as the north ore body. The ore mined in 1919 was taken in about equal amounts from the 400 and 410 stopes.

ALASKA–EBNER MINE.

After a period of inactivity of about a year, development work was resumed at the Alaska–Ebner mine of the United States Smelting & Refining Co., near Juneau, in the summer of 1919. A main tunnel running 3,200 feet in a northeasterly direction, thence eastward 1,400 feet, had previously been driven, intersecting the ore body. The present development work consists in the continuation of the main tunnel northeastward from the 3,200-foot point, with the intention of intersecting the ore body farther northwest.

JUALIN MINE.

Development work was continued at the Jualin mine, in the Berners Bay district, owned by the Jualin-Alaska Mines Co., but no ore was produced. Fifty-five men were employed—40 at the lower camp and 15 at the upper camp. At the lower camp work was continued on the 7,000-foot tunnel, which when completed will intersect the ore body at depth and will afford natural drainage for the mine. This tunnel is now being driven by three shifts operating two drills, advancing about 15 feet a day, and in September, 1919, had been driven 2,500 feet. If conditions are favorable, the tunnel should be completed by 1921.

The mine, at the upper camp, was pumped dry in 1919, after being flooded for a year and a half, and development and exploration work was continued. A short drift was driven on the 310-foot level, and several other drifts and crosscuts were expected to be completed before 1920. Exploration was carried on chiefly by means of two long drill holes. The first of these started from the southwest side of the property, on the 310-foot level, and was driven horizontally 1,000 feet to the southwest; the second, beginning at the east side of the mine, likewise from the 310-foot level, had been driven horizontally a little north of east about 1,250 feet in September and was to be continued to 1,500 feet. A third drill hole is planned, which will start from the northwest side of the mine and be driven west with a dip of 18° a minimum distance of 1,000 feet. In the lower tunnel drill holes will be driven every 500 feet at right angles to the tunnel on both sides to the limits of the property.

The mine is now well equipped for development and mining operations. A horse tram connects the wharf at Berners Bay with the lower and upper camps, and all three are connected by telephone. A wireless plant also affords communication with Juneau from the upper camp. Power at the upper camp is developed from Johnson Creek, which with an 80-foot head yields 100 horsepower. The water is turned back into the creek, and at the lower camp, under a head of 576 feet, 500 horsepower is developed. For use in winter, four 150-horsepower Petters semi-Diesel engines have been installed, and these are so adjusted that water may be used in conjunction with the engines when available. A 2,750 cubic foot compressor that uses 350 horsepower and will run 26 drills has also been added to the equipment. The stamp mill, which has a capacity of about 30 tons a day, with two amalgamators and two concentrating tables, at the upper camp, suffices for present mining operations, but plans for future operations include the erection of a new mill of greater capacity and the treatment on a large scale of low-grade disseminated ore, as well as the richer ore from the quartz veins.

The character of the mineralization at the Jualin mine and the number and character of the gold-quartz veins, so far as they were known in 1909, have been fully described by Knopf.[2] In addition to the three quartz veins known at that time, two others lying to the northeast, known as Nos. 4 and 5, have been discovered. The exact significance of these veins is not definitely known, but at present No. 4 is believed to be a different vein from Nos. 1, 2, and 3. Mill practice to date has demonstrated that about 80 per cent of the gold in the quartz veins is free. The remaining 20 per cent is contained with the concentrates, which are chiefly pyrite, with some chalcopyrite and galena.

[2] Knopf, Adolph, Geology of the Berners Bay region, Alaska: U. S. Geol. Survey Bull. 446, pp. 44–47, 1911.

PETERSON MINE.

Gold-lode mining on a small scale was continued on the Prairie claim, at the Peterson property, near Pearl Harbor, in 1919, and resulted in a small production. Recent work has consisted in mining two quartz veins from an open cut, practically at the surface, one about 4 feet and the other about 6 feet thick. The vein material is much weathered, disintegrated, and iron stained. A number of other croppings of vein quartz show on the property, but little exploration or development work has been done. It is certain, however, that a number of quartz veins are present.

The ore is carried by horse tram to a small 3-stamp mill which has a capacity of 1½ tons in 16 hours and is operated by water power. Here the ore is reduced and plated, and the concentrates are collected on a concentrating table. About 80 per cent of the gold is free and is recovered on the plates. The concentrates are shipped to Tacoma for treatment.

MINE OF ENDICOTT-ALASKA MINING & MILLING CO.

A low-grade copper mine is being developed by the Endicott-Alaska Mining & Milling Co. at William Henry Bay, on the southwest side of Lynn Canal, about 8 miles due west of Point St. Mary, at the entrance to Berners Bay. The bay is three-fourths of a mile long and 800 yards wide, is easy to enter, and is considered to be a good anchorage. Beardslee River enters at its head.

The mining property is about a mile west of the head of the bay, 160 feet above sea level. Development work has been in progress for about three years, and it will soon be possible to determine the amount and grade of available ore. Sixteen claims are held, of which 11 have been surveyed for patents.

The geology of the west side of Lynn Canal is complex and has so far been little studied. The strike of the rocks is roughly parallel to Lynn Canal, which is considered to lie along an extended fault zone. Hence correlation between the rocks on the east and west sides of the canal, as no paleontologic data are at hand and the lithologic sequence is imperfect, is hardly warranted. Along the shores of William Henry Bay the bedrock consists of a highly contorted limestone, in part thin bedded and in part more massive, with which some slaty argillite is interbedded, considerable chert, both massive and banded, greenstone flows, and clastic derivatives of the greenstone, classifiable under the general designations greenstone tuffs and graywackes. One of the greenstone derivatives consists of a conglomeratic rock, composed of rounded pebbles of limestone and other rocks embedded in and cemented by the tuffaceous material. Large dikes of diabase cut the stratified series of rocks. North of William

Henry Bay the greenstone tuffs and related rocks are the dominant rocks along Lynn Canal, continuing northwestward to the entrance of Chilkat Inlet, but limestones and other sedimentary rocks are present a short distance inland. South of William Henry Bay the rocks along the coast line are chiefly sedimentary, including argillite, slate, and limestone. It appears, therefore, that the boundary line between the greenstone series and the limestone-argillite rocks may run inland in a general northwesterly direction from William Henry Bay.

The country rock at the mine is in general greenstone tuff with interbedded lava flows, cut here and there by dikes. The tuffs and flows appear to be quite different in petrographic character. The tuffs, which in reality grade into graywacke, are greenish to greenish-gray rocks, of fine-grained texture and very difficult to classify in the hand specimen. Under the microscope they are seen to be clastic rocks composed mainly of angular to subangular grains of acidic plagioclase, chiefly albite and oligoclase-albite, in an indefinite groundmass or cement of sericitic and kaolinic material. They also contain grains of an igneous rock, which on account of the character of the plagioclase feldspar would be classed as sodic trachyte or albite andesite. Commonly these rocks are altered and show more or less calcite, quartz, epidote, and chloritic and sericitic material. In much of the rock the feldspars and other detrital constituents are bent, fractured, and veined by secondary minerals. The interbedded flows, which form a minor part of the sequence at this locality, are difficult to distinguish in the hand specimen from the clastic rocks, for they are likewise greenish and aphanitic. They are somewhat darker in color, however, and under the microscope are found to be basaltic. They are holocrystalline to somewhat glassy; are composed essentially of labradorite, augite (sometimes basaltic hornblende), and iron oxides; and are in places much altered, particularly in the feldspar, which has been changed to sericite. The only dike seen in the mine was a fine-grained holocrystalline rock composed of biotite and augite, with iron oxides and apatite, joined by interstitial albite. This rock is a sodic augite minette.

Along the mountain side southwest and west of the mine rocks of the same general character were seen. At an elevation of 1,200 feet, about S. 40° W. from the head of William Henry Bay, is a steep face of rock known as the Palisades. This rock is a fine-grained greenish-gray graywacke, which under magnification is seen to be composed of subangular to rounded grains of quartz, oligoclase-albite, and felsic rock, in a cement composed of epidotic, kaolinic, and sericitic material. Somewhat higher up, at an elevation of 1,900 feet, is a tuffaceous rock of the same general composition but of coarser grain and approaching more closely a true igneous rock in appearance, which continues upward to a high flat on top of the spur. To the northwest along this ridge the country rock changes to a series of interbedded argillite and limestone.

A short distance northwest of the mine, in a little creek, tuffaceous graywacke of the same general character as that at the mine is exposed. Some of this rock shows considerable dynamic metamorphism, being sheared and rendered more or less schistose. One specimen was found to be essentially a fine-grained quartz-mica schist, although under the microscope the original fragmental character could still be observed.

The copper lode that is being developed is a vein composed chiefly of calcite, with considerable silica in the form of tiny veinlets of quartz and chalcedony. The copper ore is exclusively chalcopyrite and occurs with the quartz. The vein pinches and swells but probably averages 10 feet in thickness. The general strike is about N. 75° E. and the dip 80° S., but there are many local irregularities in attitude, due mainly to faulting. The ore carries only small quantities of gold or silver and is classed as a low-grade copper ore. The mine is being developed on the assumption that a 2 per cent copper ore can be produced.

The tunnel starts on the Bonanza No. 3 claim, cuts diagonally across the Endicott No. 2 claim, and enters the Endicott No. 3 claim. It is driven in a general southwesterly direction and intersects the vein 700 feet from the portal, at a point where the vein shows a displacement of 100 feet to the south, due to a fault. The tunnel follows the vein for 400 feet. Numerous small faults met in the tunnel show displacements of the vein ranging from practically nothing up to 10 feet and suggest step faults to take up the movement caused by larger displacements some distance away. At a distance of 1,100 feet from the portal a crosscut prospect tunnel has been started which will be driven northwestward, in the hope of cutting other veins.

The vein that is being explored in the tunnel crops out on the hillside west of the mine at an elevation of 500 feet. At this point the vein strikes about due east, stands vertical, and has a thickness of about 12 feet, with an 18-inch horse of country rock in the center. The vein material here also is practically all calcite with quartz veinlets and chalcopyrite. A little pyrite was seen, and this has oxidized and caused brown staining of the vein matter, particularly along fractures caused by later movements in the vein. The footwall side of the vein is slickensided and grooved, showing that considerable movement has occurred. The country rock is the same as in the mine. It is apparent that faulting is very prevalent and is likely to present some troublesome difficulties in mining.

No other surface outcrops of this or any other veins of mining importance have been found. On the ridge west of the mine, at an elevation of 2,300 feet, is a small calcite vein about 1 foot thick, which carries some quartz, chalcedony, and a little chalcopyrite, with secondary malachite. This vein, which strikes N. 78° E. and stands vertical, is now in part an open fissure, owing to decomposition and solution of the calcite.

Water power is utilized under a head of 300 feet to run a compressor for two drills. No reduction plant has yet been used, and therefore no ore has been milled or shipped. A 30-stamp No. 3 Austin gyratory mill, which was formerly used at the Sea Level mine, on Thorne Arm near Ketchikan, has been purchased and will be installed in 1920. A combination of Wilfley tables and oil flotation will be used. During the summer of 1919 a dock was in process of construction on the southeast side of William Henry Bay, with a depth of 4 fathoms at its outer end at low tide. Substantial buildings have been erected at the head of the bay, on the west side, and a wagon road connecting the bay with the mine has been built.

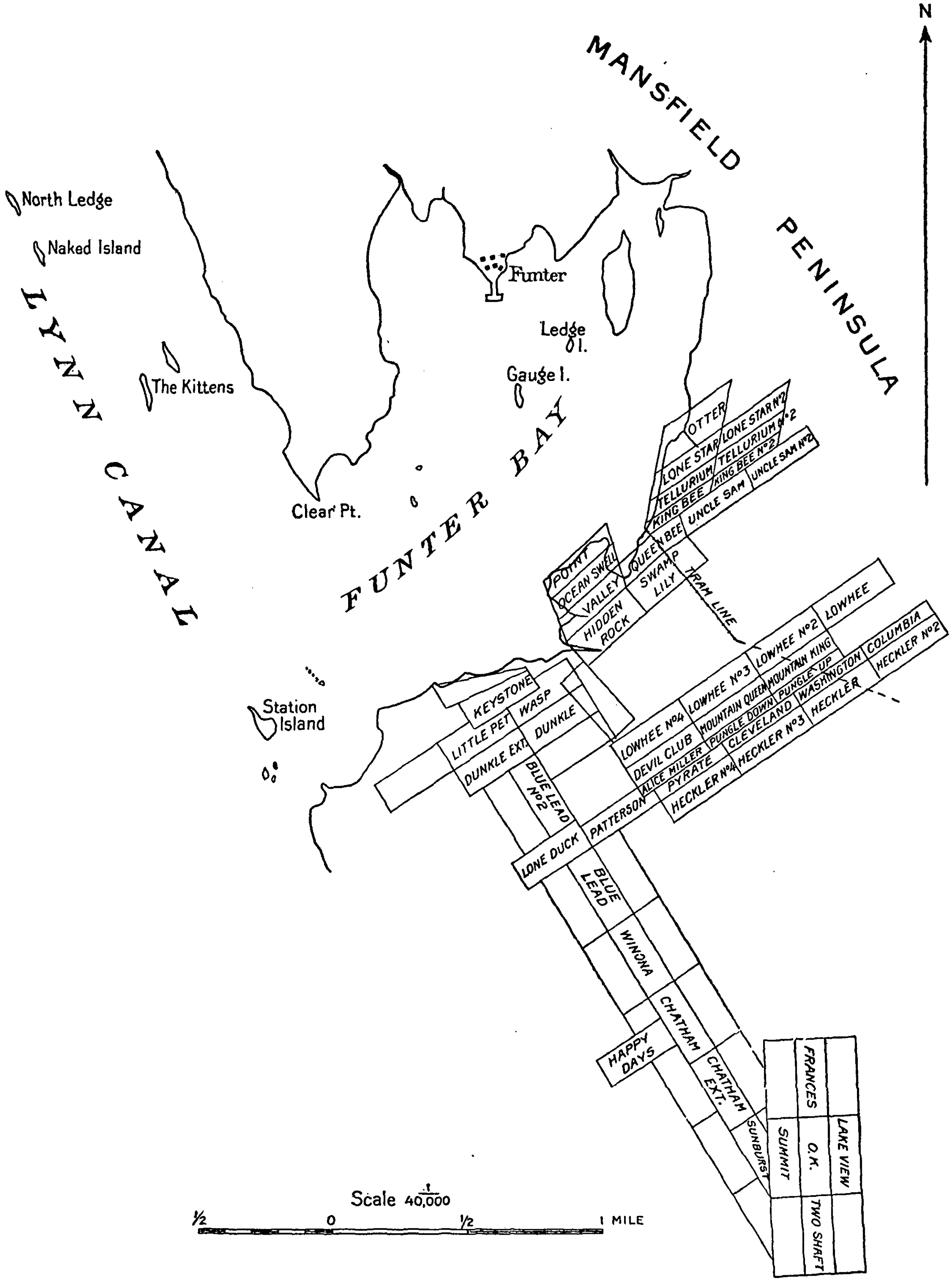
At the lower end of William Henry Bay, along the northwest shore, mineralization has occurred in the rocks at some places. The ore minerals consist for the most part of disseminated pyrites, but at one locality a deposit of sulphides, including arsenopyrite, chalcopyrite, and pyrite was seen in the cherty rocks.

DOUGLAS ISLAND.

The Ready Bullion mine, the one remaining mine of the Treadwell group that was not flooded by the cave-in of 1917, was operated during 1919 at a rate of output of about 24,000 tons a month. About 30 men were employed at the mine, and about 25 at the mill and cyanide plant. The mine now has levels at 2,000, 2,200, 2,400, 2,600, and 2,800 feet, and the main shaft has been extended nearly to 2,900 feet. Most of the ore being mined at present is being taken from the four stopes of the 2,200-foot level, but some is being drawn from the 2,400-foot level. The latest work is the cutting out of three stopes on the 2,600-foot level, preparatory to drawing ore.

The ore is treated at the Ready Bullion 150-stamp mill and cyanide plant. The ore, after being crushed to 40 mesh by the stamps, is conveyed to a small ball mill which reduces the first product to 200 mesh. The oversize is separated by classifiers and returned to the ball mill. The 200-mesh product is conveyed to the cyanide plant, where it is cyanided, washed, filtered, dried, and retorted.

The Treadwell Co. is now operating a 2-ton electric furnace for making steel for its own use in steel castings. Scrap iron collected around the plant has so far been utilized as the raw product, but considerable hematite purchased in Seattle has also been used as a



SKETCH MAP OF MINING CLAIMS, FUNTER BAY, ADMIRALTY ISLAND.

decarbonizer. The carbon content of the steel is reduced to 0.3 to 0.5 per cent. The other necessary ingredients, including ferrosilicon, chrome, manganese, and aluminum (used as deoxidizer), are also purchased. Local magnetites from Haines and Port Snettisham have been tried in place of hematite, but they require too high temperature and too much coke. Both these magnetites have been found to contain considerable TiO_2, and that from Port Snettisham carries some P_2O_3. A few iron and brass castings have also been made.

ADMIRALTY ISLAND (FUNTER BAY).

GENERAL FEATURES.

Funter Bay, on Admiralty Island, is a well-known harbor on the east side of Lynn Canal, practically at the junction of Lynn Canal, Chatham Strait, and Icy Strait. It is a safe and convenient anchorage, and on account of the frequency of stormy weather on Lynn Canal and Chatham Strait it is much visited by small boats. The bay has a general northeasterly trend and is about 2 miles long and three-fourths of a mile wide at the entrance. A cannery and a post office (Funter) have been established on a point on the north side of the bay. Funter Bay is but 18 miles from Juneau in an air line, but 50 miles or more by water.

The shore line of Funter Bay is in general a cliff that rises 20 feet or more above sea level and is bordered by a low-terraced platform which rises gradually to the hills behind. On the northeast side of the bay this platform connects with low hills, but on the southeast side the lowland area gives way to high mountains that rise abruptly to an elevation of nearly 4,000 feet. Both lowlands and mountains are timbered, the mountains up to an elevation of about 2,500 feet.

The lode properties lie chiefly along the southeast side of the bay, beginning at the shore line and extending up into the high hills. Gold-quartz veins were discovered at this locality in 1887, and a number of properties have been held since that time. Many quartz veins have been discovered and a good deal of prospecting has been done, but as yet there has been little mining. At the present time development work is being done on the claims of the Admiralty-Alaska Gold Mining Co. and prospecting is being continued on the Nowell-Otterson group of claims. The former embrace two groups of claims, a lower and an upper group, about midway of the bay on the southeast side; the latter adjoin these claims on the southwest. A good-sized stream, Mountain Creek, lies between the two properties. The general position of these two groups of claims is shown on the accompanying map (Pl. IV).

The claims, particularly those of the Admiralty-Alaska Gold Mining Co., have been examined a number of times by different members of the Geological Survey, and two reports [3] have been prepared and published. No extensive study of the regional geology has so far been attempted, but the different quartz veins have been fairly well described. The present notes are only supplementary to the earlier reports.

The general geology has been briefly described by Eakin [4] as follows:

The rocks of the Funter Bay district include a highly altered bedded series, dominantly greenstone schist and subordinately limestone or marble, and a few small dikes of diabase, andesite, and diorite, which cut the bedded rocks at wide intervals. The schistose cleavage of the metamorphic rocks is generally parallel with the bedding planes. Locally intense crumpling and close folding on a small scale are apparent, but in general the bedded rocks lie in broad and gentle folds. Over considerable areas both schistosity and bedding are near the horizontal. Joint systems on both large and small scales cut the bedded rocks at high angles with the schistosity and bedding or near the vertical. The major joint planes in places persist for hundreds and even for a thousand feet or more with great regularity in strike and dip. Such large fractures were probably accompanied by some differential movement between the blocks which they separate, but there is no definite indication of the maximum displacement. These planes are generally marked by quartz veins, which range in thickness, in the different individuals observed, from mere films to nearly 60 feet. At one locality four approximately parallel veins were measured in a section 330 feet across, whose thickness aggregated 90 feet. Obviously the introduction of this amount of quartz in a narrow section involved displacement of masses of the rock. T-shaped and L-shaped bends in some of the veins indicate differential movements amounting at least to the thickness of the veins. Other veins, which gradually thin out to their ends, do not have this significance. Faults later than the veins and offsetting them occur only here and there, according to present evidence.

The metamorphism of the bedded rocks is for the most part of regional character and of earlier age than the igneous dikes or the quartz veins, which are unsheared. Later metamorphic agencies have affected the bedded rocks locally, adjacent to the quartz veins, resulting in silicification and bleaching of the greenstone schists, accompanied by the introduction of sulphide minerals and in places of gold. Such minerals also occur in bands of greenstone schist without associated quartz veins at two localities, but they are not believed to represent a distinct period of mineralization.

The schists of the Funter Bay area, grouped by Eakin under the general designation of greenstone schist, consist of a variety of rock types, including chlorite schist, mica schist, quartz-chlorite schist, quartz-chlorite-mica schist, zoisite-chlorite schist, albite-zoisite schist, albite-chlorite schist, and albite-mica schist, as well as nonschistose blocky rocks of the same general character, usually carrying little mica. Among the metamorphic rocks are also to be found gneissoid rocks, including albite granite gneiss and albite syenite gneiss. Normal dioritic or andesitic rocks were not observed by the writer, but a variety of other dike rocks containing plagioclase high in soda were recognized. These are chiefly albite granite, albite syenite (or albite diorite), and albite trachyte. One dike of olivine diabase was noted.

[3] Wright, C. W., A reconnaissance of Admiralty Island: U. S. Geol. Survey Bull. 287, pp. 147–150, 1906. Eakin, H. M., Lode mining in the Juneau gold belt: U. S. Geol. Survey Bull. 662, pp. 84–92, 1918.

[4] Eakin, H. M., op. cit., pp. 84–85.

The above is by no means an exhaustive list of the different varieties of rocks found at Funter Bay but is given chiefly to illustrate a feature of these rocks that has been generally overlooked, namely, their sodic character. All the acidic and intermediate types of intrusive rocks examined by the writer contain albite or oligoclase-albite plagioclase feldspar, and albite is also of common occurrence among the schists and gneisses. This feature is of more than passing interest when considered in relation to the sodic character of the intrusive rock at the Treadwell mines, on Douglas Island, about 15 miles to the east. It is not unlikely that mineralization at these two localities took place at the same general period and had a similar origin.

CLAIMS OF ADMIRALTY-ALASKA GOLD MINING CO.

The Admiralty-Alaska Gold Mining Co. holds 52 claims, of which the principal ones are shown on the accompanying sketch map (Pl. IV). These claims lie in two groups, a lower group on the low terrace leading back from the beach, and an upper group on the mountain slope to the southeast. In the lower group the principal lodes are the Tellurium, King Bee, Uncle Sam, and Lone Star; a number of smaller veins also occur. The upper group includes a large number of veins, among the most valuable of which are the Blanket lode, the veins on the several Heckler claims, including the Big lode and the Washington lode, the Devil Club lode, and the Patterson lode. Both the lower and the upper veins have been described adequately by Eakin, and no new work has been done on their surface outcrops in the meanwhile.

A tunnel is now being driven from the end of the tram line to prospect the quartz veins of the upper group. This tunnel starts about a mile from the beach, at an elevation of about 250 feet, and is being driven S. 65° E. with the intention of crosscutting at depth the veins on the Lowhee No. 2, Mountain Kink, Pungle Up, Washington, and Heckler claims. Work was begun on this tunnel in the fall of 1918, and by midsummer of 1919 it had been driven about 800 feet. One drill is being used.

A compressor plant, with a capacity of 12 drills, has recently been installed. Water power under a head of 500 feet, delivered to the compressor in a 6-inch stream, is utilized. A sawmill has also been built. From 5 to 15 men were employed during the summer of 1919.

The tunnel is driven in a greenstone schist, which differs in character in different parts of the tunnel. At the face in 1919, about 800 feet from the portal, it consists of a recrystallized rock, somewhat schistose in appearance, composed essentially of a mixture of zoisite and chloritic material, chiefly pennine, together with considerable quartz and some pistacite and titanite, and would be designated a zoisite-chlorite schist. The dip of the schist in the tunnel is in general away from the beach. About 400 feet from the portal a small ore body consisting of a sheared mixture of quartz and schist, with about 8 inches of milky quartz on the hanging wall, was intersected. This vein and its accompanying zone of shearing is parallel with the cleavage of the schist. The sulphide minerals include pyrite, pyrrhotite, and a little chalcopyrite. The hanging wall was found to be a fine-grained igneous rock, with a pronounced flow structure, composed essentially of unaltered oligoclase-albite in tiny laths, forming a felty trachytic groundmass, and an interstitial filling of chloritic material, derived probably in part from rock glass. Some larger laths or phenocrysts of oligoclase-albite are partly altered to epidote and calcite. Secondary quartz, epidote, and calcite are present. This hanging-wall rock is a sodic trachyte.

No other quartz veins of any importance have so far been crosscut, but it is planned to continue the tunnel until the Heckler Blanket lode, the Big lode, and other veins that crop out on the Heckler group of claims are intersected. No accurate base map of the property has been made, but it is estimated roughly by the writer that a 2,000-foot tunnel will be required to reach the Heckler Blanket vein, if the strike and dip shown at the outcrop continue below the surface to the level of the tunnel. The strike and dip of the Big lode are not sufficiently well known, owing to the lack of stripping at the outcrop, to justify a guess as to how far the tunnel will have to go to cut this large body of quartz. The vein crops out farther southeast than the Heckler Blanket vein, but the dip may be lower, thus partly or wholly compensating for the greater surface distance.

NOWELL-OTTERSON CLAIMS.

The Nowell-Otterson group of claims lies southeast of the property of the Admiralty-Alaska Gold Mining Co. and includes 19 claims stretching from Funter Bay to the top of the mountain to the southeast. The general position of these claims is indicated on the accompanying sketch map (Pl. IV). A good trail has been built from the bay to the top of the mountain, making these claims easy of access.

On the Winona claim, at an elevation of 675 feet, a tunnel 64 feet long has been driven on two quartz seams, which strike about N. 55° E., conformably with the country rock, and dip southeast. The upper of these seams is fairly persistent and ranges from 6 to 24 inches in thickness; the lower seam is lenticular and discontinuous. The footwall is graphitic chlorite schist, and the hanging wall a quartz-mica schist. The quartz is iron stained and carries stringers of country rock. Some pyrite and pyrrhotite were seen in the quartz.

On the Chatham claim, at an elevation of 1,050 feet, a tunnel has been driven 200 feet and crosscuts four thin quartz seams, from 2 to 4 inches wide, which strike N. 45° E. and dip 45° NW., thus cutting almost directly across the structure of the country rock, a quartz-mica schist. The quartz carries pyrite, pyrrhotite, and gold.

To the east of the tunnel, on a small creek, several small quartz veins of similar character are exposed. A small shipment of ore (about 5 tons) from one of these veins, which ranges in thickness from 8 inches to 2 feet, was valued at $120 a ton, and a second sample at a later date ran $80 to the ton. At least 10 such small veins, most of them measurable in inches, are exposed in the creek. The quartz carries pyrite, pyrrhotite, and in places a little galena, in addition to the gold.

The vein of most interest on the Nowell-Otterson group is the Big Thing lode, which crops out on the line between the Francis and O. K. claims at an elevation of 3,100 feet and has been traced 800 feet to the north and over 1,500 feet to the south. The vein, which strikes about N. 20° W. and dips steeply to the east, lies parallel with the schistosity of the country rock. The hanging wall is a chlorite schist composed of chloritic material, quartz, calcite, and epidote. The footwall is a graphitic schist. On the line between the O. K. and Francis claims about 20 feet of quartz is exposed, with a horse of schist in the center of the vein. The quartz is heavily iron stained and is mineralized by iron sulphides (pyrite and pyrrhotite), galena, and hematite. It is characteristic of these sulphides to be concentrated in pockety masses in the quartz. The owners aver that the average of assays so far made is about $5 to the ton in gold.

On the Two Shaft claim, about 1,800 feet north of the outcrop just described, at an elevation of about 3,050 feet, a vein of quartz from 15 to 25 feet thick crops out and is believed to be the continuation of the Big Thing lode. The country rock here is a quartz-mica schist, and the vein strikes about N. 15° W. and dips steeply to the east, as at the other locality. The quartz is of the same general character as the quartz above described, but more galena is present, and some chalcopyrite was also seen. A good deal of free gold may be seen with the naked eye, and it is apparent that some of this material is high-grade ore.

Another vein, distinct from the Big Thing lode, also crops out on the Two Shaft claim, some distance west of the one just described, at an elevation of about 2,750 feet. This is a smaller vein of quartz, about 30 inches thick, striking N. 20° W. and dipping steeply to the east, which lies comfortably with the schist and is heavily impregnated with sulphides. The quartz where unaffected by the mineralizing solutions is white and milky, but elsewhere it is heavily iron stained. Pyrite, galena, chalcopyrite, and specular hematite are found with the quartz. Green malachite staining and to a lesser extent blue azurite discoloration are apparent. An irregular body of calcite cuts transversely through the vein and appears to represent a later phase in the sequence of mineral deposition. This vein carries very little gold but is reported by the owners to give high assay results in silver and lead.

A number of other quartz veins crop out on this mountain in the vicinity of the O. K., Two Shaft, and Summit claims, but little prospecting has been done on them, and therefore little is known of their character and extent.

KETCHIKAN DISTRICT.

PRINCE OF WALES ISLAND.

SHAKAN MOLYBDENITE LODE.

A molybdenite lode was opened in 1917 by the Alaska Treadwell Mining Co., and development work has continued to the present time, although no ore has yet been shipped. This lode is about three-fourths of a mile south of Shakan, at an elevation of 600 feet, at the north end of Prince of Wales Island, on the east side of a small stream that enters Shakan Bay.

The country rock consists of tuffaceous sediments intruded by diorite. The lode is in diorite, which varies somewhat in character and composition but in general is composed of zonally grown plagioclase feldspar, ranging from albite on the rims to bytownite in the centers of the crystals, and with an average composition perhaps of andesine; a small amount of orthoclase; considerable hornblende; and biotite, augite, iron oxides, and apatite. Being composed essentially of plagioclase feldspar and hornblende, this rock is classed as a hornblende diorite. Pegmatite is present in dikes and veins cutting the diorite and is in fact related genetically to the molybdenite in the lode. The pegmatite is composed essentially of orthoclase feldspar and quartz, with accessory sphene and small amounts of secondary sericite, chlorite, and epidote.

The vein at its maximum is 6 feet thick, with a strong, clean-breaking hanging wall and an indistinct footwall. It varies considerably in strike and dip, as is shown by the crookedness of the main tunnel which follows the vein. The average strike is about N. 70° W. and the dip ranges from 10° to 25° S. Considerable faulting is apparent, particularly along the hanging wall, where in places the vein matter for 6 inches or more has been reduced to a fault gouge. Some of the best of the ore has been taken from this zone along the hanging wall. The gangue of the vein is partly quartz and partly pegmatitic material, and these two appear to grade into one another, indicating that at least a part of the quartz is of primary origin. The sulphide minerals in the gangue include molybdenite, pyrite, pyrrhotite, and chalcopyrite. The molybdenite is in some places scattered through the quartz and pegmatite and in others more or less concentrated, particularly in the gouge zone. Pyrite and chalcopyrite are distributed throughout the gangue, but pyrrhotite is most often found in pockets or kidneys. The paragenesis of the sulphide minerals has not been deciphered.

A tunnel, now driven 360 feet, is the main underground development work. At 250 and 300 feet from the portal cross faults were met, the first striking N. 10° E. and the second N. 10° W., with offsets at both places. The molybdenite content of the vein becomes very low beyond the 300-foot point in the tunnel, and at this point the direction of the tunnel was changed to one somewhat south of the strike on the working hypothesis that the true vein at the 300-foot point has been replaced through faulting by a barren quartz vein. It is equally possible, however, that a molybdenite ore shoot in the vein has been terminated by the fault, and that the vein exposed beyond the fault is a barren zone of the same vein. In this event, further drifting on the vein or sinking an inclined shaft down the dip will afford the greater chance of discovering ore.

A tramway has been constructed from the portal of the tunnel across the small stream above mentioned and down the opposite side of the valley to tidewater. A small dock has also been built. All the mining has so far been done by hand, but in September, 1919, a compressor plant was at the dock awaiting installation. Six men, working in two shifts, were at work at the time of the writer's visit.

RUSH & BROWN MINE.

The Rush & Brown mine, about half a mile west of Lake Ellen, at the head of Kasaan Bay, was the only copper mine in southeastern Alaska that was operated in 1919. The property includes two ore bodies that have been developed to a productive basis and a number of others that have not been explored. The larger of the two productive ore bodies is a contact-metamorphic deposit of copper-bearing magnetite, and the smaller a fault-zone deposit, with chalcopyrite as the chief sulphide. The former is of too low a grade to be worked at the present price of copper; but the latter carries a higher grade of copper ore and also considerable gold and silver, and in recent years mining has been confined to this deposit. Eight men were employed in the mine in 1919, and several others at the surface.

The contact-metamorphic deposit lies in contact rock between diorite and graywacke, trends about due east, and stands practically vertical, plunging perhaps at a high angle to the north. The ore has been exposed in a glory hole and numerous drifts from it to a depth of 140 feet, for a distance of about 200 feet, and shows a width ranging from 50 feet at the west end to 125 feet at the east end. The deposit, however, is irregular in outline and variable in ore content, owing to the inclusions of numerous horses of country rock. Both the ore and the country rock are much faulted, but in general the throw of the faults seems to be small. A series of lamprophyric dikes, chiefly sodic vogesites, cut directly across the magnetite and country rock, striking in general about north. These dikes appear to represent the latest phase of the igneous activity. The chief sulphides contained in the magnetite are chalcopyrite and pyrite, but they are so scattered that it is difficult to find copper ore of a commercial grade. The whole deposit of cupriferous magnetite, if mined completely, should yield not less than 0.5 per cent and possibly 1 per cent of copper. Such ore should sometime become of value, if worked for both its copper and its iron content.

About 160 feet north of the contact ore at the surface lies the shear-zone deposit, observations upon which show that the vein is irregular in attitude, ranging in strike from N. 65° E. to east and in dip from 45° to 60° S. If the strike is taken at N. 80° E. and the dip at 60° S., it appears that the shear zone should intersect the contact deposit at a vertical depth of about 280 feet from the surface, or about 325 feet measured down the slope. The inclined shaft down the vein on the shear zone has now been sunk 430 feet but without yet encountering the contact deposit. This may be due to faulting.

The deposit now being worked is a body of sheared graywacke and tuff, ranging in thickness from a few inches to 8 feet, lying between well-defined foot and hanging walls. The sulphide ore, chiefly chalcopyrite with some pyrite and pyrrhotite, occurs in lenses and reticulating veins and veinlets within the sheared material, more commonly nearer to the hanging wall than to the footwall. Some solid veins of chalcopyrite have been found, of which the largest so far mined has not exceeded 4 feet in thickness. The gangue material consists of crushed country rock, rather than gangue minerals such as quartz or calcite. The two walls evidently represent the outer limits of movement, for they are slickensided, and the sheared and crushed vein material ends abruptly against them. Moreover, the ground outside the vein is firm, as indicated by the fact that no timbering is required in the drifts. As would be expected, ore is found in soft ground, where shearing and granulation have reached a maximum. There appears to have been little if any movement along the vein subsequent to ore deposition, but cross faulting is not uncommon. On the 200-foot level a well-marked fault, known as Murphy's slip, intersects the vein, offsetting it 25 feet on this level. This fault strikes approximately north and dips 50°–80° E., and has been traced 400 feet by tunnel. Faults similar in strike and dip may be seen on other levels, particularly west of the shaft, and appear to constitute a system of parallel faults formed subsequent to ore deposition. It seems likely that the dikes of vogesite previously mentioned were intruded along such fracture planes.

At several localities in the mine small deposits of cupriferous magnetite lead off from the vein, existing apparently as isolated outliers of the contact deposit near by and relating the two types of deposits genetically to the same agency—the intrusive diorite. Small ore shoots of commercial copper ore were found in some of these deposits and mined.

The mine is developed by levels at depths of 100, 200, 250, 300, 350, and 400 feet. A vertical shaft connects the 200-foot level with the surface, and a hoist operates a lift which handles either men or an ore car. The lower levels are reached by ladder down an inclined shaft that follows the vein; and ore from the lower levels is raised up this shaft on a skip. A moderate flow of water, about 50 gallons a minute, is raised by a pump from the lower levels to the 200-foot level, whence it goes into a sump and is picked up by another pump and hoisted to the surface.

All mining and development work so far has been done by hand mining, but a new Ingersoll-Rand compressor, with a capacity of four drills, has been partly installed and should soon be ready for use. A small boiler of about 50 horsepower, operated on wood, now supplies all the power that is needed; but a larger boiler is being installed to run the compressor. The output of the mine should be materially increased by the use of power drills. The ore is transported by a small locomotive and cars over a narrow-gage railroad to tidewater, a distance of about 2 miles.

SALT CHUCK MINE.

The Salt Chuck mine, formerly known as the Goodro mine, is about half a mile northeast of Lake Ellen and at an equal distance from the head of the Salt Chuck, at the head of Kasaan Bay. Mining was begun originally on what was considered to be a low-grade copper deposit, but subsequently it was discovered that the ore was of more value for its content of platinum metals than for its copper, so that now this mine is more properly described as a palladium-copper mine. It has been operated continuously since 1917, and in 1919 it employed about 16 men.

The lode crops out at an elevation of 400 feet, upon a little knoll rising from one of the rounded ridges characteristic of this glaciated area. A few other surface outcrops have been found near by, but the general surficial configuration of the mineralized zone has not been determined, owing in part to the timber and dense vegetation of the surrounding area, but particularly to the irregular distribution of the mineralization, which gives no clue as a guide in prospecting. The ore zone, however, or the zone within which the discovery of ore shoots may be expected, is believed to be at least 250 feet wide and is thought to extend in a direction about N. 75° W.

This deposit, unlike most of the other commercial ore deposits of Kasaan Peninsula, occurs in an area of coarse-grained intrusive rock, which has been mapped by Wright[5] under the general designation granitic intrusives. Such intrusive rocks invade the Paleozoic sedimentary rocks of Kasaan Peninsula at many localities, occurring as small and large bodies of varying petrographic character. The normal type of these rocks is a diorite, low in quartz and orthoclase, but numerous other facies have been evolved by magnetic differentiation. In the acidic differentiates low potassium and high soda content expresses itself through the formation of sodic granite and syenite, the chief feldspar of which is albite, in place of orthoclase, the normal type in such rocks. Much diversification is apparent among the basic types of differentiated rocks, although few of these have been described in any detail. This differentiation is well illustrated at the Salt Chuck mine, where the country rock is in general a pyroxenite, with gabbroic and gabbro-pegmatitic phases. Wright referred to the country rock at the Salt Chuck mine as a gabbro, but in his petrographic description he showed clearly that the plagioclase feldspar constitutes only from 5 to 10 per cent of the rock. It seems better, therefore, to designate the intrusive rock at the mine pyroxenite, remembering, however, the gradual transition to the true gabbroic intrusives in this vicinity. The chief rock-forming mineral is augite, and the subordinate constituents are biotite, iron oxides, plagioclase, apatite, and titanite, though not all of these are invariably present in any one specimen. Biotite in particular is variable in distribution, and much of it occurs as large splendent crystals. The pyroxene and plagioclase are in places much altered, the alternation resulting in the development of rocks rich in epidote and in chloritic and sericitic material.

The ore minerals consist of copper sulphides, distributed in grains and small patches as ore shoots in the pyroxenite. Bornite is the chief copper mineral, but a small proportion of chalcopyrite also occurs locally. Chalcocite and covellite are both present, as alteration products of the bornite and also of the chalcopyrite. Finely disseminated chalcocite and native copper have been reported by Knopf[6] as occurring in some drifts about halfway between the upper and lower tunnels, leading from a connecting winze. Practically no gangue minerals are found with the ore. In addition to copper, gold, silver, palladium, and platinum are recovered.

[5] Wright, C. W., Geology and ore deposits of Copper Mountain and Kasaan Peninsula, Alaska: U. S. Geol. Survey Prof. Paper 87, p. 73, 1915.

[6] Knopf, Adolph, Mining in southeastern Alaska, 1910: U. S. Geol. Survey Bull. 480, p. 101, 1911.

The metallic content of the Salt Chuck ores was shown in a table of analyses by Campbell,[7] and this table, with the addition of three determinations of concentrates, is given below.

Metallic content of Salt Chuck ores.

[Copper in per cent; other metals in ounces to the ton.]

<table>
<tr><th></th><th>Copper.</th><th>Gold.</th><th>Silver.</th><th>Platinum.</th><th>Palladium.</th></tr>
<tr><td>Gloryhole</td><td>1.92</td><td>0.07</td><td>0.17</td><td colspan="2">0.41</td></tr>
<tr><td>150-foot level</td><td>1.08</td><td>.07</td><td>.24</td><td colspan="2">.18</td></tr>
<tr><td>Bottom of winze</td><td>1.28</td><td>.05</td><td>.24</td><td colspan="2">.17</td></tr>
<tr><td>Average of ore analyses</td><td>1.427</td><td>.063</td><td>.217</td><td colspan="2">.253</td></tr>
<tr><td>Gabbro</td><td>.06</td><td>.01</td><td>.10</td><td colspan="2">.01</td></tr>
<tr><td>Chalcopyrite</td><td>27.66</td><td>.11</td><td>2.08</td><td colspan="2">1.01</td></tr>
<tr><td>Concentrates</td><td>43.81</td><td>1.17</td><td>4.60</td><td colspan="2">3.54</td></tr>
<tr><td>Concentrates (Eng. and Min. Jour., Sept. 27, 1919)</td><td>36.96</td><td>1.27</td><td>6.10</td><td>0.10</td><td>2.93</td></tr>
<tr><td>Concentrates</td><td>........</td><td>........</td><td>........</td><td>.04</td><td>2.56</td></tr>
<tr><td>Concentrates</td><td>39.41</td><td>1.20</td><td>5.18</td><td>.04</td><td>3.38</td></tr>
<tr><td>Average of concentrates</td><td>40.06</td><td>1.213</td><td>5.293</td><td colspan="2">3.147</td></tr>
</table>

From these data it is possible to estimate the percentage recovery of the precious metals in the concentrates. If the concentrates average 40.06 per cent of copper each ton of concentrate will contain 801.2 pounds of copper. Then, as the average copper content of the ore is 1.427 per cent, each ton of ore contains 28.54 pounds of copper; and the number of tons of ore used to produce 1 ton of concentrates, on the assumption of a copper recovery of 100 per cent, would be $801.2 \div 28.54 = 28.07$ tons. The recovery of gold, silver, and platinum metals in ounces per ton is obtained by dividing their respective figures in the "average of concentrates." by 28.07; and the ratio of the resulting quantities to the corresponding quantities given in the "average of ore analyses" yields the percentage of recovery for the precious metals in terms of the assumed 100 per cent recovery of copper—that is, gold 68 per cent, silver 87 per cent, and platinum metals 44 per cent. The exact percentages of precious metals recovered are obtained by multiplying these computed percentages by the true recovery of copper.

On reducing the copper percentage to troy ounces per ton and comparing the result with the figures for the precious metals, it appears that the ratio of the copper to the gold, silver, and platinum metals is 6,607, 1,918, and 1,645 to 1 respectively, and that the ratio of the gold to the silver and platinum metals is roughly 1 to 3 and 4 respectively. Of course, an average of three assays affords no basis for any exact deductions, but nevertheless these figures are useful in giving a general idea of the occurrence of these metals.

[7] Campbell, D. G., Palladium in Alaska lode deposits: Min. and Sci. Press, vol. 119, pp. 520–522, 1919.

A little free gold may be seen in some of the ore, but the disparity between the recovery of gold and the recovery of platinum metals leads to the belief that a considerable part of the gold is chemically combined or mechanically held with sulphides. The high content of silver relative to gold indicates an additional source of silver besides that alloyed with gold, and the high silver recovery indicates that the silver is present as some silver or copper-silver mineral, probably a sulphide or sulpho-salt, which is highly adapted to the flotation process. Possibly it occurs in both these forms. The high content but low recovery of platinum metals, when considered in the light of the known relationship between copper and platinum metals in these ores, indicates that the larger part of the platinum metals are held mechanically by the copper minerals and are liberated in the ball mill. The ratio of palladium to platinum appears to vary considerably but is believed to average about 50 to 1.

The analysis of the chalcopyrite is also of some interest. Gold, silver, and platinum metals are found in the chalcopyrite, and although this fact does not permit any inferences as to the state of existence of the precious metals, it serves partly to corroborate the nfluences above drawn. The ratio of gold to silver to platinum metals in the chalcopyrite is about 1 to 19 to 9, whereas in the average of ore analyses it is 1 to 3 to 4. The higher ratio of silver to gold in the chalcopyrite analysis is probably due in part to the lower content of gold in the chalcopyrite than in average ores, owing to the presence of a certain percentage of free gold in the country rock; but probably it is due more largely to the higher content of silver in the chalcopyrite, as a result of the presence of intergrown silver or copper-silver sulphides. The higher ratio of platinum metals to gold in the chalcopyrite analysis is interpreted as evidence that more of the platinum metals are associated with the copper minerals than occur free in the country rock, thus corroborating the relationship that appears to exist between the copper and platinum metals in the mine. The analyses above given show from 0.13 to 0.21 ounce of platinum metals to the ton for each 1 per cent of copper; the lower figure is more probably representative of the average.

The mode of formation of this deposit and the distribution of the ore present some puzzling features. The country rock, though mainly pyroxenite, shows gabbroic and gabbro-pegmatitic phases, and at the west end of the glory hole a basic dike 4 feet thick cuts the pyroxenite. Considerable epidote also occurs, in part replacing the minerals of the country rock and in part as traversing veinlets. The ore is evidently later than the dike, for a bornite-chalcopyrite ore shoot cuts directly across the dike. The country rock is much fractured, but there is no particular system to the fractures, and no large displacements. The general trend of the zone of the fractured and faulted rock, however, is believed to be about N. 75° W.

At first sight the bornite and chalcopyrite may be regarded as ores segregated from the gabbro mass. The copper minerals do not appear to follow the larger fracture planes to the extent that might be expected in an ore deposited from circulating waters. The ore occurs in shoots, which appear more or less independent of the rock fractures, and the bornite is found as disseminated particles within these shoots, some of it in massive country rock at some distance from any apparent openings. Also, free gold was observed which had been drawn out and elongated by faulting subsequent to its deposition, showing that at least some of the fracturing movements occurred after the deposition of the ore. On the other hand, some of the copper ore, particularly the chalcopyrite, lies along the fractures in such a manner as to show clearly that it entered the rocks and was deposited subsequent to the fracturing. Moreover, where the bornite occurs in massive, unfractured pyroxenite, the rock-forming minerals of the pyroxenite are noticeably altered, chiefly to epidote, with less chloritic material; and the degree of this alteration appears to be a function of the amount of ore present. Finally, the texture of the ore as seen under the microscope belies the appearance of primary character which is seen in hand specimens. The country rock contains many minute cracks, adequate for circulating ore solutions, and the ore itself shows that it has entered the rock in this manner and replaced the rock minerals. Hence, though all the details of the ore deposition can not be explained, it seems certain that this is at least an epigenetic deposit—that is, it was formed later than the containing country rock.

The presence of chalcocite, covellite, and native copper point unmistakably to enrichment, due to the action of meteoric waters working downward from the surface. The chalcocite and native copper observed by Knopf[8] were at a depth of about 200 feet below the surface and shows that enrichment has occurred at least to this depth. This is rather remarkable for southeastern Alaska, for it has generally been believed that in that region the recent glaciation had removed the zone of oxidation and practically all of the secondary sulphide zone. It would be of interest to know whether this supergene enrichment is a remnant representing a preglacial secondary sulphide zone, or whether it has occurred in postglacial time. In either case the theoretical conclusion is that the ore will be found to become leaner with depth, but it is doubtful if this feature will prove of much economic importance, as the percentage of secondary sulphides appears to be relatively small.

[8] Knopf, Adolph, Mining in southeastern Alaska, 1910: U. S. Geol. Survey Bull. 480, p. 101, 1911.

The Salt Chuck ore deposit has been developed at the surface by a small glory hole and an open cut almost adjoining it on the east, and underground by a tunnel 300 feet long which at its face opens upward through a stope into the glory hole. Near the face of this tunnel a winze has been sunk 200 feet, connecting with a new lower tunnel, and the winze has been continued upward as a raise for 90 feet. A tram 2,200 feet long has heretofore been used to transport ore from the mine to the mill. The new lower tunnel, 1,225 feet long, has now been completed and will be used as the main oreway.

Ore is now being taken from the stope that connects the upper tunnel with the glory hole. One of the difficulties of mining operations at this property is the irregular distribution of ore stopes. There are practically no data on which to base prospecting, for there is no vein or well-defined shear zone, and the stopes occur seemingly at random. There is a limit to the mineralized zone, which probably coincides with the limit of the faulted and fractured area of peridotite, but this is neither sufficiently definite nor sufficiently circumscribed to be of value in laying out the mine. That such a limit exists is shown in the new lower tunnel, which is 1,225 feet long and in which no ore was seen until the tunnel had been driven 990 feet. The horizontal sequence in this tunnel from the portal inward is as follows:

Sequence in lower tunnel of Salt Chuck mine.

	Feet.
Barren country rock	990
Zone of disseminated bornite	15
Barren country rock	15
Zone of disseminated bornite	30
Barren country rock	170
Zone of disseminated ore, chiefly chalcopyrite, subordinately bornite	5

It is not known in what manner the ore zones shown are cut by the tunnel, and the thicknesses given, therefore, may or may not represent true cross sections of the shoots.

The ore is reduced in a concentration and flotation plant on the property. Power for the mill and mine is generated partly by water and partly by means of a 75-horsepower Fairbanks-Morse semi-Diesel engine. Water is taken from a 31-acre lake and delivered to the wheels in a 10-inch stream, under a head of 179 feet; and when the supply is adequate, 220 horsepower is generated by this means. The supply of water, however, is usually inadequate, and the engine has to be run much of the time. This constitutes one serious handicap to economical mining.

Ore is delivered at the mill into a 175-ton storage bin, from which it goes through two sets of jaw crushers and is reduced to about 2-inch size. This material is then dumped into a 75-ton bin, whence it is fed automatically to a Worthington ball mill, with a rated capacity of 60 tons in 24 hours. Final grinding is at present accomplished by this operation, but the ball mill is overtaxed, and it is planned to introduce rolls between the crushers and the ball mill, reducing the product to 1¼-inch size before delivery to the mill. This will be a great improvement. The pulp from the ball mill goes to a classifier, from which the oversize is conveyed back by a scraper belt to a trommel, while the fines flow off and are raised by a bucket elevator belt to the flotation cells. The oversize from the trommel goes back to the ball mill, and the undersize to a Biester-Overstrong concentrating table. The flotation plant consists of five cells, in which are used mixtures of oil of pine, pine tar, creosote, and coal tar. About 90 per cent of the ore is caught in the first two cells. From these the concentrate goes to Callow cones, where it is largely dewatered. Final drying is accomplished in filter presses, where the moisture is drawn off by compressed-air suction. A shipping product containing only 10 per cent of moisture is said to be produced.

DUNTON MINE.

The Dunton mine, the property of the Dunton Gold Mining Co., is on Harris Creek about 2 miles from the post office of Hollis, at the upper limit of high tide. Harris Creek is navigable for small boats at high tide up to the mine. This property lies at the south end of a zone of mineralization, which extends somewhat east of north for 4 or 5 miles, reaching some distance north of May-be-so Creek. The Dunton property includes two claims along this mineralized zone.

The country rock in this vicinity, according to Chapin,[9] consists of "a complex assemblage of igneous and sedimentary rocks. The bedded rocks include tuff, breccia, schist, limestone, black slate, argillite, and graywacke and are cut by a large boss of quartz diorite and associated porphyritic dikes." The country rock at the mine is a graphitic slate, which ranges in strike from east to N. 30° W., averaging perhaps N. 30° E., and dips 12°–35° SE. The slate is much faulted and slickensided, but the displacements are for the most part parallel with the rock structure. The highly graphitic character of the slate is particularly evident along the slickensided surfaces. Fine-grained dike rocks, in places porphyritic, also intrude the country rock more commonly parallel with the structure of the slate than otherwise.

The mineralized zone on which the Dunton mine is located extends about 2 miles to the northeast and then changes in trend or joins another zone which extends northward to May-be-so Creek. The northeastward-trending zone ends at the Hollis group of claims, and the northward-trending zone, which begins at that point, includes the Crackerjack and Ready Bullion lodes, to the north, although these

[9] Chapin, Theodore, Mining developments in the Ketchikan district, 1917: U. S. Geol. Survey Bull. 692, p. 87, 1919.

two lodes appear to be separate veins. According to Chapin[10] three veins, known as the lower, middle, and upper veins, are recognized at the surface in this mineralized zone. "These are approximately parallel and form a lode system following intrusive porphyry dikes." The vein that is mined at the Dunton mine is the upper vein. A 10-inch quartz seam lies 15 feet below this, and a barren quartz vein lies 150 feet lower.

The Dunton lode consists of a number of quartz stringers which form a mineralized zone in and conformable with the slate. The thickness averages about 7 feet, though increasing locally to 12 feet. The individual quartz stringers range in thickness from a few inches up to 1 or 2 feet. Much faulting has taken place parallel with the vein, crushing and slickensiding the ore and country rock but causing no apparent displacement. Dikes run parallel with the vein, more commonly on the hanging than on the footwall side, but here and there cutting across the lode. Many of these dikes are mineralized with pyrite, but they do not constitute minable ore. They have been greatly altered to secondary products, and the original petrographic character could not be inferred. The vein pitches on the average about 28° SE.

The quartz is mineralized by auriferous pyrite, gold, and a little galena. Good ore occurs in shoots, which appear to be localized in parts of the vein where the dip is lowest. The ore is best where pyrite is most abundant. Locally the slaty country rock carries some gold, particularly where it is pyritized. About 75 per cent of the gold is free, and the concentrates consist almost wholly of pyrite. Taken as a whole, the quartz and mineralized country rock, which together form the ore, would be classed as a low-grade gold ore, but only ore from the richer shoots is mined. This gives a higher-grade ore but limits the available tonnage.

The mine is developed by an adit 364 feet long, which follows down the dip of the vein. Four drifts—a short one at 70 feet, another at 100 feet, a third at 180 feet, and the fourth at 250 feet—constitute the chief development work. The ore is reduced by a 5-stamp Chalmers & Williams mill, with plates and concentrating table, operated by three vertical turbines generating together 90 horsepower. The mill has a capacity of 12 tons a day. Water is brought from Harris Creek through a 250-foot flume and delivered with a head of 13 feet.

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[10] Chapin, Theodore, op. cit., p. 88.

NOTES ON THE SALMON-UNUK RIVER REGION.

Compiled by J. B. MERTIE, Jr.

INTRODUCTION.

The Salmon-Unuk River region, in southeastern Alaska, is a trapeziform area of about 1,800 square miles, lying between parallels 55° 50′ and 56° 30′ north latitude and meridians 129° 50′ and 131° 10′ west longitude. The international boundary between Alaska and British Columbia, extending in a general northwesterly direction along the crest of the Coast Range, delimits the area on the northeast. This district is adjacent to tidewater, reaching Behm Canal on the southwest side and Portland Canal on the southeast side. On account of mining activity in the vicinity of Portland Canal, the southeastern part is referred to by Americans as the Portland Canal district and by Canadians as the Portland Canal mining division.

This portion of southeastern Alaska, along the international boundary and adjacent to the intrusive rocks on the Coast Range, has been recognized for years as favorable for the occurrence of mineral deposits, and in the last 22 years numerous more or less promising deposits have been discovered and located. The present renewal of public interest in this part of Alaska and British Columbia is due mainly to the recent successful development of some of these deposits at the head of Portland Canal, on the Canadian side of the boundary, and the promise which such development holds forth for the subsequent exploitation of similar deposits that lie along this same zone of mineralization.

A considerable amount of topographic and geologic work, both American and Canadian, has been done in this district and in the area adjoining it. The first and most essential preliminary requirement—that is, a topographic map—was prepared by the Canadian Boundary Commission in 1902, in connection with the accurate location of the international boundary; and in 1910 a topographic map of the Portland Canal mining area (map 50 A) was prepared by the Geological Survey of Canada. The later map covers mainly the area drained by Bear River, one of the headwater tributaries of Portland Canal. The accompanying base map (Pl. V) is compiled mainly from these two sources. A new map of this area is soon to be issued by the International Boundary Commission.

The principal publications by workers in the United States Geological Survey that have a bearing on the geology and mineralization of the Salmon-Unuk River district are as follows, named in chronologic order.

Brooks, A. H., Preliminary report on the Ketchikan mining district, Alaska: U. S. Geol. Survey Prof. Paper 1, 1902.

Wright, F. E., The Unuk River mining region of British Columbia: Canada Geol. Survey Summary Rept. for 1905, Ottawa, 1906.

Wright, F. E., and C. W., The Ketchikan and Wrangell mining districts, Alaska: U. S. Geol. Survey Bull. 347, 1908.

Chapin, Theodore, Mining developments in southeastern Alaska in 1915: U. S. Geol. Survey Bull. 642, pp. 94–98, 1916.

The Skeena and Portland Canal mining divisions include that part of the Salmon-Unuk River region that lies in British Columbia. Notes on the progress of mining in these divisions have been published annually for a number of years by the British Columbia Bureau of Mines. The latest of these reports dealing with the valley of Salmon River are as follows:

Clothier, G. A., Portland Canal mining division: British Columbia Bur. Mines Ann. Rept. for 1917, pp. F68–F73, 1918.

Jack, P. S., Portland Canal mining division: Idem, p. F84.

Clothier, G. A., Portland Canal mining division: Idem for 1918, pp. K80–K83, 1919.

Investigations have also been carried on by the Geological Survey of Canada in these mining divisions, and this work is still in progress. Four reports have so far been published, and a fifth is in course of publication. The published reports are as follows:

McConnell, R. G., Portland Canal district, British Columbia: Canada Geol. Survey Summary Rept. for 1909, pp. 59–89, 1910.

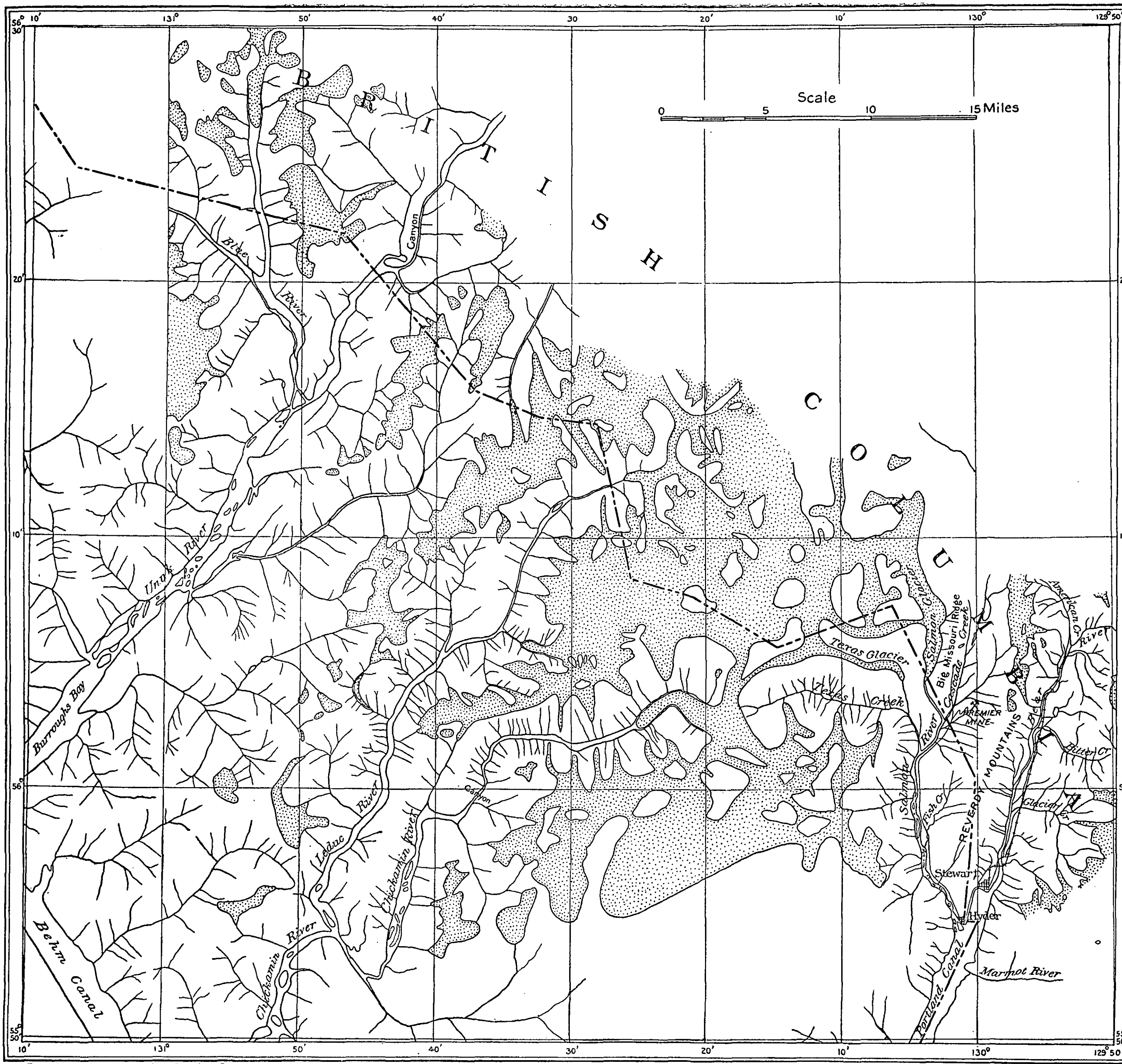
McConnell, R. G., Salmon River district, British Columbia: Idem for 1911, pp. 50–56, 1912.

McConnell, R. G., Portland Canal district, British Columbia: Idem, pp. 56–71.

McConnell, R. G., Portions of Portland Canal and Skeena mining divisions, Skeena districts, British Columbia: Canada Geol. Survey Mem. 32, 1913.

The last named of these four publications is essentially a compilation from the three earlier summary reports.

The present report represents no original work whatever on the part of the writer. It is essentially a brief compilation of the work of earlier American and Canadian workers, prepared to meet the demand for a statement of the available information on the area beginning at Portland Canal and extending northwestward. The only qualification of the writer for the preparation of such a statement is a general familiarity with the country gained by geologic field work in southeastern Alaska. The latest work by the United States Geological Survey was done in the Portland Canal district by Theodore Chapin in 1915, and his report is cited above.



From surveys by the International Boundary Commission

MAP OF SALMON-UNUK RIVER REGION.

PHYSICAL AND ECONOMIC GEOGRAPHY.

RELIEF.

The Salmon-Unuk River region belongs in large part to the Coast Range province of southeastern Alaska and is therefore an area of considerable relief. The area included in this report extends from tidewater at Behm and Portland canals to the crest of the Coast Range and therefore lies mainly in the western half of the Coast Range. The range in this area is about 100 miles wide and has rather poorly defined crest line. Many of the peaks of the range attain elevations of 6,000 to 9,000 feet, but within this area none exceed 8,000 feet. The mountain summits are more uniform in elevation in this western portion of the range, within the area of granitic rocks, than on the east side, where argillites and greenstones occur.

Some of the larger streams in this vicinity, such as Stikine, Nass, and Skeena rivers, cut completely through the Coast Range, and the smaller streams are in general deeply incised, resulting in the development of a marked relief. Thus Unuk River at the international boundary flows at an elevation of 600 feet above sea level, and a peak a short distance northwest rises to 6,200 feet. Similarly, Salmon and Bear rivers have their upper basins adjacent to mountains of 7,000 to 8,000 feet in elevation and reach tidewater within a distance of about 15 miles.

In addition to marked relief, this area is further characterized by very precipitous slopes, caused mainly by intense glaciation. The higher peaks are sharp and serrated, owing to crest-line sapping by the glaciers. Below 5,500 feet the hills were overridden by flowing ice and the crests are smooth and rounded, but the valley walls have been oversteepened by glacial scouring and are everywhere very precipitous and in places sheer, unscalable cliffs.

DRAINAGE.

The principal streams that drain this area, named in order from northwest to southeast, are Blue, Unuk, Leduc, Chickamin, Salmon, and Bear rivers. Of these, Blue River is tributary to the Unuk and Leduc River to the Chickamin. Unuk River enters Burroughs Bay, an inlet from Behm Canal, and Chickamin River enters Behm Canal. Salmon and Bear rivers enter Portland Canal at its head. Both Unuk and Chickamin rivers rise within the Coast Range and flow through more or less canyon-like valleys in their upper courses. In their lower courses, however, the valleys of these two streams broaden out and are characterized by wide, gravel-covered bottoms. At the head of Unuk River, about 60 miles from Burroughs Bay, a narrow divide leads over to a branch of Iskoot River, through the valley of which it is possible to enter the inland plateau of British Columbia.

Salmon and Bear rivers, though shorter than the Unuk and Chickamin, are of the same general character. Salmon River heads in Salmon Glacier and flows 13 miles to Portland Canal. Its principal tributaries are Texas Creek from the west and Cascade Creek from the north. Big Missouri Ridge, on which are some of the chief mining properties of the district, lies between Cascade Creek and Salmon Glacier, and Bear River Ridge is the divide between Bear and Salmon rivers.

Bear River is a swift mountain stream about 18 miles in length that enters the upper end of Portland Canal. It heads against Strohn Creek, a tributary of Nass River, in a low pass comparable with the pass at the head of Unuk River.

GLACIERS.

The upland areas of this region are covered with snow above an elevation of about 5,000 feet, and these snow fields form the reservoir or collecting ground for numerous glaciers that extend down into the valleys. At least one-fourth of the region here described is thus covered with snow and ice. The glaciers are of the valley or alpine type, and few of them extend far down into the valley bottoms. Practically all the major streams head against the terminals of these ice lobes. This present condition of alpine glaciation is an aftermath of the greater piedmont glaciers which at an earlier period covered all the mountains of this area and formed a continuous sheet of flowing ice that extended from sea level up to an elevation of about 5,500 feet.

CLIMATE.

This region has the characteristically wet climate of the western flank of the Coast Range, though the precipitation is not so great as at some other localities in southeastern Alaska, being probably about 100 inches a year. The summer climate is cool, with considerable rainfall, and the least precipitation occurs late in the spring and early in the summer. The winter climate is comparable with that of Juneau, and the thermometer seldom falls below zero. Snow falls in the valleys from November to March. Snowslides from the steep slopes are of common occurrence late in the winter and in the spring.

TIMBER AND VEGETATION.

The region is heavily forested up to an elevation of about 3,500 feet, and stunted timber grows in places 1,000 feet higher. In the valley bottoms, where the best timber is found for mining purposes, hemlock is the most abundant as well as the most valuable tree and furnishes good timber for mining and structural uses. Sitka spruce and cottonwood are also well represented in the valleys. Balsam and mountain hemlock are more abundant on the higher slopes. In addition to trees, a thick mantle of other vegetation, including moss and brush of several varieties, covers the bedrock exposures, except at high altitudes and on unscalable cliffs. This mantle makes prospecting difficult and accounts in part for the slow development of the mining resources.

WATER POWER.

Water powers should be available at many localities in this region, owing to the large size and steep gradients of the streams. In summer, as is the general rule in an area of high precipitation, with streams fed by melting snow and ice, water is usually plentiful. In winter, however, the supply is much less, for the precipitation is in the form of snow, and glacial melting is at a minimum. Careful measurements of the minimum run-off in winter should precede the establishment of power plants. Two power plants have already been established in Canadian territory, on Glacier and Lydden creeks, tributaries of Bear River.

SETTLEMENTS.

The two important settlements are Stewart and Hyder, the former in Canadian and the latter in American territory. Stewart, the distributing point for the Canadian part of the mining district, is at the head of Portland Canal, at the mouth of and on the west side of Bear River. It had a population of about 250 people in the fall of 1919. Hyder, the American distributing point, is about 2 miles from Stewart, at the mouth of and on the east side of Salmon River. In the fall of 1919 it was said to consist of 30 to 40 houses and was supplied with a wharf.

MEANS OF COMMUNICATION.

Hyder and Stewart, being on tidewater, are connected by steamship and gas-boat service with Prince Rupert and Ketchikan. A railroad starting from Stewart has been built up Bear River for a distance of about 12 miles, and a wagon road has also been constructed up the Bear River valley. Another wagon road has been built up the east side of Salmon River from Hyder for 11 miles, and a trail continues up onto the ridge between Salmon Glacier and Cascade Creek as far as the Big Missouri mine, a distance from Hyder of about 20 miles. A good wagon road has been built from Elevenmile up to the Premier mine, a distance of 5 miles. Another good road connecting Stewart and Hyder is nearing completion. During the summer of 1920 a road will probably be built from Elevenmile up Big Missouri Ridge. The Salmon River road is the only feasible means of egress from the Canadian mining properties along the west side of Bear River and on Big Missouri Ridge.

Another means of entrance to this region is by way of Unuk River. In 1905 a wagon road was built up Unuk River for a distance of 42 miles to a mining prospect, but portions of the road are now washed out.

GEOLOGY.

SALIENT FEATURES.

Little geologic work has been done in the American part of the Salmon-Unuk River region, chiefly because the rocks are mainly intrusive and afford little information regarding the geologic history of the region. On the Canadian side, however, a considerable amount of geologic study and mapping has been accomplished, chiefly by R. G. McConnell, of the Geological Survey of Canada, whose reports are listed on page 130. Subsequent work has been done by J. J. O'Neill, of the same organization, but the results of his investigations have not yet been published. The writer has merely compiled a condensed summary of the geology, so far as known at present.

The Coast Range batholith of granitic rocks is bordered on the east in the vicinity of Portland Canal by two series of sedimentary rocks, mainly of argillaceous character, between which lies a volcanic complex of massive and fragmental igneous rocks, usually of greenstone habit. All three of these formations are cut by intrusive rocks. At some localities Tertiary lavas are also present. Overlying the hard rocks are surficial deposits of alluvial, estuarine, and glacial origin. These six rock units, named in order from oldest to youngest, are the Bitter Creek formation, the Bear River formation, the Nass formation, the granitic rocks of the Coast Range, the Tertiary lavas, and the surficial deposits. The Bear River formation is a complex of volcanic rocks, in which has occurred the mineralization on Bear River and Big Missouri ridges, where mining developments are now progressing so rapidly.

BITTER CREEK FORMATION.

In the vicinity of Portland Canal the Bitter Creek formation is not known to occur west of Bear River, and therefore it will probably not be seen along the international boundary, where present mining interest centers. The formation consists mainly of argillite, which in places has developed a slaty cleavage, usually parallel with the original bedding planes. Some beds of much altered greenstone of tuffaceous origin and small nonpersistent beds of crystalline limestone are interstratified with the argillite at certain localities. This series of rocks as exposed east of Bear River dips southwestward under the other formations and is considered older. These rocks are either Paleozoic or Mesozoic; their exact age is not known. In the valleys of Glacier and Bitter creeks, eastern tributaries of Bear River, quartz veins and other mineralized zones are present in the Bitter Creek formation.

The upper 25 or 30 miles of Unuk River drains a schist-argillite belt, which begins about 4 miles upstream from the international boundary and is probably, at least in part, the equivalent of the Bitter Creek formation as known east of Bear River. It is likely that the schistose members in this belt have been developed by dynamic metamorphism caused by the intrusion of the Coast Range batholith. This belt of argillite appears to parallel the granite of the east from British Columbia to Skagway, and is characterized along its whole extent by the occurrence here and there of silver and gold bearing veins in the vicinity of the granitic rocks. Placer gold and lode deposits of silver, gold, and lead have been found in the upper valley of Unuk River, on the Canadian side of the boundary.

At least two narrow bands of schist cross Unuk River below the international boundary, and a somewhat wider band follows along the east side of Behm Canal. These schistose rocks are believed to represent metamorphosed phases of the sedimentary series of rocks east of the Coast Range batholith.

BEAR RIVER FORMATION.

Overlying the Bitter Creek formation is the Bear River formation, which crops out along the east side of Salmon River in Alaska and continues northeastward into British Columbia. This formation is the main country rock of the Salmon River valley, where a number of promising mining properties are situated. It is a complex made up chiefly of massive and tuffaceous volcanic rocks. The massive rocks are in general of andesitic nature and are called porphyrites. In general they are porphyritic, though this feature is not noticeable in all hand specimens, and they show a flow structure in many thin sections. Plagioclase feldspar in two generations is the chief constituent and is accompanied by subordinate amounts of augite or hornblende, iron oxides, and apatite. Secondary minerals, including chlorite, calcite, epidote, leucoxene, and hematite, are sufficiently common to impart to the rocks as a whole a greenstone habit. The fragmental rocks consist of tuff, volcanic breccias, and agglomerates and evidently indicate that sedimentation played a considerable part in the formation of this complex. This inference is further borne out by the presence of some thin intercalated beds of argillite.

Along the east side of Salmon Creek, in American territory, where this series of rocks abuts against the granite of the Coast Range, the greenstones are intensely sheared and metamorphosed and have developed into coarse greenish and grayish schists, in which the schistosity roughly parallels the greenstone-granite contact. The rocks dip steeply toward the granite, and in general the metamorphism increases in intensity in that direction.

NASS FORMATION.

Little need be said of the group of rocks that constitute the Nass formation, for they are not known to occur in Alaska and have not been found to be mineralized. Like the Bitter Creek formation, the Nass consists of a thick series of argillite, with some coarse clastic beds. In the upper Salmon River valley, within British Columbia, isolated bodies of such rocks overlie the Bear River formation.

GRANITIC ROCKS OF THE COAST RANGE.

The intrusive rocks that compose the Coast Range batholith range from granite to diorite and even to gabbro. Quartz-hornblende diorite, however, is the predominating type. The major part of the Salmon-Unuk River region is occupied by granitic rocks.

Within the central part of the granitic batholith the granite is of rather uniform texture, but at the edges, particularly along the west flank, variations are seen. Thus along the shores of Behm Canal pegmatite and aplite dikes form an intricate network of white strands at the edge of the granodiorite, and in the adjacent schist several generations of such dikes may be observed. At a distance this complex of granodiorite, schist, and dikes resembles a breccia. The granodiorite is also commonly gneissoid, and the included fragments of schist merge into rocks resembling basic differentiation products. As a result of this condition, brought about by intrusion at great depth, the contact between the granite and other country rock is indistinct in many places along the western flank of the batholith. This condition is less apparent along the eastern flank, although dike rocks are also present there.

The typical quartz-hornblende diorite of the Coast Range is composed essentially of plagioclase, feldspar, quartz, biotite, hornblende, and orthoclase, named in the order of abundance. Titanite, magnetite, and apatite are accessory minerals, and small amounts of secondary products such as epidote, sericite, calcite, and chlorite also occur in the central part of the batholith.

These granitic rocks are the source of the mineralizing solutions that have produced the ore deposits in this district, but the methods of formation of the deposits have been devious, and the resulting ores show wide differences in location, character, extent, and mineral content. It is noticeable, however, that important mineralization does not appear to have occurred within the main batholith but was confined to the edges of the granitic rocks and the adjacent sedimentary rocks. This is due to the fact that the mineralizing solutions found their easiest upward course along the fractured zones near the contact. The practical importance of this generalization is that the best hope of finding ore deposits on the American side of the Unuk-

Salmon River district is along the east side of Salmon River, where the Bear River formation occurs.

TERTIARY BASALT.

The Tertiary basalts of this region are gray-green to black porphyritic rocks ranging in composition from basic andesite to normal basalt, composed essentially of plagioclase, pyroxene, and magnetite, with a little olivine or quartz. Some alteration has taken place, but as a rule these rocks are very fresh in appearance. These beds of lava have been little disturbed since their formation and in most places lie almost horizontal. Some tuffaceous layers are interbedded with the lavas. Postglacial basaltic lavas are found in the lower valley of Blue River, just above its junction with the Unuk.

SURFICIAL DEPOSITS.

The surficial deposits are chiefly of three types, glacial, estuarine, and alluvial. The glacial deposits consist of till, glaciofluviatile material, and boulder clay, collected in deposits of many types. Estuarine deposits similar to those now being formed in the heads of the fiords are found on the hillsides at a height of 350 to 500 feet above the present sea level and point unmistakably to a postglacial uplift. Alluvial deposits composed of silt, sand, and gravel occur in the valleys and are due to aggradation by the present streams. Lacustrine deposits are also present in small areas.

MINERAL RESOURCES.

GENERAL LOCATION.

The mineralized zone of the Salmon-Unuk River region lies mainly along the east flank of the Coast Range granite batholith and is therefore largely in Canadian territory, except in the valley of Salmon River, at the head of Portland Canal. Prospecting and mining have been done at two general localities, one around the headwaters of Unuk River and the other at the head of Portland Canal, in the valleys of Salmon and Bear rivers. A zone of mineralization, however, lies along the east side of the granite batholith in British Columbia, and it is very likely that other mineral deposits will be found along this zone. It is significant that mineral deposits have been found at both the localities mentioned, which, as before pointed out, are the two natural passages through the range from the west in this particular district. The Portland Canal area is the more advantageously situated, for Portland Canal cuts completely through the granite and brings tidewater almost to the mines. The renewal of interest in mining in this district is due to the successful development of the Premier mine, and other properties of similar character in the upper valley of Salmon Creek. Most of these properties are on the Canadian side of the boundary, but it is not unlikely that others worth while will ultimately be located on the American side.

UNUK RIVER.

Placer gold was reported in the Canadian part of the Unuk Valley during the Cassiar excitement in the early seventies but received little attention. In the early eighties gold-bearing gravels were discovered on Sulphide Creek, and some placer gold was mined. Subsequent to the rush of 1898 lode deposits were located on Sulphide, Canon, and Bowlder creeks, tributaries of Unuk River, and on the North and South forks of the Unuk. On Sulphide Creek two quartz veins in particular were prospected—one a 2 to 8 inch vein of high-grade ore and the other a 20 to 30 foot vein of lower-grade ore. The high-grade ore from the narrow vein consisted chiefly of tetrahedrite (gray copper), pyrite, sphalerite, galena, and native silver. About 100 tons of ore from this vein was milled in a small stamp mill in 1901 and is reported to have given high assay returns, particularly in silver. The ore minerals of the other vein consisted of pyrite, galena, sphalerite, and chalcopyrite, with a little native gold in the oxidized parts of the vein. The remoteness of these lodes from the coast and the difficulties of access, even after a road was built up Unuk River, have caused a loss of interest in this mineralized area, and of late years no work has been done in this vicinity. It is admitted that a low-grade property would be of little value at that distance from the coast, but further prospecting along the east side of the granite batholith, north and south from Unuk River, with the purpose of locating lodes of high-grade ore, might be well worth while.

SALMON RIVER.

GEOGRAPHY.

Salmon and Bear rivers, at the head of Portland Canal, particularly the former, are the centers of the present mining interest in this district. Bear River flows entirely in British Columbia, but Salmon River lies partly in British Columbia and partly in Alaska. On this account, and because interest centers in this locality, only the conditions in the valley of Salmon River will be discussed here.

Salmon River rises in Salmon Glacier and flows about 13 miles to Portland Canal about 2 miles below Stewart. All of Salmon River proper lies in Alaska. Cascade and Texas creeks are the two important headwater tributaries. Cascade Creek rises in British Columbia and flows about 6 miles southward to join Salmon River about 2 miles below the glacier. Texas Creek lies entirely in Alaska, is about 10 miles in length, and flows in a general easterly direction to Salmon River about 4 miles below the glacier. The main ridge between Salmon and Bear rivers is known as Bear River Ridge, and the smaller ridge lying between Salmon Glacier and Cascade Creek is called Big Missouri Ridge. (See Pl. V.) The properties now under intensive development lie in the valley of Salmon River along the west side of Bear River Ridge and on Big Missouri Ridge.

AREAL GEOLOGY.

The country rock along the east side of Salmon River and Salmon River Glacier is mainly the andesitic greenstone of the Bear River formation. To the west lies the granite of the Coast Range. The contact between these two formations, however, is irregular and is marked by Salmon River only in the most general way. Isolated areas of granodiorite are present in the Bear River formation east of Salmon River and in fact are the immediate sites of a number of the ore deposits.

The greenstone near the granitic rocks is sheared and at places rendered schistose, the schistosity trending north and dipping toward the granite. The shearing and fissuring that are related to the ore deposition, however, cut transversely across the earlier structure, as may be seen at the Premier mine. Dike rocks of a variety of types, ranging from granite to more basic rocks, together with other intrusives of similar composition but of a fine-grained porphyritic character, are found in the Bear River formation. Some of these dikes are connected with the intrusion of the Coast Range batholith; others are no doubt more closely related to the andesitic greenstone sequence. It is presumed that the mineralization is connected with the intrusive igneous rocks of the Coast Range.

TYPES OF DEPOSITS.

Two general types of lode deposits may be found along the east side of the Coast Range batholith, within the Salmon–Unuk River region. These may be designated vein deposits and replacement deposits. The vein deposits consist of metallic minerals, usually with quartz, which have been laid down in open fractures, with a minimum of replacement of the country rocks. Where such deposits fill openings of regular form, such as openings along fault or joint planes, true veins are developed. Where the infiltration and deposition have occurred in irregularly fractured areas, something akin to a brecciated ore zone results. The replacement deposits are those which have been formed in zones of shearing and fissuring, with or without gangue minerals but accompanied by much replacement of the country rock. Naturally these two types are not mutually exclusive, and both types may be found in close association at some localities. It appears that the lodes along the east side of the Coast Range have been deposited at shallower depth than those along the west side, as at Juneau, and in contradistinction to the lodes of Kasaan Peninsula they show little or no evidence of contact-metamorphic origin.

Deposits of both the types mentioned are found in the Salmon River valley. The low-grade ores are chiefly impregnation and replacement deposits of considerable size lying along zones of fissuring and shearing. They are characterized by indistinct rather than sharp boundaries. The ore minerals are usually pyrite, sphalerite, galena, and chalcopyrite, and the valuable constituents are gold, silver, zinc, and to a smaller extent copper. Pyrrhotite is present at some localities, but it carries little gold, as the gold is apparently associated for the most part with pyrite. At and in the vicinity of these impregnated zones the country rock is much silicified and altered to calcite, chlorite, and sericite. In places the gangue material consists solely of such altered country rock. Considerable oxidation has taken place, as is indicated by the discoloration at the surface outcrops, and there is reason for the belief that downward enrichment may have played some part in the formation of some of the lodes.

The high-grade deposits are essentially rich silver and gold ores, occurring both as veins and as replacement deposits, many of them within zones of lower-grade ores. These higher-grade ores have not been studied in detail, and their exact relation to the lower-grade ores is not definitely understood, though the evidence available points to their formation at a somewhat later period. The silver minerals present in the high-grade ores include argentite (silver glance), argentiferous tetrahedrite, native silver, pyrargyrite, and proustite, and possibly stephanite and other silver minerals. Little native gold is seen, and ores with high gold content are characterized by much pyrite.

LODE PROPERTIES.

The properties at present being prospected or developed include the Premier, Mineral Hill, Big Missouri, Bush mines, Forty-Nine, Indian mines, International, Payroll, Yellowstone, Boundary, Northern Light, Cascade Forks, Spider, Hercules, Silver Tip, Bunting, Unicorn, Lake & O'Leary, New Alaska, Knobhill, and other groups of claims. All these are in British Columbia. The International, Premier, Bunting, and Bush mines properties lie along the west flank of Bear River Ridge, but the Indian, Boundary, Payroll, Mineral Hill, Big Missouri, Hercules, Forty-Nine, and Yellowstone groups of claims stretch northward up Big Missouri Ridge.

The Premier mine is at present considered the most promising of these properties. A description of the history and development of this mine is given by Charles Bunting.[1] This property, which originally consisted of two claims, lies along the west side of Bear River Ridge and was discovered and staked in June, 1910. These and adjoining claims later passed into the hands of O. B. Bush, who organized the Salmon-Bear River Mining Co. This company and others to which the property was successively bonded carried on development work until the spring of 1919, when the potentialities of the property were finally recognized and demonstrated by R. K. Neill, of Spokane. Partial ownership and financial control have now passed into the hands of the American Smelting & Refining Co.

The lode is reported to consist of three low-grade ore bodies and one of high grade, which appear to be of the replacement type above described. The country rock is the Bear River formation, or andesitic greenstone, greatly sheared, fissured, and fractured. The high-grade deposit, on which the most work has been done, is an ore zone in the fractured porphyry and follows a shear zone of fissuring and fracturing which strikes N. 80° E. and dips 60° S. The gangue is chiefly the silicified country rock. The ore minerals are reported to be argentite (silver glance), argentiferous tetrahedrite, stephanite (brittle silver), pyrargyrite, proustite, native silver, and pyrite carrying much gold. A little pyrrhotite is present, but it carries only a small percentage of gold. Small stringers in the larger ore body are reported to carry wonderful specimens of the silver minerals. Though classed as a rich silver mine, the ore is valuable for both gold and silver, the latter predominating. A sampling of all the present workings and openings is reported by Bunting to have given an average value well over $30 a ton in silver and gold. The 512 tons that has so far been shipped gave smelter returns of $168,000.

Less is known as yet of the possibilities of the low-grade deposits on the Premier property, but it is assumed that like other low-grade deposits near by, they consist of silicified zones in the andesitic greenstone, impregnated with sulphides, chiefly pyrite, galena, sphalerite, and chalcopyrite, carrying both gold and silver.

The big Missouri, Mineral Hill, and Bush properties are also being developed.

With regard to mining properties in the Alaska portion of the Salmon River valley the following notes by Chapin[2] give some idea of what had been accomplished up to 1915:

> A group of claims extending from Sevenmile, on Salmon River, to Fish Creek, has been located, but only two of them have been developed. On the Riverside claim a tunnel 100 feet above the river flat has been driven for 140 feet along a strong fissure vein. The vein averages about 4 feet in width but pinches to 18 inches and in places widens to 6 feet. Both walls are well defined. The wall rock is somewhat

[1] Bunting, Charles, The Premier gold mine, Portland Canal, British Columbia: Min. and Sci. Press, Nov. 8, 1919, pp. 670–672.

[2] Chapin, Theodore, Mining developments in southeastern Alaska, 1915: U. S. Geol. Survey Bull. 642, pp. 97–98, 1916.

altered but contains little gouge. The vein filling is quartz with abundant sulphides. Pyrite is the most abundant along the hanging wall and occurs in solid bunches and in disseminated particles associated with chalcopyrite. On the footwall galena is the most plentiful sulphide. The country rock is crystalline schist. On a parallel lode of much the same character the Riverview claim is being developed. The vein strikes N. 60° W. and dips about 60° NE. An adit has been driven for 17 feet, exposing a vein that varies from 1 foot to 4 feet in width. At the mouth of the opening it is 2 feet wide on the roof and widens to 4 feet on the floor of the adit. At the face it is from 12 to 18 inches in width. Although the vein swells and narrows from place to place, the walls are well defined.

At Elevenmile a little prospecting has been done, and several claims have been located. On the Elevenmile and Iron claims a number of open pits have exposed an iron-stained lode that follows a brecciated zone filled with veins of quartz carrying chalcopyrite, sphalerite, and galena. Stringers of sulphide form shoots of very rich ore with high silver content. On the Iron claim a ton of this high-grade ore has been sacked ready for shipment. The lode strikes northeast and dips steeply northwest. On the hillside above Elevenmile, at an altitude of 1,500 feet, the Bertha and Western claims are being developed on a northeastward-trending lode. One surface cut shows the lode to be at least 15 feet in width. It consists of silicified schistose green tuff of the "Bear River formation," with disseminated pyrite, chalcopyrite, galena, and sphalerite. A number of claims have been staked on a zone of disseminated deposits exposed along Salmon River at Eightmile and Ninemile, but only a little work has been done.

Some promising fissure lodes have been located by Murphy & Stevenson on Fish Creek and its tributary, Skookum Creek, where more than the necessary amount of assessment work has been done. Near the mouth of Skookum Creek an adit was driven for 25 feet along a fissure that had been traced by surface trenches for 2,000 feet The vein is 4½ feet wide, strikes N. 40° E., and dips about 55° SE. The quartz gangue carries galena, chalcopyrite, tetrahedrite, sphalerite, and pyrite in veinlets and irregular patches. It is being exploited mainly for its gold and silver content.

Near the head of Skookum Creek, at an altitude of 1,600 feet, a fissure vein has been opened by an adit 320 feet in length and several crosscuts and inclines. The gangue is quartz. Metallic sulphides present are tetrahedrite, chalcopyrite, galena, sphalerite, and pyrite in blebs and veinlets penetrating the quartz, and the richest ore occurs in veinlets of tetrahedrite and galena. The country rock is porphyry and schistose tuff of the "Bear River formation." The lode strikes N. 55° W. and dips 45° SW. At the portal it is about 18 inches wide. At 70 feet from the portal only a part of the vein is exposed, as the ore has been removed to a wall within the vein. At this place the vein is 3 feet wide plus an unknown width in the wall of the adit. At various places portions of the vein said to be very rich have been stoped out. At 300 feet from the adit mouth the lode is abruptly cut by a vertical fault trending nearly perpendicular to the lode, and short drifts along the fault plane in both directions had not shown the position of the faulted lode. Samples of ore said to come from a near-by prospect, which was not visited, contain particles of free gold in siliceous gangue.

Several claims have been staked on Texas Creek. The ore bodies are reported to be quartz veins carrying seams of tetrahedrite penetrating granite and pegmatite. Little work has been done in this locality.

WATER-POWER INVESTIGATIONS IN SOUTHEASTERN ALASKA.[1]

By George H. Canfield.

INTRODUCTION.

Systematic investigation of the water resources of Alaska was begun by the United States Geological Survey in 1906 and has been carried on in different parts of the Territory to the present time. This investigation was undertaken in response to the need for definite information in regard to water available for many uses, among which the most important are hydraulicking, dredging, and supplying power for mines, canneries, and sawmills.

The investigation of the water resources of southeastern Alaska was begun by the Geological Survey in cooperation with the Forest Service in 1915 and was designed to determine both the location and the possibilities of water-power sites. The results of previous years' work have already been published.[2] A table showing water-power possibilities in southeastern Alaska is given on page 184.

The Geological Survey maintained a number of gaging stations in southeastern Alaska throughout the year, and other stations were installed in cooperation with individuals and corporations. The records obtained at these stations are contained in this paper. Acknowledgment is made to those who have assisted in this work, particularly to Mr. W. G. Weigle and Mr. Charles H. Flory, supervisors of the Forest Service at Ketchikan, and to Mr. Philip H. Dater, district engineer at Portland, Oreg.

The stations for which the records are presented are the following:

- Myrtle Creek at Niblack.
- Ketchikan Creek at Ketchikan.
- Fish Creek near Sealevel.
- Swan Lake outlet at Carroll Inlet.
- Orchard Lake outlet at Shrimp Bay.
- Shelockum Lake outlet at Bailey Bay.
- Karta River at Karta Bay.
- Cascade Creek at Thomas Bay.
- Green Lake outlet at Silver Bay.

[1] In cooperation with the United States Forest Service.
[2] U. S. Geol. Survey Bull. 662, pp. 100-154, 1918; Bull. 692, pp. 43-83, 1919.

Baranof Lake outlet at Baranof.
Sweetheart Falls Creek near Snettisham.
Crater Lake outlet at Speel River, Port Snettisham.
Long River below Second Lake, at Port Snettisham.
Grindstone Creek at Taku Inlet.
Carlson Creek at Sunny Cove.
Sheep Creek near Thane.
Gold Creek at Juneau.
Falls Creek at Nickel.
Porcupine Creek near Nickel.

STATION RECORDS.

MYRTLE CREEK AT NIBLACK, PRINCE OF WALES ISLAND.

LOCATION.—Halfway between beach and Myrtle Lake outlet, which is one-third mile from tidewater, 1 mile from Niblack, in north arm of Moira Sound, Prince of Wales Island, and 35 miles by water from Ketchikan.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—July 30, 1917, to December 31, 1919.

GAGE.—Stevens continuous water-stage recorder on right bank; reached by a trail which leaves beach near the mouth of the creek.

DISCHARGE MEASUREMENTS.—At medium and high stages made from a cable across creek at outlet of lake; at low stages made by wading.

CHANNEL AND CONTROL.—The gage is in a pool 10 feet upstream from a contracted portion of the channel, at a rocky riffle that forms a well-defined and permanent control. At the cable section the bed is smooth, the water deep, and the current uniform and sluggish.

EXTREMES OF DISCHARGE.—Maximum stage during year from water-stage recorder, 3.07 feet at 9 a. m. December 18 (discharge, 196 second-feet); minimum stage 1.08 feet, September 8–9 (discharge, 28 second-feet).

1917–1919: Maximum stage recorded, 4.40 feet at 5 p. m. November 18, 1917; discharge, estimated from extension of rating curve, 387 second-feet; minimum stage, 1.08 feet September 8–9, 1919 (discharge, 28 second-feet).

ICE.—Stage-discharge relation not affected by ice.

ACCURACY.—Stage-discharge relation permanent. Rating curve, determined by five discharge measurements, is very well defined between 30 and 220 second-feet. Operation of water-stage recorder satisfactory except for periods shown in footnote to daily-discharge table. Daily discharge ascertained for periods recorder was operating by applying to rating table mean daily gage height; for periods recorder was not operating by determining with a planimeter the monthly means from an estimated hydrograph drawn by means of staff gage readings by observer about once every 10 days, maximum and minimum stages indicated by the recorder, and recorded hydrograph, and by comparison of the record for this station with that for Karta River. Records good except for periods when the recorder stopped, for which they are fair.

Myrtle Lake, the outlet of which is 800 feet from Niblack Anchorage, is 95 feet above sea level and covers 122 acres. Niblack Lake, the outlet of which is 5,700 feet from Niblack Anchorage, is 450 feet above sea level and covers 383 acres. Mary Lake, unsurveyed, is about 600 feet above sea level and is a mile long and one-fourth to one-half mile wide. The large lake area in this small drainage basin is the cause of the well-maintained flow during the winter and periods of little rainfall.

The following discharge measurement was made by G. H. Canfield:

August 29, 1919: Gage height, 1.20 feet; discharge, 32 second-feet.

Daily discharge, in second-feet, of Myrtle Creek at Niblack for 1919.

Day.	Jan.	Feb.	Mar.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	79	....	44	....	49	39	31	33	50	48
2	96	....	42	....	48	39	30	33	46	46
3	99	....	42	....	48	39	29	34	....	45
4	157	56	43	....	52	38	29	33	....	44
5	134	52	44	....	51	37	29	33	....	43
6	146	52	43	....	49	37	30	35	....	42
7	200	51	42	....	50	36	29	46	....	42
8	213	63	41	....	72	36	29	40	....	41
9	220	77	41	....	67	35	28	37	....	40
10	220	100	39	....	58	35	28	56	....	39
11	194	84	38	....	58	34	29	54	....	38
12	175	73	38	....	78	34	35	50	....	36
13	194	79	37	....	82	35	44	47	....	36
14	163	73	37	....	85	35	38	46	57	36
15	140	68	36	....	75	39	34	....	63	42
16	127	88	35	....	68	50	32	....	64	76
17	112	91	35	....	64	45	58	....	88	105
18	105	100	34	....	60	40	77	....	94	175
19	92	100	....	....	57	44	76	50	77	125
20	84	85	....	....	55	64	58	48	118	92
21	....	73	....	....	52	52	60	....	102	79
22	....	66	....	....	51	45	63	....	84	116
23	....	60	....	....	49	39	53	....	88	134
24	....	57	....	....	48	36	46	....	73	120
25	....	54	....	....	47	35	44	33	64	....
26	....	52	....	....	45	34	40	....	58	....
27	....	48	....	55	44	33	38	....	58	....
28	....	47	....	53	43	33	36	....	56	....
29	....	....	....	52	42	33	35	....	53	....
30	....	....	....	50	41	33	35	47	50	....
31	....	....	....	....	41	32	....	53	....	....

NOTE.—Discharge for following periods estimated because of unsatisfactory operation of water-stage recorder, from maximum and minimum stages indicated by recorder and by comparison with hydrograph for Karta River: Jan. 21–31, 80 second-feet; Feb. 1–3, 65 second-feet; Mar. 19–31, 60 second-feet; Apr. 1–31, 100 second-feet; May 1–31, 110 second-feet; June 1–26, 90 second-feet; Dec. 25–31, 115 second-feet. Discharge for following periods estimated from records for Karta River: Oct. 15–18, 40 second-feet; Oct. 21–24, 35 second-feet; Oct. 26–29, 35 second-feet; Nov. 3–13, 40 second-feet.

Monthly discharge of Myrtle Creek at Niblack for 1919.

Month.	Discharge in second-feet.			Run-off (in acre-feet).
	Maximum.	Minimum.	Mean.	
January	220	....	124	7,620
February	100	47	69.4	3,850
March	61	34	48.1	2,960
April	....	....	100	5,950
May	....	....	110	6,760
June	....	50	85.0	5,060
July	85	41	55.8	3,430
August	64	32	38.6	2,370
September	77	28	40.8	2,430
October	56	33	40.3	2,480
November	118	....	59.4	3,530
December	175	36	78.9	4,850
The year	220	28	70.8	51,300

KETCHIKAN CREEK AT KETCHIKAN.

LOCATION.—One-fourth mile below power house of Citizens Light, Power & Water Co. one-third mile northeast of Ketchikan post office, downstream 200 feet from mouth of Schoenbar Creek (entering from right), 1¼ miles from mouth of Granite Basin Creek (entering from left), and 1½ miles from outlet of Ketchikan Lake.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—November 1, 1909, to June 30, 1912; June 9, 1915, to December 17, 1919.

GAGE.—Vertical staff fastened to a telephone pole near board walk on left bank at bend of creek 200 feet downstream from mouth of Schoenbar Creek; read by employee of the Citizens Light, Power & Water Co. The gage used since June 9, 1915, consisted of the standard United States Geological Survey enameled gage section graduated in hundredths, half-tenths, and tenths from zero to 10 feet. The original gage, established November, 1909, and read until June 30, 1912, is at same location and same datum. It is a staff with graduations painted every tenth. Gage not replaced when a new telephone pole was placed December 17, 1919, by the company.

DISCHARGE MEASUREMENTS.—At medium and high stages from footbridge about 500 feet upstream from gage; measuring section poor, as the bridge makes an angle of 20° with the current, and at high stages the flow is broken by large stumps near left bank and at middle of bridge. Low-stage measurements made by wading 50 feet below bridge or at another section 100 feet above gage. The flow of Schoenbar Creek has been added to obtain total flow past gage.

CHANNEL AND CONTROL.—Gage is located in a large deep pool of still water at a bend in creek. The bed of the stream at the outlet of this pool is a solid rock ledge, but changes in a gravel bar at lower right side of pool cause occasional changes in stage-discharge relation.

EXTREMES OF DISCHARGE.—1909–1912 and 1915–1919: Maximum stage recorded, 8.3 feet November 18, 1917 (discharge estimated from extension of rating curve, 4,400 second-feet); minimum discharge, 34 second-feet, September 24, 1915.

ICE.—Ice forms along banks but control remains open.

DIVERSIONS.—A small quantity of water is diverted above the station for the use of the town of Ketchikan, the New England Fish Co., and the Standard Oil Co.

REGULATION.—Small timber dam and headgates are located at outlet of Ketchikan Lake. Water diverted through power house is returned to creek above gage but causes very little diurnal fluctuation. During low water the flow is increased by water from the reservoir.

ACCURACY.—Stage-discharge relation changed during high water August 19, 1917. Rating curve used August 19, 1917, to December 17, 1919, fairly well defined below and poorly defined above 800 second-feet. Gage read to hundredths once daily. Daily discharge ascertained by applying gage height to rating table.

The following discharge measurement was made by G. H. Canfield:

February 27, 1919: Gage height, 0.18 foot; discharge, 49 second-feet.

Daily discharge, in second-feet, of Ketchikan Creek at Ketchikan for 1917–1919.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1917.												
1	118	61	54	42	125	228	720	180	110	180	2,370	95
2	69	54	54	42	93	196	382	200	110	450	1,778	83
3	71	54	61	245	90	196	493	160	95	466	450	72
4	66	108	66	241	74	196	720	180	95	295	295	55
5	64	176	69	125	76	220	616	160	95	1,150	230	67
6	74	249	66	99	160	308	357	160	95	410	1,530	80
7	142	232	61	82	160	216	382	160	89	230	3,930	160
8	262	285	54	79	523	436	285	160	80	160	1,200	570
9	87	212	50	76	285	262	180	142	80	144	450	160
10	262	216	50	76	220	196	160	241	80	125	700	95
11	276	168	52	71	216	200	160	142	95	295	490	67
12	115	125	54	76	220	204	142	125	104	230	370	55
13	82	523	52	76	212	204	142	108	110	180	2,950	55
14	79	450	48	64	200	204	142	160	140	160	4,000	55
15	74	740	44	64	180	204	142	285	205	180	1,350	55
16	64	377	44	64	180	196	139	241	225	180	490	55
17	66	180	66	66	180	204	139	332	160	180	1,250	55
18	66	118	61	90	285	553	142	1,290	180	180	4,400	55
19	85	108	54	142	220	493	142	31,60	140	160	2,310	53
20	74	69	61	176	200	332	125	1,530	110	295	950	53
21	61	66	54	142	180	382	125	530	110	330	530	51
22	64	66	71	139	172	357	125	1,890	110	750	230	45
23	102	64	69	142	160	220	125	450	107	700	230	45
24	142	64	56	142	176	220	285	260	107	260	450	45
25	204	61	54	142	180	180	155	205	205	230	490	45
26	125	61	54	142	176	180	125	200	119	260	370	45
27	122	64	44	142	180	180	180	295	205	230	750	43
28	90	54	44	139	180	160	142	530	295	410	295	45
29	66	......	46	142	216	160	142	230	378	260	160	210
30	64	......	44	139	220	180	142	205	354	900	116	260
31	61	......	42	......	220	......	180	195	......	2,490	......	230
1918.												
1	205	60	55	55	144	152	180	140	77	67	800	850
2	630	55	55	60	316	125	164	134	75	95	370	700
3	260	450	53	75	410	125	148	110	67	152	140	470
4	570	230	45	80	410	122	125	67	67	1,590	116	122
5	230	148	45	62	370	95	125	104	65	1,530	180	80
6	180	119	43	53	390	86	128	62	62	470	650	53
7	125	116	43	60	370	75	131	570	55	309	390	116
8	45	95	43	89	260	67	125	510	55	800	288	104
9	45	134	43	180	242	60	119	450	53	370	160	86
10	55	119	43	92	230	110	125	330	67	323	122	67
11	86	110	43	110	220	160	95	180	65	1,770	80	64
12	89	80	43	110	205	168	119	160	55	490	134	52
13	86	67	45	119	205	180	95	80	55	330	288	53
14	65	60	45	125	172	205	89	72	53	316	225	263
15	89	55	45	134	160	205	101	75	45	230	122	230
16	83	53	45	125	180	200	86	89	53	248	134	230
17	230	53	45	119	205	200	80	92	260	610	92	281
18	309	51	45	260	205	172	80	89	205	205	67	295
19	144	45	45	402	215	160	80	122	67	370	65	230
20	110	45	45	330	225	160	77	260	53	725	67	110
21	89	45	80	316	230	156	75	205	53	312	410	104
22	254	45	53	323	160	152	75	675	53	140	230	92
23	260	45	55	260	148	152	75	510	95	119	248	160
24	274	45	75	160	125	152	72	295	65	122	370	134
25	131	43	77	152	122	160	92	205	260	92	410	610
26	110	43	67	148	110	172	104	180	125	900	370	1,000
27	119	45	75	131	110	160	530	650	62	390	288	260
28	101	67	80	131	330	125	530	288	55	370	750	125
29	80	......	89	140	205	125	200	295	55	281	1,950	101
30	60	......	62	172	200	152	148	137	53	330	1,200	67
31	55	......	55	......	176	......	180	125	......	825	......	55

Daily discharge in second-feet, of Ketchikan Creek at Ketchikan for 1917–1919.—Contd.

Day	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1919.												
1	80	67	55	950	152	205	144	89	67	67	370	65
2	410	60	53	700	122	200	125	80	67	62	230	62
3	260	55	55	390	110	180	116	80	65	77	140	67
4	1,000	55	53	260	104	172	148	77	65	80	67	55
5	610	67	53	248	92	160	110	77	67	80	67	62
6	410	55	53	180	83	160	104	75	65	410	65	67
7	630	60	51	168	80	152	95	77	62	110	62	62
8	950	205	53	370	119	140	110	80	62	101	92	60
9	610	168	55	110	125	140	107	77	60	160	80	62
10	370	140	60	92	140	152	116	77	67	80	67	60
11	370	125	55	140	160	160	118	80	67	205	89	62
12	230	119	53	92	180	152	110	83	89	125	450	60
13	140	110	53	92	160	131	230	168	67	110	370	62
14	119	86	53	95	295	134	370	172	67	101	370	67
15	104	67	55	89	610	134	260	610	65	89	570	230
16	86	116	53	95	530	128	152	172	67	122	1,100	700
17	67	110	53	89	230	125	390	110	1,650	77	1,590	630
18	67	230	53	95	470	125	110	101	1,100	67	1,410	......
19	65	110	53	95	725	152	116	134	750	72	1,350	......
20	62	75	62	370	610	248	107	725	570	75	1,150	......
21	67	72	83	323	281	267	113	205	1,100	75	750	......
22	110	67	95	570	180	458	98	125	800	67	570	......
23	101	65	89	295	195	570	110	101	205	67	390	......
24	80	62	86	220	248	394	95	95	180	65	230	......
25	72	62	53	172	260	180	101	80	134	65	125	......
26	80	60	53	650	281	205	98	70	110	72	116	......
27	80	55	62	750	230	180	98	75	89	80	95	......
28	74	55	86	634	220	160	104	75	80	72	67	......
29	180	......	195	295	140	152	101	72	67	67	67	......
30	110	......	650	180	122	140	107	67	67	225	67	......
31	75	......	530	......	116	......	95	80	......	205	......	......

Monthly discharge of Ketchikan Creek at Ketchikan for 1917–1919.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
1917.				
January	267	61	106	6,520
February	740	54	179	9,940
March	71	42	54.8	3,370
April	245	42	114	6,780
May	523	74	192	11,800
June	553	160	249	14,800
July	720	125	240	14,800
August	3,160	108	455	28,000
September	378	80	146	8,690
October	2,490	125	402	24,700
November	4,400	116	1,170	69,600
December	570	43	99	6,090
The year	4,400	42	283	205,000
1918.				
January	630	45	167	10,300
February	450	43	90.1	5,000
March	89	43	54.3	3,340
April	402	53	152	9,040
May	410	110	227	14,000
June	205	60	144	8,570
July	530	72	140	8,610
August	675	62	234	14,400
September	260	45	81.0	4,820
October	1,770	67	480	29,500
November	1,950	65	357	21,200
December	1,000	53	231	14,200
The year	1,950	43	198	143,000

Monthly ischarge of Ketchikan Creek at Ketchikan for 1917–1919—Continued.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
1919.				
January	1,000	62	247	15,200
February	230	55	92.1	5,120
March	650	51	98.9	6,080
April	950	89	294	17,500
May	725	80	238	14,600
June	570	125	195	11,600
July	390	95	137	8,420
August	725	67	135	8,300
September	1,650	60	266	15,800
October	410	62	107	6,580
November	1,590	62	406	24,200
December 1-17	700	55	143	4,820
The year				138,000

FISH CREEK NEAR SEALEVEL, REVILLAGIGEDO ISLAND.

LOCATION.—In latitude 55° 24′ W., near outlet of Lower Lake on Fish Creek, 600 feet from tidewater at head of Thorne Arm, 2 miles northwest of mine at Sealevel, and 25 miles by water from Ketchikan.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—May 19, 1915, to December 31, 1919.

GAGE.—Stevens water-stage recorder on right shore of Lower Lake, 200 feet above outlet.

DISCHARGE MEASUREMENTS.—At medium and high stages made from cable across creek, 1 mile upstream from gage and 500 feet above head of Lower Lake; at low stages made by wading at cable. Only one small creek enters Lower Lake, at point opposite gage, between the cable site and control.

CHANNEL AND CONTROL.—The lake is about 500 feet wide opposite the gage. Outlet consists of two channels, each about 60 feet wide, separated by an island 40 feet wide. From the lake to tidewater, 200 feet, the creek falls about 20 feet. Bedrock exposed at the outlet of the lake forms a well-defined and permanent control.

EXTREMES OF DISCHARGE.—Maximum stage during year from water-stage recorder 4.78 feet at 11 p. m., December 18 (discharge computed from an extension of rating curve, 3,810 second-feet); minimum stage, 0.63 foot, March 19 (discharge, 40 second-feet).

1915–1919: Maximum stage recorded, 5.33 feet November 1, 1917 (discharge, 4,600 second-feet); minimum stage, 0.50 foot, February 11, 1916 (discharge, 22 second-feet).

ICE.—Lower Lake freezes over, but as gage is set back in the bank ice does not form in well, and the relatively warm water from the lake and the swift current keep the control open.

ACCURACY.—Stage-discharge relation permanent. Rating curve well defined below and extended above 1,500 second-feet. Operation of water-stage recorder satisfactory except for period indicated by break in record shown in footnote to daily-discharge table. Daily discharge ascertained by applying to rating table mean daily gage height determined by inspecting gage-height graph, or, for days of considerable fluctuation, by averaging results obtained by applying to rating table mean gage heights for regular intervals of day. Records good, except for short period of break in record, for which they are fair.

There are three large lakes in the upper drainage basin. Big Lake, 2 miles from beach at an elevation of 275 feet, covers 1,700 acres; Third Lake, 250 acres; and Mirror Lake, at an elevation of 1,000 feet, 800 acres. Two-thirds of the drainage basin is covered with a thick growth of timber and brush interspersed with occasional patches of beaver swamp and muskeg. Only the tops of the highest mountains are bare. This large area of lake surface and vegetation, notwithstanding the steep slopes and shallow soil, affords a little ground storage and after a heavy precipitation maintains a good run-off. During a dry, hot period in summer, however, after the snow has melted, the flow becomes very low because of lack of ice or glaciers in the drainage basin.

No discharge measurements were made at this station during the year.

Daily discharge, in second-feet, of Fish Creek near Sealevel for 1919.

Day.	Jan.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	157	65	1,960	539	351	312	172	116	132	228	139
2	153	62	1,620	421	395	285	168	106	116	238	116
3	188	60	1,100	329	512	280	164	98	119	210	106
4	790	58	806	285	595	351	157	89	202	....	....
5	1,200	56	726	259	512	466	157	84	296	....	....
6	965	56	595	254	428	460	168	84	324	....	....
7	1,690	55	473	285	368	408	168	80	408	....	....
8	1,960	53	378	351	330	356	161	78	546	....	....
9	1,560	55	334	408	345	329	149	73	492	....	....
10	1,060	56	285	402	395	302	142	69	408	104	....
11	790	56	280	378	408	296	132	69	402	104	....
12	560	51	285	368	384	285	123	69	460	94	....
13	492	50	275	362	356	296	116	80	460	123	....
14	368	48	243	378	351	340	132	123	356	307	50
15	296	50	233	492	345	384	285	129	275	525	51
16	249	48	....	610	351	378	539	142	220	766	123
17	197	45	....	595	345	351	492	210	176	1,070	470
18	172	42	....	512	351	324	395	710	149	1,960	3,110
19	161	40	....	595	368	296	368	983	142	1,840	2,940
20	136	45	....	920	492	275	866	938	312	1,460	1,460
21	126	60	....	875	610	254	806	655	460	1,200	806
22	....	94	....	632	560	243	539	648	506	875	553
23	....	126	....	506	567	238	378	595	460	710	595
24	....	123	312	610	610	224	275	447	340	553	625
25	....	111	312	830	539	220	210	351	259	408	....
26	....	104	525	790	440	220	168	307	206	312	....
27	....	91	947	686	434	210	149	259	168	259	....
28	....	157	938	610	395	210	132	210	161	228	1,060
29	....	312	875	506	362	206	116	172	168	197	734
30	....	1,010	670	460	340	202	116	153	176	165	492
31	....	1,620	....	384	....	188	123	....	224	....	346

NOTE.—Discharge for following periods estimated, because of unsatisfactory operation of water-stage recorder, from maximum and minimum stages indicated by recorder and by comparison with hydrographs of other stations: Jan. 22–31, 140 second-feet; Feb. 1–28, 155 second-feet; Apr. 16–23, 320 second-feet; June 8 and 9, as shown in table; Nov. 4–9, 120 second-feet; Dec. 4–13, 70 second-feet; and Dec. 25–27, 1,100 second-feet.

Monthly discharge of Fish Creek near Sealevel for 1919.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
January	1,960	....	473	29,100
February	....	....	155	8,610
March	1,620	40	157	9,650
April	1,960	....	558	33,200
May	920	254	504	31,000
June	610	330	428	25,500
July	466	188	296	18,200
August	866	116	260	16,000
September	983	69	271	16,100
October	546	116	294	18,100
November	1,960	....	489	29,100
December	3,110	....	573	35,200
The year	3,110	40	373	270,000

SWAN LAKE OUTLET AT CARROLL INLET, REVILLAGIGEDO ISLAND.

LOCATION.—Halfway between Swan Lake and tidewater, on east shore of Carroll Inlet 1 mile from its head, 30 miles by water from Ketchikan.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—August 24, 1916, to December 31, 1919.

GAGE.—Stevens water-stage recorder on left bank, half a mile from tidewater; reached by a trail which leaves beach back of old cabin one-fourth mile south of mouth of creek. Gage was washed out by extreme high water in November, 1917. New gage installed 10 feet farther back in bank at old datum, but with a new control, on May 5, 1918.

DISCHARGE MEASUREMENTS.—At medium and high stages, made from a cable across stream 100 feet downstream from gage; at low stages, made by wading.

CHANNEL AND CONTROL.—The gage well is in a deep pool 25 feet upstream from a contracted portion of the channel, where a fall of 1 foot over bedrock forms a permanent control. The effect of the violent fluctuation of the water surface outside of the gage well is decreased in the inner float well, because the intake holes at the bottom are very small. At the cable section the bed is rough, the water shallow, and the current very swift. Point of zero flow is at gage height −1.0 foot.

EXTREMES OF DISCHARGE.—Maximum stage during year, from water-stage recorder, 6.55 feet at 10 a. m., December 18 (discharge, computed from extension of rating curve, 3,700 second-feet); minimum stage, −0.04 foot March 19–20 (discharge, 36 second-feet).

1915–1918: Maximum stage occurred probably on November 1, 1917 (discharge, estimated by comparison with Fish Creek, 5,500 second-feet); minimum discharge, 36 second-feet, March 19–20, 1919.

ICE.—Stage-discharge relation not affected by ice.

ACCURACY.—Stage-discharge relation permanent. Rating curve, determined by five discharge measurements and point of zero flow, is fairly well defined below 2,000 second-feet. Water-stage recorder operated satisfactorily except for periods indicated in footnote to daily-discharge table. Daily discharge ascertained by applying to rating table mean daily gage heights determined by inspecting gage-height graph, or, for days of considerable fluctuation, by averaging discharges obtained by applying to rating table mean gage heights for regular intervals of day. Results good except for periods of break in record, for which they are fair.

Swan Lake, whose area is about 350 acres, is 1½ miles from tidewater, at an elevation of 225 feet.

Discharge measurements of Swan Lake outlet at Carroll Inlet during 1919.

[Made by G. H. Canfield.]

Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*
Mar. 2	0.23	61
Aug. 30	.95	201

Daily discharge, in second-feet, of Swan Lake outlet at Carroll Inlet for 1919.

Day.	Jan.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Nov.	Dec.
1	176	....	2,240	505	390	390	294	181	....	150
2	170	....	1,540	390	477	374	282	156	....	132
3	188	....	1,020	328	684	397	277	139	....	118
4	720	....	770	306	711	621	274	124	....	107
5	875	....	711	309	577	730	274	118	....	98
6	711	....	577	358	473	621	309	120	....	90
7	1,500	....	445	437	437	533	306	118	....	84
8	1,610	55	358	537	441	465	274	112	103	79
9	1,540	53	303	553	321	441	265	107	126	74
10	1,050	54	280	473	577	418	262	111	114	70
11	745	54	277	465	573	418	257	118	103	66
12	517	54	271	465	505	429	229	143	94	63
13	418	52	251	441	461	473	218	254	143	60
14	384	50	235	608	449	545	254	257	248	59
15	343	50	213	930	433	545	384	221	577	78
16	297	47	193	902	433	481	706	193	760	196
17	254	44	203	720	437	445	590	936	1,420	1,410
18	213	44	274	735	449	411	465	1,750	2,640	3,470
19	176	43	414	1,320	565	384	425	1,500	2,000	2,400
20	141	43	425	1,290	848	364	1,110	1,020	1,470	1,260
21	137	92	400	875	848	358	960	735	1,290	745
22	143	107	343	621	745	340	621	795	875	698
23	141	103	343	497	795	321	425	....	630	1,020
24	135	87	374	726	735	321	321	....	497	1,020
25	132	78	433	1,170	594	343	411	....	374	1,230
26	128	72	848	902	537	337	218	....	297	1,320
27	....	68	1,140	693	521	334	193	....	257	1,170
28	....	111	902	608	473	340	181	....	226	1,020
29	....	210	730	509	457	343	174	....	196	698
30	....	1,260	630	437	425	328	193	....	170	....
31	....	1,890	....	397	....	303	198	....	....	....

NOTE.—Discharge for following periods estimated, because of unsatisfactory operation of water-stage recorder, by comparison with records for Fish Creek: Jan. 14–19, as shown in table; Jan. 27–31, 140 second-feet. From maximum and minimum stages indicated by recorder and by comparison with record for other stations as follows: Feb. 1–28, 120 second-feet; Mar. 1–7, 60 second-feet; Sept. 23–30, 350 second-feet; Oct. 1–31, 340 second-feet; Nov. 1–7, 200 second-feet. Discharge, Dec. 30–31, estimated at 400 second-feet by comparison with record for Fish Creek.

Monthly discharge of Swan Lake outlet at Carroll Inlet for 1919.

Month.	Discharge in second-feet.			Run-off (in acre-feet).
	Maximum.	Minimum.	Mean.	
January	1,610	....	437	26,900
February	....	....	120	6,660
March	1,890	43	166	10,200
April	2,240	193	571	34,000
May	1,320	306	629	38,700
June	848	321	546	32,500
July	730	303	424	26,100
August	1,110	174	366	22,500
September	1,750	....	400	23,800
October	....	....	340	20,900
November	2,640	94	534	31,800
December	3,470	59	638	39,200
The year	3,470	43	433	313,000

ORCHARD LAKE OUTLET AT SHRIMP BAY, REVILLAGIGEDO ISLAND.

LOCATION.—In latitude 55° 50′ N., longitude 131° 27′ W., at outlet of Orchard Lake, one-third mile from tidewater at head of Shrimp Bay, an arm of Behm Canal, 46 miles by water from Ketchikan.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—May 28, 1915, to December 31, 1919.

GAGE.—Stevens water-stage recorder on right bank 300 feet below Orchard Lake and 100 feet above site of timber-crib dam, which was built in 1914 for proposed pulp mill and washed out by high water August 10, 1915. Datum of gage lowered 2 feet September 15, 1915. Gage heights May 29 to August 10 referred to first datum; August 11, 1915, to August 17, 1916, to second datum. Datum of gage lowered 1 foot August 17, 1916. Gage heights August 18 to December 31, 1916, referred to this datum. Gage washed out probably during high water on November 1, 1917. New gage installed on April 28, 1918, at old site at the datum of August 17, 1916.

DISCHARGE MEASUREMENTS.—At medium and high stages made from cable 5 feet upstream from gage; at low stages by wading one-fourth mile below gage.

CHANNEL AND CONTROL.—From Orchard Lake, at elevation 134 feet above high tide, the stream descends in a series of rapids for 1,000 feet through a narrow gorge, then divides into two channels and enters the bay in two cascades of 100-foot vertical fall. Opposite the gage the water is deep and the current sluggish. At the site of the old dam bedrock is exposed, but for 30 feet upstream the channel is filled in with loose rock and brush placed during construction of dam. This material forms a riffle which acts as a control for water surface at gage at low and medium stages and is scoured down when ice goes out of lake; the rock outcrop at site of old dam acts as a control at high stages and is permanent.

EXTREMES OF DISCHARGE.—Maximum stage during year from water-stage recorder, 9.65 feet at 12 p. m. December 18 (discharge, 6,660 second-feet); minimum stage recorded, —0.02 foot March 19 (discharge, 35 second-feet).

1915–1919: Maximum stage occurred, probably, on November 1, 1917 (discharge estimated by multiplying maximum discharge at Fish Creek on that date by 1.55, which is the ratio between the maximum discharges of Orchard Lake outlet and Fish Creek on October 16 and 15, 1915, 7,100 second-feet); minimum discharge, estimated, 20 second-feet February 11, 1916.

ICE.—Stage-discharge relation not affected by ice.

ACCURACY.—Stage-discharge relation changes occasionally during high water. Rating curve, determined by five discharge measurements made since new gage was installed, point of zero flow, and form of upper portion of old rating curve, is well defined below 4,000 second-feet. Water-stage recorder operating satisfactory except for periods indicated in footnote to daily-discharge table Daily discharge ascertained by applying to rating table mean daily gage height determined by inspecting gage-height graph, or, for days of considerable fluctuation, by averaging results obtained by applying to rating table mean gage heights for regular intervals of day. Records good, except for period of break in record, for which they are fair.

The highest mountains on this drainage basin are only 3,500 feet above sea level and are covered to an elevation of 2,500 feet by a heavy stand of timber and a thick undergrowth of brush, ferns, alders, and devil's club. The topography is not so rugged as that of the area surrounding Shelockum Lake, and the proportion of vegetation, soil cover, and lake area is greater, so that more water is stored and the flow in the Orchard Lake drainage is better sustained.

Discharge measurements of Orchard Lake outlet at Shrimp Bay during 1919.

[Made by G. H. Canfield.]

Date.		Gage height.	Discharge.
		Feet.	*Sec.-ft.*
Mar. 4		0.21	59
Sept. 3		1.17	193

Daily discharge, in second-feet, of Orchard Lake outlet at Shrimp Bay for 1919.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Dec.
1	172	99	77	2,530	660	620	600	374	323	....
2	166	92	72	1,550	522	720	560	368	242	....
3	232	85	63	1,080	433	1,000	580	353	203	....
4	1,070	84	57	880	407	1,060	762	347	166	....
5	1,310	81	55	762	426	880	980	359	148	....
6	955	75	54	660	533	762	830	362	145	....
7	2 090	75	53	514	720	720	740	338	140	....
8	2,000	75	51	400	905	720	640	305	131	66
9	1,980	94	51	338	855	785	596	323	125	64
10	1,310	148	52	326	700	855	572	320	122	64
11	980	203	51	338	660	830	580	291	130	64
12	660	203	48	329	660	785	588	272	145	65
13	522	176	46	308	616	740	628	254	214	65
14	440	159	44	286	855	700	628	257	225	66
15	353	140	42	254	1,280	700	628	317	201	66
16	272	148	41	235	1,130	700	604	572	174	90
17	216	203	40	280	930	700	600	529	951	1,140
18	188	230	37	485	1,030	720	568	474	1,860	5,790
19	164	244	35	660	1,890	830	532	492	1,820	3,040
20	138	240	37	612	1,680	1,060	514	1,250	1,160	1,450
21	125	205	44	522	1,080	1,030	511	1,110	880	680
22	125	162	61	426	762	905	474	710	980	740
23	128	140	83	467	680	980	442	503	680	1,310
24	124	124	97	580	1,430	880	443	368	....	1,490
25	119	113	97	700	1,430	700	471	286	....	1,680
26	115	105	94	1,030	1,030	640	453	235	....	1,960
27	108	96	87	1,490	880	640	450	207	....	1,160
28	106	84	110	1,160	785	640	467	194	....	1,080
29	106	....	398	930	700	680	460	212	....	660
30	110	....	1,910	762	660	660	420	344	....	433
31	105	....	2,410	....	620	....	384	400	....	305

NOTE.—Daily discharge for following periods estimated, because of unsatisfactory operation of water-stage recorder: Feb. 22 to Mar. 3, by comparison with hydrographs for other stations; Apr. 8 and 9, by interpolation; May 27 to June 16, from gage-height graph drawn through maximum and minimum stages shown by recorder and by comparison with record for Swann Lake outlet. Discharge for following periods estimated from maximum and minimum stages indicated by recorder and by comparison with records for other stations: Sept. 24–30, 320 second-feet; Oct. 1–31, 500 second-feet; Nov. 1–12, 200 second-feet; Nov. 13–30, 850 second-feet; and Dec. 1–7, 100 second-feet.

Monthly discharge of Orchard Lake outlet at Shrimp Bay for 1919.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
January	2,090	105	532	32,700
February	244	75	139	7,720
March	2,410	35	206	12,700
April	2,530	235	696	41,400
May	1 890	407	869	53,400
June	1,060	620	788	46,900
July	980	384	571	35,100
August	1,250	194	411	25,300
September	1,860	122	447	26,600
October	....	....	500	30,700
November	....	....	590	35,100
December	5,790	....	791	48,600
The year.	5,790	35	548	396,000

SHELOCKUM LAKE OUTLET AT BAILEY BAY.

LOCATION.—In latitude 56° 00′ N., longitude 131° 36′ W., on mainland near outlet of Shelockum Lake, three-fourths mile by Forest Service trail from tidewater at north end of Bailey Bay and 52 miles by water north of Ketchikan.

DRAINAGE AREA.—18 square miles (measured on sheets Nos. 5 and 8 of the Alaska Boundary Tribunal, edition of 1895).

RECORDS AVAILABLE.—June 1, 1915, to October 31, 1919. (Gage-height graph, December 8–31, 1919, could not be removed from recorder, because of ice in bay, in time for inclusion in this bulletin.)

GAGE.—Stevens continuous water-stage recorder on right shore of lake, 250 feet above outlet. Gage house was pushed off the well by a snowslide January 4, 1917. Gage not put into operation again until May 23, 1917.

DISCHARGE MEASUREMENTS.—Made from cable across outlet of lake, 200 feet below gage and 50 feet upstream from crest of falls.

CHANNEL AND CONTROL.—Opposite the gage the lake is 600 feet wide; at the outlet bedrock is exposed and the water makes a nearly perpendicular fall of 150 feet. This fall forms an excellent and permanent control for the gage. At extremely high stages the lake has another outlet about 200 feet to left of main outlet. Point of zero flow is at gage height 0.6 foot.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year occurred, probably, on December 13; minimum discharge (estimated from hydrograph for Fish Creek to have occurred March 21), 8 second-feet.

1915–1919: Maximum stage, 6.84 feet at 8 a. m. November 1, 1917 (discharge, 2,780 second-feet); minimum discharge, estimated from climatic records, 2.5 second-feet, January 31, 1917.

ICE.—Stage-discharge relation not affected by ice.

ACCURACY.—Stage-discharge relation permanent. Rating curve well defined. Operation of water-stage recorder satisfactory except for periods of break in record shown in the footnote to daily-discharge table. Daily discharge ascertained by applying to the rating table mean daily gage height determined by inspection of gage-height graph, or, for days of considerable fluctuation, by averaging results obtained by applying to rating table mean gage heights for regular intervals of day. Records excellent, except for periods of break in record, for which they are fair.

Shelockum Lake, at an elevation of 344 feet, covers only 350 acres. The drainage basin above the lake is rough, precipitous, and covered with little soil or vegetation. There are no glaciers or ice fields at the source of the tributary streams. Therefore, because of little natural storage, the run-off after a heavy rainfall is rapid and not well sustained, and during a dry summer or winter the flow becomes very low. The large amount of snow that accumulates on the drainage basin during the winter maintains a good flow in May and June.

The following discharge measurement was made by G. H. Canfield:

March 4, 1919: Gage height, 1.14 feet; discharge, 15 second-feet.

Daily discharge, in second-feet, of Shelockum Lake outlet at Bailey Bay for 1919.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept
1	51	....	....	....	220	220	250	172	95
2	73	....	....	....	190	252	241	168	71
3	115	....	....	....	164	350	245	162	64
4	350	....	18	....	150	392	363	160	55
5	299	....	17	....	160	336	490	164	50
6	620	....	18	....	210	311	407	164	48
7	730	....	19	....	237	292	336	156	45
8	438	....	19	....	363	292	292	145	42
9	....	....	20	....	350	306	277	137	39
10	....	....	21	....	275	304	275	132	40
11	....	....	20	....	241	301	270	119	48
12	....	....	19	....	263	299	287	110	65
13	....	....	17	....	252	294	363	100	156
14	....	....	17	....	311	292	392	123	176
15	....	....	16	....	490	287	363	184	141
16	....	....	....	....	392	282	311	392	110
17	....	....	....	....	311	280	287	455	453
18	....	....	....	....	299	287	275	316	1,180
19	....	....	....	....	422	336	252	287	860
20	45	....	....	....	378	508	237	660	472
21	43	....	....	....	311	508	226	455	407
22	45	....	....	....	287	407	216	275	525
23	45	....	....	....	263	407	204	180	311
24	45	....	....	....	378	369	206	132	220
25	43	....	....	....	363	306	216	102	....
26	41	....	....	542	311	275	210	84	....
27	41	....	....	640	287	277	210	73	....
28	41	....	....	472	263	275	210	68	....
29	48	....	....	336	252	273	208	75	....
30	57	....	....	263	241	259	196	100	....
31	48	....	....	....	230	....	180	140	....

NOTE.—Discharge for following periods estimated, because of unsatisfactory operation of water-stage recorder, from maximum and minimum stages indicated by recorder and by comparison with hydrographs for other stations: Jan. 9–19, 115 second-feet; Feb 1–28, 45 second-feet; Mar. 1–3, 20 second-feet; Mar. 16–31, 75 second-feet; Apr. 1–25, 220 second-feet; Aug. 28 to Sept. 1, daily discharge as shown in table; Sept. 25–30, 110 second-feet; and Oct. 1–31, 200 second-feet.

Monthly discharge of Shelockum Lake outlet at Bailey Bay for 1919.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
January	730	41	145	8,920
February	....	....	45	2,500
March	....	....	47.8	2,940
April	....	....	258	15,400
May	490	150	288	17,700
June	508	220	319	19,000
July	490	180	274	16,800
August	660	68	193	11,900
September	1,180	39	211	12,600
October	....	....	200	12,300
The period	....	....	....	120,000

KARTA RIVER AT KARTA BAY, PRINCE OF WALES ISLAND.

LOCATION.—In latitude 55° 34′ N., longitude 132° 37′ W., at head of Karta Bay, an arm of Kasaan Bay, on east coast of Prince of Wales Island, 42 miles by water across Clarence Strait from Ketchikan.

DRAINAGE AREA.—49.5 square miles (U. S. Forest Service reconnaissance map of Prince of Wales Island, 1914).

RECORDS AVAILABLE.—July 1, 1915, to December 31, 1919.

GAGE.—Stevens continuous water-stage recorder on left bank, half a mile above tidewater, at head of Karta Bay and 1¼ miles below outlet of Little Salmon Lake. Two per cent of total drainage of Karta River enters between outlet of lake and gage.

DISCHARGE MEASUREMENTS.—At medium and high stages made from cable across river 50 feet upstream from gage; at low stages by wading at cable section.

CHANNEL AND CONTROL.—From Little Salmon Lake, 1½ miles from tidewater, the river descends 105 feet in a series of rapids in a wide, shallow channel, the banks of which are low but do not overflow. The bed is of coarse gravel and boulders; rock crops out only at outlet of lake. Gage and cable are at a pool of still water formed by a riffle of coarse gravel that makes a well-defined and permanent control.

EXTREMES OF DISCHARGE.—Maximum stage during the year from water-stage recorder, 4.75 feet estimated to have occurred December 18 (discharge, from extension of rating curve, 3,900 second-feet); minimum stage, 0.85 foot, March 19 (discharge, 54 second-feet).

1915–1919: Maximum stage, 5.5 feet November 1, 1917 (discharge, 5,070 second-feet); minimum flow, 21 second-feet, February 11, 1916.

ACCURACY.—Stage-discharge relation permanent. Rating curve well defined between 80 and 1,500 second-feet; extended below 80 second-feet to the point of zero flow and above 1,500 second-feet by estimation. Operation of water-stage recorder satisfactory except for periods indicated by breaks in record as shown in footnote to daily-discharge table. Daily discharge ascertained by applying to rating table mean daily gage height determined by inspecting gage-height graph, or, for days of considerable fluctuation, by averaging results obtained by applying gage heights for regular intervals to rating table. Records excellent except for periods of breaks in record, for period affected by ice, and for discharge above 1,500 second-feet, for which they are fair.

The combined area of Little Salmon Lake at elevation 105 feet and Salmon Lake at elevation 110 feet is 1,600 acres. The slopes along the right shore of lakes and at head of Salmon Lake are gentle, and the area included by the 250-foot contour above lake outlet is 5,500 acres. The drainage area to elevation 2,000 feet is heavily covered with timber and dense undergrowth of ferns, brush, and alders. The upper parts of the mountains are covered with thin soil and brush. Only a few peaks at an elevation of 3,500 feet are bare. This large lake and flat area and thick vegetal cover afford considerable natural storage, which, after heavy precipitation, maintains a good run-off. The snow usually melts by the end of June, and the run-off becomes very low during a dry, hot summer.

The Forest Service in the summer of 1916 constructed a pack trail from tidewater to outlet of Little Salmon Lake.

The following discharge measurement was made by G. H. Canfield:

March 6, 1919: Gage height, 0.98 foot; discharge, 85 second-feet.

Daily discharge, in second-feet, of Karta River at Karta Bay for 1919.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	......	176	......	1,700	565	402	238	115	88	160	302	......
2	......	156	......	1,410	474	428	229	109	88	142	290	......
3	......	145	......	1,090	402	441	233	103	83	152	238	......
4	......	142	......	907	356	448	320	97	76	197	215	......
5	......	135	......	880	356	448	350	94	71	220	172	......
6	......	128	83	756	402	422	338	91	69	248	152	......
7	......	121	83	610	480	389	308	88	64	448	128	......
8	......	156	83	522	572	338	314	88	58	515	125	......
9	......	206	83	480	565	344	314	88	58	448	145	......
10	......	248	86	448	558	395	308	86	56	550	152	......
11	......	259	83	434	773	376	296	83	56	572	145	......
12	......	233	81	454	714	350	308	78	56	529	135	......
13	......	233	78	434	633	338	314	78	60	448	......	......
14	633	233	74	415	799	332	338	76	69	363	......	......
15	501	215	71	382	925	332	338	78	69	290	......	......
16	395	269	66	344	943	320	314	145	71	248	......	......
17	308	460	60	344	826	302	285	164	164	215	......	......
18	264	508	58	422	782	296	269	176	1,050	210	......	......
19	228	522	54	633	1,170	338	243	238	1,420	382	......	......
20	196	460	56	714	1,330	382	233	415	1,070	515	......	1,270
21	180	396	91	673	1,080	389	215	320	808	529	......	790
22	192	308	138	580	782	396	206	308	853	515	......	756
23	206	264	168	529	633	382	197	238	681	434	......	1,100
24	197	215	168	558	826	363	180	192	515	350	......	1,060
25	188	192	160	602	1,000	338	172	156	428	290	......	1,470
26	176	164	145	898	826	344	160	132	350	238	......	2,240
27	184	......	152	1,040	665	326	149	112	290	215	......	1,760
28	197	......	184	925	550	302	142	100	238	238	......	1,230
29	196	......	338	835	494	280	135	94	206	215	......	808
30	220	......	961	697	467	254	128	91	180	215	......	580
31	197	......	1,230	......	428	......	121	97	......	302	......	454

NOTE.—Discharge estimated for following periods, because of unsatisfactory operation of water-stage recorder,from maximum and minimum stages indicated by recorder and by comparison with hydrographs for other stations: Jan. 1-13, 1,300 second-feet; Feb. 27–28, 135 second-feet; Mar. 1-5, 100 second-feet; Nov. 13-30, 800 second-feet; Dec. 1-14, 90 second-feet; and Dec. 15-19, 1,500 second-feet.

Monthly discharge of Karta River at Karta Bay for 1919.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
January	....	176	695	42,700
February	522	121	243	13,500
March	1,230	54	172	10,600
April	1,700	344	691	41,100
May	1,330	356	690	42,400
June	448	254	360	21,400
July	350	121	248	15,200
August	415	76	140	8,610
September	1,420	56	312	18,600
October	572	142	335	20,600
November	....	....	553	32,900
December	....	....	719	44,200
The year	....	54	431	312,000

CASCADE CREEK AT THOMAS BAY, NEAR PETERSBURG.

LOCATION.—One-fourth mile above tidewater on each shore of south arm of Thomas Bay; 22 miles by water from Petersburg. One small tributary enters the river from the left half a mile above gage and 2 miles below lake outlet.

DRAINAGE AREA.—21.4 square miles (measured on the United States Geological Survey geologic reconnaissance map of the Wrangell mining district, edition of 1907).

RECORDS AVAILABLE.—October 27, 1917, to December 31, 1919.

GAGE.—Stevens water-stage recorder on left bank, one-fourth mile from tidewater; reached by trail which leaves beach back of old cabin at mouth of creek.

DISCHARGE MEASUREMENTS.—At medium and high stages, made from log footbridge across stream one-fourth mile upstream from gage; at low stages, made by wading.

CHANNEL AND CONTROL.—From the outlet of a lake at an elevation of 1,200 feet above sea level and 3 miles from tidewater the river descends in a continuous series of rapids and falls through a narrow, deep canyon. Gage is in a protected eddy above a natural rock weir, which forms a well-defined and permanent control. The bed of river under the footbridge is rough and the current swift and irregular, but this section is the only place on the whole river where even at low and medium stages there are no boils and eddies.

EXTREMES OF DISCHARGE.—Maximum stage during year from water-stage recorder, 7.0 feet at 10 p. m. September 21 (discharge, from extension of rating curve, 1,570 second-feet); minimum discharge, 20 second-feet, estimated from climatic data and record of flow of Sweetheart Falls Creek.

1917–1919: Maximum stage, 7.65 feet at 11 p. m. November 18, 1917 (discharge computed from extension of rating curve, 1,980 second-feet); minimum stage 0.80 foot about April 6, 1918 (discharge, 17 second-feet).

ICE.—Stage-discharge relation affected by ice for short periods.

ACCURACY.—Stage-discharge relation permanent. Rating curve well defined below 1,200 second-feet. Operation of water-stage recorder satisfactory except for periods indicated in footnote to daily-discharge table. Daily discharge ascertained by applying to rating table mean daily gage height determined by inspecting gage-height graph, or, for days of considerable fluctuation, by averaging discharge for equal intervals of day. Records good except for periods when recorder did not operate satisfactorily, for which they are fair.

The first site on this stream for a storage reservior is at a small lake 3 miles from tidewater, at an elevation of 1,200 feet above sea level. The drainage area above the gaging station is 21 square miles and above the lake outlet 17 square miles. Flow during summer is augmented by melting ice from glaciers on upper portion of drainage area.

No discharge measurements were made at this station during the year.

Daily discharge, in second-feet, of Cascade Creek at Thomas Bay for 1919.

Day.	Feb.	Mar.	Apr.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1			75	145	380	518	250	146	86	57
2			60	180	380	485	200	150	76	54
3			55	192	395	470	167	532	68	51
4			48	183	485	470	153	890	63	49
5			47	175	518	518	153	890	57	46
6			44	167	535	500	150	1,110	54	44
7			40	183	518	440	160	1,040	50	42
8			38	200	470	485	183	658	48	40
9			40	240	470	570	200	410	48	
10			39	280	518	518	410	342	46	
11			42	280	485	470	605	330	44	
12				292	500	455	518	270	42	
13				292	535	455	570	200	54	
14	25			270	570	710	588	160	59	
15	25			260	622	850	485	134	88	
16	25			280	535	978	440	119	87	
17	26			318	455	790	672	111	122	
18	26			318	380	810	850	109	342	
19	26			380	355	910	692	146	280	
20	26			605	380	1,320	552	302	270	
21	24			570	395	890	976	640	220	
22	25			500	395	640	1,140	425	153	
23	24			455	395	455	830	260	131	
24	24			440	395	368	850	183	112	
25	23			410	425	342	1,020	146	96	
26	23			440	425	330	675	126	83	
27	23			425	470	342	440	121	74	
28	22			395	552	395	292	124	69	
29		27		395	622	440	220	107	65	
30		70		380	640	440	175	94	61	
31		82			570	342		92		

NOTE.—Discharge for following periods estimated, because of ice effect or unsatisfactory operation of water-stage recorder, from hydrograph drawn by comparison with that for Sweetheart Falls Creek through maximum and minimum stages indicated by recorder: Jan. 1–13, 161 second-feet; Feb. 1–13, 30 second-feet; Feb. 26–28, daily discharge; Mar. 1–28, 24 second-feet; Apr. 12–30, 90 second-feet; May 1–31, 155 second-feet; June 1–2, daily discharge; Dec. 9–15, 38 second-feet; and Dec. 16–31, 100 second-feet.

Monthly discharge of Cascade Creek at Thomas Bay for 1919.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
January			161	9,900
February		22	27.0	1,500
March	82		27.4	1,680
April		38	74.6	4,440
May			155	9,530
June	605	145	322	19,200
July	640	355	476	29,300
August	1,320	330	571	35,100
September	1,140	150	487	29,000
October	1,110	92	334	20,500
November	342	42	102	6,070
December			72.5	4,460
The year	1,320	22	236	171,000

GREEN LAKE OUTLET AT SILVER BAY, NEAR SITKA.

LOCATION.—In latitude 56° 59′ N., longitude 135° 5′ W., at outlet of Green Lake, head of Silver Bay, 10½ miles by water south of Sitka.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—August 22, 1915, to December 31, 1919.

GAGE.—Stevens water-stage recorder on right bank, at outlet of lake, reached by trail which leaves the beach one-fourth mile north of mouth of stream, ascends a 600-foot ridge, and then drops down to the outlet of the lake. Gage datum lowered 1 foot December 27, 1916.

DISCHARGE MEASUREMENTS.—Made from cable across outlet 30 feet below gage.

CHANNEL AND CONTROL.—From Green Lake, 240 feet above sea level and 1,800 feet from tidewater, the stream descends in a series of falls and rapids through a narrow canyon whose exposed rock walls rise vertically more than 100 feet.

EXTREMES OF DISCHARGE.—Maximum stage during year, 12.4 feet, probably on October 6, estimated from vertical line traced by recording pencil while clock of recorder did not run (discharge, estimated from extension of rating curve, 3,000 second-feet); minimum stage recorded, −0.05 foot March 27–29 (discharge, 10 second-feet).

1915–1919: Maximum stage recorded, 13.0 feet, September 26, 1918 (discharge, estimated from extension of rating curve, 3,300 second-feet); minimum stage recorded, −0.05 foot March 27–29, 1919 (discharge, 10 second-feet).

ICE.—Ice forms on lake and at gage, but because of current and flow of relatively warm weather from the lake the control remains open.

ACCURACY.—Stage-discharge relation permanent. Rating curve well defined between 10 and 1,300 second-feet. Operation of water-stage recorder satisfactory except for periods indicated by breaks in record, as shown in the footnote to the daily-discharge table. Daily discharge ascertained by applying to the rating table mean daily gage height, determined by inspecting gage-height graph, or, for days of considerable fluctation, by averaging results obtained by applying to rating table gage heights for regular intervals of day. Records good, except those for periods when gage was not operating satisfactorily, which are fair.

In the fall and winter the flow is low because there is little ground storage, and on most of the drainage area the precipitation is in the form of snow. This accumulated snow produces a large run-off during the spring, and the melting ice from the glacier and the ice-capped mountains augments the run-off from precipitation during the summer. The area of Green Lake is estimated to be about 175 acres. [3]

The discharge measurements were made at the station during the year.

[3] Supersedes figure published in U. S. Geol. Survey Bulls. 662, 692, and 712.

Daily discharge, in second-feet, of Green Lake outlet at Silver Bay for 1919.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Oct.	Nov.	Dec.
1	70	44	16	147	138	172	303	......	......	......	66
2	142	43	16	164	114	212	354	......	......	......	60
3	188	40	15	140	100	233	461	......	......	......	60
4	144	40	......	132	97	233	620	......	......	......	60
5	173	38	......	130	102	212	673	......	......	......	57
6	713	38	......	126	124	206	557	......	......	......	62
7	1,580	38	......	100	206	200	547	......	......	......	69
8	820	34	......	85	286	194	547	......	......	......	59
9	568	36	......	79	294	240	547	......	......	......	46
10	557	42	......	76	226	286	547	......	......	......	38
11	480	48	......	73	337	380	557	......	......	......	37
12	226	43	......	73	182	328	599	......	......	......	38
13	177	38	......	76	247	354	588	......	......	......	40
14	138	38	......	76	312	312	630	......	......	......	43
15	122	33	......	70	470	286	518	461	......	......	44
16	107	32	......	67	442	312	397	433	......	......	......
17	92	37	......	66	490	362	346	415	......	......	......
18	80	42	......	85	303	371	337	371	......	......	......
19	73	58	......	134	397	490	362	433	182	......	......
20	67	59	12	156	528	652	388	641	338	......	......
21	66	48	18	142	406	547	406	489	820	......	......
22	67	40	18	116	262	588	288	371	397	......	......
23	67	36	16	107	212	620	388	303	219	......	......
24	61	30	14	126	226	508	380	......	172	......	......
25	59	27	12	154	303	499	354	......	142	......	......
26	55	24	11	240	240	452	362	......	126	......	......
27	55	18	10	294	194	415	452	......	134	......	......
28	53	18	10	219	168	415	652	......	......	......	......
29	60	......	10	168	162	388	706	......	......	......	......
30	57	......	12	155	164	346	652	......	......	79	......
31	51	......	30	......	166	......	518	......	......	......	......

NOTE.—Discharge for following periods extimated, because of unsatisfactory operation of water-stage recorder, by comparison with hydrographs for other stations: Mar. 3, 15 second-feet and Mar. 4–19, 15 second-feet; from maximum and minimum stages indicated by recorder and by comparison with record of flow for Sweetheart Falls Creek: Aug. 1-14, 500 second-feet; Aug. 24–31, 385 second-feet; Sept. 1-30, 500 second-feet; and Oct. 1-18, 500 second-feet; from maximum and minimum stages indicated by recorder and by comparison with climatic data for Juneau and hydrographs of other stations: Oct. 28-31, 155 second-feet; Nov. 1-29, 185 second-feet; and Dec. 16-31, 200 second-feet.

Monthly discharge of Green Lake outlet at Silver Bay for 1919.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
January	1,580	51	231	14,200
February	59	18	37.9	2,100
March	30	10	14.8	910
April	294	66	126	7,500
May	528	97	255	15,700
June	652	172	358	21,300
July	706	303	488	30,000
August	......	......	452	27,800
September	......	......	500	29,800
October	......	......	392	24,100
November	......	......	181	10,800
December	......	37	128	7,870
The year	1,580	10	265	192,000

BARANOF LAKE OUTLET AT BARANOF, BARANOF ISLAND.

LOCATION.—In latitude 57° 5′ N., longitude 134° 54′ W., at townsite of Baranof, at head of Warm Spring Bay, east coast of Baranof Island, 18 miles east of Sitka across island but 96 miles from Sitka by water through Peril Strait.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—June 28, 1915, to December 31, 1919.

GAGE.—Stevens water-stage recorder on right bank 700 feet below Baranof Lake and 800 feet above tidewater at head of Warm Spring Bay.

DISCHARGE MEASUREMENTS.—At medium and high stages, from cable across stream 100 feet below lake and 600 feet above gage; at low stages, by wading 100 feet below cable.

CHANNEL AND CONTROL.—From Baranof Lake, at elevation 130 feet above sea level and 1,500 feet from tidewater, the stream descends in a series of rapids and small falls and enters the bay in a cascade of about 100 feet concentrated fall. The bed is of glacial drift, boulders, and rock outcrop. The gage is in an eddy 50 feet downstream from the foot of a small fall and 100 feet upstream from a riffle which forms a well-defined control.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 4.78 feet at 3 p. m., October 6 (discharge, computed from an extension of rating curve, 2,610 second-feet); minimum flow, estimated by comparison with record of flow for Green Lake outlet, 20 second-feet, March 27–29.

1915–1919: Maximum stage recorded during period, 5.3 feet August 10, 1915 (discharge, computed from extension of rating curve, 3,350 second-feet); minimum flow, estimated, 20 second-feet, March 27–29, 1919.

ICE.—Because of the swift current and flow of relatively warm water from the lake the stream remains open.

DIVERSIONS.—The flume to Olsen's sawmill diverts from the stream 200 feet below gage only sufficient water to operate a 25-horsepower Pelton water wheel.

ACCURACY.—Stage-discharge relation permanent, not affected by ice. Rating curve well defined below 2,000 second-feet. Operation of water-stage recorder satisfactory except for periods indicated in footnote to daily-discharge table. Daily discharge ascertained by applying to rating table mean daily gage height determined by inspecting gage-height graph, or, for days of considerable fluctuation, by averaging discharge for equal intervals of day. Records good except for periods when recorder did not operate satisfactorily and for periods when water was frozen in well, for which they are roughly approximate.

The drainage area is rough and precipitous, and the vegetable and soil cover is thin, even on the foothills of the mountains. The run-off is rapid, and the ground storage is small. During a hot, dry period, however, the flow is greatly augmented by melting ice from several small glaciers and ice-capped mountains.

No discharge measurements were made at this station during the year.

Daily discharge, in second-feet, of Baranof Lake outlet at Baranof for 1919.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1		255	396	640		392	279	171
2		222	436	640		321	435	141
3		197	450	668		285	1,540	124
4		187	450	890		261	2,000	110
5		191	436	1,100		252	1,940	94
6		225	456	1,010		252	2,320	83
7		297	468	930		264	1,540	84
8		380	456	820		300	855	80
9		420	500	788		424	545	
10		460	615	820		615	476	
11		788	640	890		590	392	
12		695	640	1,050		640	345	
13		545	668	1,100		1,940	285	
14		725	668	1,140		1,650	255	
15		970	615	930		1,010	230	
16		820	590	725		755	230	
17	119	615	615	640		890	230	
18	129	590	615	590		1,330	270	
19	173	695	725	615		1,050	291	
20	235	788	930	668		788	500	
21	252	640	855	725		1,540	545	
22	235	522	855			1,430	396	
23	242	464	890			855	306	
24	261	590	855			1,010	255	
25	282	615	820			1,380	218	
26	321	484	820			820	193	
27	366	404	788			545	191	
28	348	356	788			420	189	
29	312	342	755		590	352	183	
30	291	348	668		590	321	203	
31		366			500		193	

NOTE.—Discharge for following periods estimated, because of unsatisfactory operation of gage, by comparison with record for Green Lake outlet: Jan. 1-31, 280 second-feet; Feb. 1-28, 60 second-feet; Mar. 1-31, 30 second-feet; Apr. 1-16, 170 second-feet. Discharge for following periods estimated by comparison with record for Sweetheart Falls Creek: June 3-4, 450 second-feet; July 22-31, 825 second-feet; Aug. 1-28, 770 second-feet. Following periods estimated from maximum and minimum stages shown by gage and by comparison with records for other stations: Nov. 9-30, 210 second-feet; Dec. 1-15, 55 second-feet; Dec. 16-31, 215 second-feet.

Monthly discharge of Baranof Lake outlet at Baranof for 1919.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
January			280	17,200
February			60	3,330
March			30	1,840
April			210	12,500
May	970	187	490	30,100
June	930	396	649	38,600
July			827	50,800
August			750	46,100
September	1,940	252	756	45,000
October	2,320	183	575	35,400
November			184	10,900
December			138	8,480
The year			415	300,000

SWEETHEART FALLS CREEK NEAR SNETTISHAM.

LOCATION.—In latitude 57° 56½′ N., longitude 133° 41′ W., on east shore 1 mile from head of south arm of Port Snettisham, 3 miles south of mouth of Whiting River, 7 miles by water from Snettisham, and 42 miles by water from Juneau. No large tributaries enter river between gaging station and outlet of large lake, 2½ miles upstream.

DRAINAGE AREA.—27 square miles (measured on United States Geological Survey topographic map of the Juneau gold belt, edition of 1905).

RECORDS AVAILABLE.—July 31, 1915, to March 31, 1917; May 21, 1918, to December 31, 1919.

GAGE.—Stevens water-stage recorder on right bank, 300 feet upstream from tidewater on east shore of Port Snettisham. Gage washed out in November, 1917, and record from April 20, 1917, lost with gage. New Stevens water-stage recorder installed May 21, 1918, at same datum and at approximate location of old gage.

DISCHARGE MEASUREMENTS.—At medium and high stages, made from cable across river one-fourth mile upstream from gage; at low stages, made by wading in channel at mouth of creek exposed at low tide.

CHANNEL AND CONTROL.—From the outlet of the lake at an elevation of 520 feet above sea level and 2½ miles from tidewater the water descends in a series of rapids and falls through a narrow, deep canyon. Gage is in a pool at foot of two falls, each 25 feet high, which are known as Sweetheart Falls; outlet of pool is a natural rock weir, which forms a well-defined and permanent control for gage.

EXTREMES OF DISCHARGE.—Maximum stage during year from water-stage recorder, 6.0 feet at 10 p. m. October 6 (discharge computed from extension of rating curve, 2,260 second-feet); minimum stage, 0.15 foot 12 a. m. March 29 (discharge, 28 second-feet).

1915–1919 (except for period of no record): Maximum stage recorded, 7.15 feet at midnight, September 26, 1918 (discharge, computed from an extension of the rating curve, 2,880 second-feet); minimum flow, estimated from discharge measurement and climatic data, 15 second-feet February 11, 1916.

ICE.—Stage-discharge relation affected by ice only for short periods during extremely cold weather.

ACCURACY.—Stage-discharge relation permanent. Rating curve well defined between 40 and 1,300 second-feet; extended beyond these limits by estimation. Operation of water-stage recorder satisfactory except for periods shown in footnote to daily-discharge table. Daily discharge ascertained by applying to rating table mean daily gage height determined by inspecting gage-height graph, or, for days of considerable fluctuation, by averaging results obtained by applying to rating table gage heights for regular intervals of day. Records excellent except for periods of ice effect or break in record and for discharge above 1,300 second-feet, for which they are fair.

In the fall and winter the run-off is small because the precipitation is in the form of snow, and because of the small amount of ground storage; during a hot, dry period the low run-off from the ground and lake stage is augmented by melting ice from one glacier.

The following discharge measurement was made by G. H. Canfield:

February 16, 1919: Gage height, 0.35 foot; discharge, 48 second-feet.

Daily discharge, in second-feet, of Sweetheart Falls Creek near Snettisham for 1919.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	102	73	42	82	240	324	565	645	545	264	121	76
2	141	67	41	98	199	351	545	565	435	216	113	70
3	176	62	41	90	176	428	505	525	348	418	102	66
4	169	58	42	90	164	449	525	470	285	1,120	90	62
5	300	55	50	141	159	424	585	525	240	1,280	84	58
6	745	58	60	141	164	382	705	605	216	2,010	79	57
7	845	50	60	119	183	365	865	565	202	2,010	74	54
8	945	49	57	109	240	365	805	565	199	1,350	70	50
9	805	48	47	108	285	393	705	645	196	885	70	44
10	585	48	42	102	294	470	705	665	255	545	67	42
11	505	49	37	95	294	525	645	585	452	386	64	41
12	365	49	34	95	294	585	585	525	488	315	62	40
13	285	47	37	92	300	585	565	488	545	258	60	39
14	225	60	44	92	306	525	645	525	925	210	64	41
15	178	52	39	90	372	488	685	705	905	176	72	52
16	152	48	33	87	463	470	625	705	705	152	85	59
17	131	47	37	85	460	525	545	665	565	146	113	113
18	113	82	38	90	442	545	525	605	685	144	270	435
19	102	64	38	117	488	545	488	665	845	164	488	382
20	93	64	48	125	645	625	505	968	725	231	442	276
21	85	58	60	129	605	725	545	968	705	585	460	196
22	87	53	58	127	488	685	565	745	1,010	565	390	159
23	90	47	48	125	410	645	565	545	1,060	390	285	144
24	90	46	39	131	382	625	545	435	990	285	210	148
25	87	44	34	183	410	605	525	382	1,170	213	150	171
26	74	44	32	300	428	705	505	348	1,170	174	127	300
27	104	44	30	400	393	785	525	324	905	148	113	330
28	88	43	30	365	354	685	605	330	605	141	104	249
29	90	......	29	315	327	625	745	393	428	137	93	188
30	87	......	38	285	315	585	825	585	330	129	84	149
31	79	......	42	......	309	......	745	625	......	125	......	133

NOTE.—Daily discharge for following periods estimated by comparison with hydrograph for Cascade Creek, because stage-discharge relation was affected by ice or because of unsatisfactory operation of water-stage recorder: Jan. 5–8, Feb. 27 to Mar. 5, Apr. 1–7, and Dec. 10–12.

Monthly discharge of Sweetheart Falls Creek near Snettisham for 1919.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
January	945	74	256	15,700
February	82	43	53.9	2,990
March	60	29	42.2	2,590
April	400	82	147	8,750
May	645	159	342	21,000
June	785	324	535	31,800
July	865	488	613	37,700
August	968	324	577	35,500
September	1,170	196	604	35,900
October	2,010	125	489	30,100
November	488	60	154	9,160
December	435	39	136	8,360
The year	2,010	29	331	240,000

CRATER LAKE OUTLET AT SPEEL RIVER, PORT SNETTISHAM.

LOCATION.—At outlet of Crater Lake, 1 mile upstream from edge of tide flats at head of north arm of Port Snettisham, 2 miles by trail from cabins of Speel River project, which are 42 miles by water from Juneau.

DRAINAGE AREA.—11.9 square miles above water-stage recorder at lake outlet, and 13 square miles above staff gage at beach (measured on topographic maps of the Alaska Boundary Tribunal, edition of 1895).

RECORDS AVAILABLE.—January 23, 1913, to December 31, 1919.

GAGE.—Stevens water-stage recorder on left shore of lake 100 feet upstream from outlet. A locally made water-stage recorder having a natural vertical scale and a time scale of 7 inches to 24 hours was used until replaced by Stevens gage June 29, 1916. The gage datum remained the same during the period. During the winter, because of inaccessible location and deep snow, the operation of the gage at the lake was discontinued, and the stage read at staff gage in channel exposed at low tide at beach. The first gage at beach was set at an unknown datum and washed out in winter of 1915–16. Another staff gage was set at about the same location November 24, 1916. Other staff gages were set at about the same location January 11 and November 13, 1918.

DISCHARGE MEASUREMENTS.—Made from cable across outlet of lake, 100 feet downstream from gage and 10 feet upstream from crest of first falls. The rope sling from which discharge measurements were first made was replaced in fall of 1915 by a standard U. S. Geological Survey gaging car, making more reliable measurements possible.

CHANNEL AND CONTROL.—The gage is on left shore of lake, 100 feet upstream from outlet, where the stream becomes constricted into a narrow channel, the bed of which is composed of large boulders and rock outcrops that form a well-defined and permanent control.

EXTREMES OF DISCHARGE.—1913–1919: Maximum stage occurred, probably, on September 26, 1918 (discharge, 2,300 second-feet, estimated by multiplying maximum discharge at Long River on September 27, 1918, by 0.44, which is the ratio between the maximum discharges of Crater Lake outlet and Long River on August 19 and 20, 1917; minimum discharge, 5 second-feet, February 1–13, 1916, estimated from one discharge measurement and by comparison with climatic data, and February 13, 1919.

ACCURACY.—Stage-discharge relation permanent. Rating curve defined by 19 discharge measurements, 13 of which were made by employees of the Speel River Project (Inc.) and 6 by an engineer of the United States Geological Survey, and is well defined below and extended above 1,000 second-feet. Rating curve used January 1 to February 10 for staff gage at beach fairly well defined. Operation of water-stage recorder satisfactory except for July 1–8, when gage clock was run down; gage-height graph August 6 to October 8 lost, when skiff capsized with G. H. Canfield, October 8. Discharge record January 1 to February 10 computed from gage-height record for staff gage at beach. Daily discharge May 23 to August 5 ascertained by applying to rating table daily gage height determined by inspecting gage-height graph, or for days of considerable fluctuation, by averaging results obtained by applying to rating table mean gage heights for regular intervals of the day.

Crater Lake is 1,010 feet above sea level and covers 1.1 square miles. The sides of the mountains surrounding the lake are steep and barren, and the tops are covered by glaciers.

Discharge measurements of Crater Lake outlet at Speel River, Port Snettisham, during 1918.

[Made by G. H. Canfield.]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*		*Feet.*	*Sec.-ft.*
Jan. 11	[a] 1.22	127	Apr. 9	[a] .74	32
Feb. 16	[a] .58	10.1	Dec. 4		14.6

[a] Referred to staff gage at beach, installed Nov. 13, 1918.

Daily discharge, in second-feet, of Crater Lake outlet at Speel River, Port Snettisham, for 1919.

Day.	Jan.	Feb.	May.	June.	July.	Aug.	Oct.	Nov.
1	32	35	....	105	272	532	....	93
2	136	35	....	120	265	472	....	83
3	82	29	....	150	261	429	....	78
4	62	18	....	156	272	416	....	69
5	78	15	....	146	304	472	....	....
6	82	13	....	129	362	....	....	....
7	200	9	....	126	502	....	....	....
8	175	7	....	129	487	....	....	....
9	165	7	....	142	443	....	402	....
10	146	10	....	174	472	....	293	....
11	127	8	....	205	457	....	221	32
12	104	7	....	221	416	....	189	31
13	74	5	....	214	472	....	161	30
14	58	9	....	200	532	....	139	36
15	55	13	....	191	502	....	122	42
16	48	10	....	189	402	....	113	87
17	44	....	....	198	338	....	112	103
18	41	....	....	200	316	....	118	293
19	35	....	....	207	316	....	164	350
20	35	....	....	237	327	....	356	327
21	35	....	....	304	375	....	422	362
22	32	....	....	304	375	....	304	251
23	32	....	126	304	375	....	212	178
24	26	....	120	304	375	....	161	132
25	29	....	142	304	350	....	134	108
26	29	....	145	316	375	....	116	92
27	29	....	126	350	429	....	113	....
28	29	....	112	316	547	....	111	....
29	35	....	103	282	675	....	102	....
30	34	....	100	275	728	....	101	....
31	32	....	100	....	610	....	98	....

NOTE.—Discharge for following periods, for which gage-height records are not available, estimated from records for Sweetheart Falls Creek: Jan. 10, 20, 30, and Feb. 11, daily discharge: Feb. 17-28, 15 second-feet; Mar. 1-31, 12 second-feet; Apr. 1-30, 47 second-feet; May 1-22, 118 second-feet: July 1-8, daily discharge; Aug. 6-31, 520 second-feet; Sept. 1-30, 420 second-feet; Oct. 1-8, 470 second-feet; Nov. 5-10, 25 second-feet; Nov. 27-30, 25 second-feet; and Dec. 1-31, 30 second-feet.

Monthly discharge of Crater Lake outlet at Speel River, Port Snettisham, for 1919.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
January	200	26	68.4	4,210
February	35	5	14.6	811
March	....	....	12	738
April	....	....	47	2,800
May	....	....	118	7,260
June	350	105	217	12,900
July	728	261	417	25,600
August	....	....	511	31,400
September	....	....	420	25,000
October	....	98	259	15,900
November	362	....	101	6,010
December	....	....	30	1,840
The year	....	5	....	134,000

LONG RIVER BELOW SECOND LAKE, AT PORT SNETTISHAM.

LOCATION.—One-half mile downstream from outlet of Second Lake, 1 mile downstream from outlet of Long Lake, one-half mile upstream from head of Indian Lake, 2½ miles by trail and boat across Second Lake from cabins of the Speel River project at head of the North Arm of Port Snettisham, 42 miles by water from Juneau.

DRAINAGE AREA.—33.2 square miles (measured on sheet No. 12 of the Alaska Boundary Tribunal maps, edition of 1895).

RECORDS AVAILABLE.—November 11, 1915, to December 31, 1919.

GAGE.—Stevens continuous water-stage recorder on right bank one-half mile below outlet of Second Lake.

DISCHARGE MEASUREMENTS.—At medium and high stages made from cable across river at gage; at low stages made by wading one-fourth mile downstream.

CHANNEL AND CONTROL.—At the gage the channel is deep and the current sluggish; banks are low and are overflowed at extremely high stages; bed smooth except for one large boulder. A rapid, 500 feet downstream, forms a well-defined and permanent control.

EXTREMES OF DISCHARGE.—Maximum stage during year probably occurred October 6, but stage is unknown as gage-height graph July 9 to October 8 was lost; minimum flow 35 second-feet, March 29.

1916–1918: Maximum stage, 10.2 feet September 27, 1918 (discharge, estimated from extension of rating curve, 5,300 second-feet); minimum flow, 23 second-feet, February 13, 1916.

ICE.—Stage-discharge relation affected by ice during January, February, March, and April.

ACCURACY.—Stage-discharge relation permanent; affected by ice or poor connection between well and river January 16 to February 27, March 6 to April 2, April 9–15, November 1–14, and December 4. Rating curve fairly well defined between 50 and 400 second-feet and well defined between 400 and 2,000 second-feet. Operation of water-stage recorder satisfactory except for periods indicated in footnote to daily-discharge table. Gage-height graph July 9 to October 8, lost on October 8, when skiff capsized with G. H. Canfield. Daily discharge ascertained by applying to the rating table daily gage height determined by inspecting the gage-height graph. Records good except for stages below 400 second-feet and periods of break in gage-height record, for which they are roughly approximate.

The area draining to Long River between Long Lake outlet and this station comprises only 1.3 square miles, including First Lake and Second Lake. Because this area is at a low altitude and has no glaciers the run-off per square mile from it is greater early in the spring but much less in summer than that from the area above Long Lake, which is partly covered by glaciers.

Discharge measurements of Long River below Second Lake, at Port Snettisham, during 1919.

[Made by G. H. Canfield.]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*		*Feet.*	*Sec.-ft.*
Jan 10	2.40	345	July 8	4.03	920
Apr. 9	[a]1.74	88	Dec. 4	1.00	63

[a] Stage of water surface in well; connection between well and river obstructed.

Daily discharge, in second-feet, of Long River below Second Lake, at Port Snettisham, for 1919.

Day.	Jan.	May.	June.	July.	Oct.	Nov.	Dec.
1	100		317	630		125	76
2	230		360	600		115	70
3	280		411	565		106	66
4	175		411	630		95	63
5	260		390	720		85	
6	500		360	900		80	
7	670		360	1,070		75	
8	720		372	970		72	
9	550		405		975	70	
10	345		474		660	68	
11	351		530		495	65	
12	252		548		405	62	
13	198		548		317	80	
14	171		512		257	130	
15	146		495		207	211	
16			495		186	317	
17			512		190	339	
18			512		252	495	
19			530		301	505	
20			600		520	530	
21			680		660	565	
22		420	700		480	414	
23		390	720		345	290	
24		366	720		259		141
25		411	710		204		267
26		405	770		171		290
27		360	820		170		239
28		331	750		232		185
29		309	680		175		150
30		290	650		149		130
31		304			141		115

NOTE.—Owing to ice effect or obstruction in connection between gage well and river, discharge was estimated for following periods from current-meter measurement of Apr. 9 and comparison with weather records for Juneau and hydrograph of Sweetheart Falls Creek: Jan. 1-9, daily discharge shown in table Jan. 16-31, 95 second-feet; Feb. 1-28, 55 second-feet; Mar. 1-31, 50 second-feet; Apr. 1-30, 125 second-feet May 1-21, 285 second-feet. Daily discharge, June 25 to July 7 determined from gage-height graph drawn through maximum amd minimum stages shown by recorder and by comparison with graph for Sweetheart Falls Creek. Discharge for following periods estimated from records for Sweetheart Falls Creek owing to loss of gage-height record: July 9-31, 900 second-feet; Aug. 1-31, 1,050 second-feet; Sept. 1-30, 1,000 second-feet; Oct. 1-8, 1,070 second-feet. Daily discharge Nov. 1-14, Dec. 1-3, and mean discharge Nov. 24-30 (125 second-feet) estimated from records for Sweetheart Falls Creek. Mean discharge, Dec. 5-23 (115 second-feet), and daily discharge, Dec. 28-31, estimated from maximum and minimum stages shown by recorder and by comparison with records for Sweetheart Falls Creek.

Monthly discharge of Long River below Second Lake, at Port Snettisham, for 1919.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
January	720		209	12,900
February			55	3,050
March			50	3,070
April			125	7,440
May			309	19,000
June	820	317	545	32,400
July			864	53,100
August			1,050	64,600
September			1,000	59,500
October		141	526	32,300
November	565	62	192	11,400
December		63	128	7,870
The year			424	307,000

GRINDSTONE CREEK AT TAKU INLET.

LOCATION.—On north shore of Taku Inlet, between Point Bishop and Point Salisbury, one-fourth mile west of mouth of Rhine Creek and 11 miles by waterfrom Juneau.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—May 6, 1916, to December 31, 1919.

GAGE.—Stevens continuous water-stage recorder on left bank, 200 feet from tidewater, installed September 16, 1916. A Lietz seven-day graph water-stage recorder was used May 6 to June 17, 1916.

DISCHARGE MEASUREMENTS.—At all stages made by wading either in the channel on the beach, which is exposed at low tide, or 100 feet below gage at high tide.

CHANNEL AND CONTROL.—For a distance of one-fourth mile from tidewater the stream descends in a series of rapids and falls through a narrow, rocky channel. The gage is at upper end of a turbulent pool between two falls, the lower of which forms a well-defined control. When gage was installed logs were jammed in channel near upper end of pool.

EXTREMES OF DISCHARGE.—Maximum stage during year, from water-stage recorder, 4.2 feet at 5 p. m. October 3 (discharge, estimated from extension of rating curve, 330 second-feet); minimum discharge, 3 second-feet March 16–20, estimated by comparison with climatic data.

1916–1919: Maximum stage, 6 feet at 7 p. m. September 26, 1918 (discharge, estimated from an extension of the rating curve, 700 second-feet); minimum stage, −0.24 foot April 5–7, 1918 (discharge, 2.6 second-feet).

ICE.—Stage-discharge relation sometimes affected by ice.

ACCURACY.—Stage-discharge relation permanent. Rating curve, revised by measurements made during 1919, well defined below 150 second-feet; extended above 150 second-feet by estimation. Operation of water-stage recorder satisfactory except for periods shown in the footnote to daily-discharge table. Daily discharge ascertained by applying to rating table mean daily gage height determined by inspecting gage-height graph, or, for days of considerable fluctuation, by averaging results obtained by applying to rating table mean gage heights for regular intervals of day. Records good except those for periods of break in record and discharge above 150 second-feet, which are poor.

Discharge measurements of Grindstone Creek at Taku Inlet during the year ending Sept. 30, 1918.

[Made by G. H. Canfield.]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*		*Feet.*	*Sec.-ft.*
Jan. 20	[a] 0.59	11.6	Apr. 22	0.59	16.0
23	[a] .43	11.0	July 7	1.71	114
Feb. 21	.15	6.1	Dec. 13	[b] .40	10.6
Mar. 22	−.05	3.8			

[a] Control partly obstructed by ice. [b] Ice cover arched over control; no backwater.

Daily discharge, in second-feet, of Grindstone Creek at Taku Inlet for 1919.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	17	10	3.5	....	19	29	47	52	35	40	19	13
2	25	9.5	3.5	....	18	41	45	47	30	85	18	15
3	19	9.0	3.0	....	17	61	67	46	26	184	17	15
4	17	9.0	3.0	....	17	64	69	48	24	130	....	13
5	19	8.0	3.0	....	17	55	73	50	24	260	....	12
6	45	7.5	3.5	....	18	48	128	46	22	189	....	12
7	40	8.0	4.0	....	19	42	130	40	22	124	....	....
8	56	8.0	3.5	....	26	39	92	71	21	87	....	....
9	38	7.5	3.0	....	34	44	92	67	48	70	....	....
10	30	7.5	3.5	....	30	59	89	48	60	60	....	....
11	28	7.5	3.5	....	28	64	80	43	34	51	....	....
12	24	7.0	3.5	....	32	56	74	39	34	45	....	....
13	20	7.0	3.5	....	31	55	79	41	116	41	....	11
14	18	7.0	3.5	....	36	52	83	57	69	36	....	10
15	17	7.0	3.5	....	44	49	71	50	50	32	....	8.0
16	16	7.0	3.0	....	48	49	61	51	43	33	....	9.5
17	14	7.0	3.0	....	43	51	57	43	....	28	....	22
18	11	7.5	3.0	....	44	50	70	43	....	38	....	34
19	11	8.0	3.0	....	48	51	62	85	....	48	....	16
20	12	7.5	3.0	....	48	70	62	79	....	48	....	14
21	12	7.0	3.5	....	41	71	60	54	....	43	....	13
22	14	6.5	4.0	17	38	66	54	45	....	32	28	13
23	11	5.5	....	18	34	59	52	37	....	28	23	15
24	11	5.0	....	19	37	53	49	34	....	25	18	16
25	11	4.5	....	30	38	54	45	31	....	24	17	18
26	11	4.0	....	52	36	70	51	28	80	23	17	27
27	11	3.5	....	43	32	71	59	43	64	27	18	19
28	10	3.5	....	34	29	61	64	38	60	24	16	16
29	10	....	....	26	28	54	74	61	52	22	15	15
30	10	....	....	24	28	49	70	52	45	22	14	16
31	10	....	....	....	29	....	57	43	....	21	....	16

NOTE.—Discharge for following periods estimated by comparison with records of flow for other stations, because stage-discharge relation was affected by ice: Jan. 19–25, Feb. 25–28, and Mar. 1–21, as shown in table. Operation of water-stage recorder not satisfactory for following periods, discharge estimated from maximum and minimum stages indicated by recorder and by comparison with records of flow for other stations: Mar. 22–31, 5 second-feet; Apr. 1–21, 15 second-feet; Sept. 17–25, 120 second-feet; Nov. 4–21, 25 second-feet; and Dec. 7–12, 11 second-feet.

Monthly discharge of Grindstone Creek at Taku Inlet for 1919.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
January	56	10	19.3	1,190
February	10	3.5	7.00	389
March	....	3.0	3.82	235
April	52	....	19.3	1,150
May	48	17	31.8	1,960
June	71	29	54.6	3,250
July	130	45	69.9	4,300
August	85	28	48.8	3,000
September	....	21	68.0	4,050
October	260	21	61.9	3,810
November	....	14	22.3	1,330
December	34	8.0	14.7	904
The year	260	3.0	35.3	25,600

CARLSON CREEK AT SUNNY COVE.

LOCATION.—At Sunny Cove, on west shore of Taku Inlet, 20 miles by water from Juneau.

DRAINAGE AREA.—22.26 square miles (determined by engineering department of Alaska Gastineau Mining Co. from surveys made by that company).

RECORDS AVAILABLE.—July 18, 1916, to December 31, 1919.

GAGE.—Stevens water-stage recorder on left bank, 2 miles from tidewater; inspected several times a week by employees of Alaska Gastineau Mining Co.

DISCHARGE MEASUREMENTS.—At high stages, made from cable across river one-half mile downstream from gage; at medium and low stages, made by wading 500 feet upstream from gage.

CHANNEL AND CONTROL.—Above the gage the stream meanders in one main channel and several small channels through a flat, sandy basin about a mile long; just below the gage the channel contracts and the stream passes over rocky falls that form a well-defined and permanent control. The point of zero flow is at gage height −1.5 feet.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 6.75 feet at 4 p. m. September 13 (discharge, from extension of rating curve, 4,440 second-feet); minimum flow, estimated by comparison with record of flow for Sweetheart Falls, 15 second-feet, March 28.

1916–1919: Maximum stage, 8.1 feet at 2 p. m. September 26, 1918 (discharge, computed from extension of rating curve, 6,200 second-feet); minimum flow, estimated from climatic data and hydrographs for streams in near-by drainage basins, 10 second-feet, April 1–7, 1918.

ICE.—Stage-discharge relation affected by ice.

ACCURACY.—Stage-discharge relation permanent. Rating curve well defined between 70 and 2,000 second-feet, extended below 70 second-feet to point of zero flow and above 2,000 second-feet by estimation. Operation of water-stage recorder satisfactory except for periods of break in record as indicated in footnote to daily-discharge table. Daily discharge ascertained by applying to rating table mean daily gage heights determined by inspecting gage-height graph, or, for days of considerable fluctuation, by averaging results obtained by applying to rating table mean gage heights for regular intervals of the day. Records good except for stages below 70 second-feet and above 2,000 second-feet and for periods of break in record, for which they are fair.

Discharge measurements of Carlson Creek at Sunny Cove during 1919.

[Made by G. H. Canfield.]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*		*Feet.*	*Sec.-ft.*
Jan. 23		[a] 40	Apr. 22	−0.30	76
Feb. 21		[a] 24	Aug. 12	1.70	474
Mar. 22		[a] 20	Dec. 13		[a] 33

[a] Creek covered with thick ice. Measurement made 2 miles below gage; measured discharge reduced 5 per cent to obtain flow at gage.

Daily discharge, in second-feet, of Carlson Creek at Sunny Cove for 1919.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Dec.
1	....	367	605	590	175	104	....
2	....	399	560	560	137	288	....
3	....	530	658	545	120	1,100	....
4	....	455	....	658	108	1,080	....
5	....	387	....	762	102	1,860	....
6	....	370	....	590	108	3,160	....
7	....	419	....	530	127	1,270	....
8	....	425	....	658	128	441	....
9	....	500	....	840	452	272	....
10	....	622	....	622	1,020	182	....
11	....	640	....	530	362	124	....
12	....	575	....	470	485	114	....
13	....	605	....	581	3,150	107	33
14	....	545	....	1,450	999	107	....
15	....	530	....	885	470	104	....
16	....	515	....	860	382	101	....
17	....	575	....	622	1,040	104	....
18	....	545	....	622	1,210	136	....
19	....	575	....	1,510	540	256	....
20	....	710	....	902	440	455	....
21	....	780	....	500	2,030	455	....
22	....	710	....	359	662	156	....
23	....	675	....	300	636	102	....
24	340	728	575	272	1,460	....	....
25	545	762	590	263	1,170	....	....
26	402	762	675	250	396	....	....
27	315	745	820	382	210	....	....
28	277	692	950	590	115	....	....
29	268	675	1,020	745	156	....	....
30	292	605	745	500	106	....	....
31	325	....	622	272	....	....	....

NOTE.—Operation of water-stage recorder unsatisfactory and discharge for following periods estimated from four current-meter measurements, weather records, and hydrographs for other stations: Jan. 1-31, 137 second-feet; Feb. 1-28, 28 second-feet; Mar. 1-31, 20 second-feet; Apr. 1-23, 65 second-feet: Apr. 24-30, 200 second-feet; and May 1-23, 320 second-feet. July 4-23, estimated at 675 second-feet by comparison with record of flow for Sweetheart Falls Creek. Discharge for following periods estimated by comparison with records for other stations: Oct. 20-23, daily discharge; Oct. 24-31, 85 second-feet; Nov. 1-30, 130 second-feet; Dec. 1-12, 45 second-feet; Dec. 14-31, 150 second-feet.

Monthly discharge of Carlson Creek at Sunny Cove for 1919.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
January	....	....	137	8,420
February	....	....	28	1,560
March	....	....	20	1,230
April	....	....	96.5	5,740
May	....	....	327	20,100
June	780	367	581	34,600
July	1,020	....	688	42,300
August	1,510	250	620	38,100
September	3,150	102	617	36,700
October	3,160	....	412	25,300
November	....	....	130	7,740
December	....	....	106	6,520
The year	....	....	....	228,000

SHEEP CREEK NEAR THANE.

LOCATION.—At lower end of flat basin, above diversion dam for flume leading to Treadwell power house at beach and 1 mile by tramway and ore railway from Thane.

DRAINAGE AREA.—4.57 square miles above gaging bridge (measured on United States Geological Survey map of Juneau and vicinity, edition of 1917).

RECORDS AVAILABLE.—July 26, 1916, to December 31, 1919.

GAGE.—Stevens water-stage recorder on right bank, at pool formed by an artificial control just below small island three-tenths mile upstream from diversion dam. Recorder inspected once a week by an employee of the Alaska Gastineau Mining Co.

DISCHARGE MEASUREMENTS.—At extremely high stages, made from gaging bridge two-tenths mile downstream from gage; at low stages, made by wading near bridge section. No streams enter between gage and measuring section, but seepage inflow ranges from a small amount to 10 per cent of total flow, the percentage of inflow usually being large after periods of heavy precipitation.

CHANNEL AND CONTROL.—The station is near the lower end of a flat basin through which the stream meanders in a channel having low banks and a bed of sand and gravel. An artificial control was built 2 feet below the intake for the gage well, to confine the flow in one channel during high water and to insure a permanent stage-discharge relation. The spillway of the control at low stages consists of a timber, 16 feet long, set in the bed of the stream. During medium and high stages another timber, 8 feet long, bolted at the top near the right end, forms part of the control. A 3-foot cut-off wall is driven at the upstream face of the spillway. There are wing walls at each end, and an 8-foot apron extends downstream from the control.

ICE.—Control covered with ice and snow for short period.

EXTREMES OF DISCHARGE.—Maximum stage during year, 2.52 feet, at 1 a. m. October 6 (discharge, estimated from extension of rating curve, 490 second-feet); minimum stage, −0.48 foot March 31 to April 2 (discharge, 4.0 second-feet).

1916–1919: Maximum stage during period, 3.5 feet, at 2 p. m. September 26, 1918 (discharge, estimated from extension of rating curve, 820 second-feet); minimum flow, 1.0 second-foot, April 6–8, 1917.

ACCURACY.—Stage-discharge relation, between 0.5 and 1.2 feet, changed January 8. Rating curve used January 1–8, fairly well defined below 700 second-feet; curve used January 9 to December 31 fairly well defined. Operation of water-stage recorder satisfactory except for periods indicated in footnote to daily-discharge table. Daily discharge ascertained by applying to rating table mean daily gage height determined by inspecting gage-height graph, or, for days of considerable fluctuation, by averaging results obtained by applying to rating table mean gage heights for regular intervals of the day. Records fair.

Discharge measurements of Sheep Creek near Thane during 1919.

[Made by G. H. Canfield.]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*		*Feet.*	*Sec.-ft.*
Jan. 25	0.66	18	July 1	1.00	74
Feb. 11	.30	9.0	Aug. 20	1.135	105
Mar. 20	−.40	4.5	Oct. 22	.86	43
Apr. 17	.65	16	Dec. 11	.53	13
May 13	.92	52			

Daily discharge, in second-feet, of Sheep Creek near Thane for 1919.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	22	13	6.5	4.0	41	61	72	72	41	46	19	......
2	22	11	6.4	4.0	35	......	72	63	36	72	18	......
3	21	9.3	6.3	4.9	32	......	96	61	35	210	17	......
4	19	9.2	6.2	5.9	31	72	108	68	34	164	17	......
5	16	9.0	6.0	7.0	30	70	108	72	34	322	16	......
6	38	8.5	......	8.3	30	84	124	68	32	379	15	......
7	68	8.4	......	9.0	34	88	134	61	34	232	15	......
8	75	8.3	......	12	50	......	108	72	34	146	15	......
9	63	8.1	......	15	61	......	108	91	68	111	14	......
10	54	8.0	......	16	52	......	115	77	103	91	14	......
11	48	7.9	......	16	50	......	108	70	54	......	14	13
12	46	7.8	......	16	52	......	105	63	56	......	13	13
13	41	7.7	......	16	54	......	113	72	244	......	13	12
14	38	7.6	......	17	63	......	115	113	121	......	13	12
15	35	7.5	......	18	86	......	103	96	88	......	19	12
16	31	7.3	......	18	91	......	91	96	72	......	......	12
17	27	7.2	......	17	79	......	88	77	96	......	......	15
18	23	7.1	......	18	82	......	94	72	98	......	......	25
19	21	7.1	......	18	96	......	91	141	84	......	......	15
20	19	7.0	4.5	19	96	......	88	113	79	......	......	16
21	19	6.9	4.5	22	84	......	86	88	251	......	68	16
22	19	6.8	4.4	22	77	......	82	77	113	43	52	16
23	19	6.7	4.4	25	72	......	79	68	108	40	38	15
24	18	6.6	4.3	23	72	......	77	61	252	40	25	15
25	18	6.6	4.3	61	84	......	77	59	176	36	......	19
26	18	6.6	4.2	84	77	......	77	52	121	34	......	35
27	17	6.6	4.2	86	68	......	86	63	94	34	......	26
28	16	6.6	4.1	68	61	......	96	68	72	32	......	22
29	16	......	4.1	59	54	......	108	88	68	27	......	19
30	16	......	4.0	50	54	......	98	68	56	26	......	17
31	15	......	4.0	......	54	......	79	54	......	23	......	18

NOTE.—Daily discharge Jan. 10–24 and Mar. 1–5 estimated, because of unsatisfactory operating of gage by comparison with records for Gold Creek. Discharge for following periods estimated from maximum and minimum stages shown by gage and comparison with records of flow for Gold Creek: Mar. 6–19, 5 second-feet; June 2–3, 80 second-feet; June 8–30, 90 second-feet; Oct. 11–21, 53 second-feet; Nov. 16–20, 60 second-feet; Nov. 25–30, 22 second-feet; Dec. 1–10, 18 second-feet; Dec. 30 and 31 as shown in table.

Monthly discharge of Sheep Creek near Thane for 1919.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
January	75	15	29.6	1,820
February	13	6.6	7.87	437
March	....	....	4.92	303
April	86	4.0	25.3	1,510
May	96	30	61.4	3,780
June	....	....	86.8	5,160
July	134	72	96.3	5,920
August	141	52	76.3	4,690
September	252	32	91.8	5,460
October	379	23	86.8	5,340
November	....	13	28.2	1,680
December	35	....	17.5	1,080
The year	379	....	51.3	37,200

GOLD CREEK AT JUNEAU.

LOCATION.—At highway bridge at lower end of Last Chance basin, 200 feet upstream from diversion dam of Alaska Electric Light & Power Co. and one-fourth mile from Juneau.

DRAINAGE AREA.—9.47 square miles (determined by engineering department of Alaska Gastineau Mining Co. from surveys made by that company).

RECORDS AVAILABLE.—July 20, 1916, to December 31, 1919.

GAGE.—Stevens continuous water-stage recorder on left bank at upstream side of highway bridge. A staff gage was installed September 19, 1916, on left wing wall of diversion dam 200 feet downstream and used in determining the time of changes in stage-discharge relation at the well gage.

DISCHARGE MEASUREMENTS.—At medium and high stages made from gaging bridge suspended, at right angles to current, from floor of highway bridge; at low stages, made by wading near gage.

CHANNEL AND CONTROL.—Station is at lower end of a flat gravel basin three-fourths mile long. For 20 feet upstream from gage the stream is confined between the abutments of an old bridge, and for 15 feet downstream it is confined between the abutments of present bridge. For a distance of 130 feet farther downstream the stream is confined in a narrow channel which is not subject to overflow. Because of the steep gradient of channel opposite and for 150 feet below gage, a short stretch of the channel immediately below the gage acts as the control. The operation of the headgates of flume at diversion dam, 200 feet downstream, does not affect the stage-discharge relation at gage, but the swift current during high stages shifts the gravel in bed of stream, thereby causing changes in the stage-discharge relation.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 4.9 feet at 2 p. m., September 13 (discharge, computed from extension of rating curve, 1,300 second-feet); minimum flow, estimated by discharge measurements and climatic data, 2 second-feet, March 15–28.

1916–1919: Maximum stage, 6.8 feet September 26, 1918 (discharge estimated from extension of rating curve, 2,600 second-feet); minimum discharge, 0.9 second-foot March 26, 1918.

ICE.—Stage-discharge relation affected by ice in February, March, and April.

DIVERSION.—Water diverted at several points upstream for power development is returned to creek above gage, except about 20 second-feet for seven months (when there is a surplus over amount used by Alaska Electric Light & Power Co., which has prior right) and 1 second-foot the remainder of year, used by the Alaska-Juneau Gold Mining Co. A dam 200 feet downstream diverts water into the flume of the Alaska Electric Light & Power Co.

REGULATION.—No storage or diversions above station regulate the flow more than a few hours in low water.

ACCURACY.—Stage-discharge relation changed during periods of high water; 13 discharge measurements were made during year, by use of which rating curves have been constructed applicable as follows: January 1 to June 21, well defined below and fairly well defined above 70 second-feet; June 22 to September 13, fairly well defined; September 14–24 (a. m.), poorly defined by one discharge measurement; September 24 (p. m.) to November 17, fairly well defined by two discharge measurements; November 18 to December 31, fairly well defined by two discharge measurements. Operation of water-stage recorder satisfactory except for periods indicated in footnote to daily-discharge table. Daily discharge ascertained by applying to rating table mean daily gage height determined by inspecting gage-height graph, or, for days of considerable fluctuations, by averaging results obtained by applying to rating table mean gage heights for equal intervals of the day. Records fair.

Discharge measurements of Gold Creek at Juneau during 1919.

[Made by G. H. Canfield.]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*		*Feet.*	*Sec.-ft.*		*Feet.*	*Sec.-ft.*
Jan. 24	0.89	14.5	May 10	1.37	59	Nov. 19	1.35	116
Feb. 10	.78	10.5	July 1	1.88	162	28	.71	24
Mar. 14	[a] .70	2.1	Aug. 6	1.86	151	Dec. 27	.92	46
Apr. 4	[a] .98	17.0	Sept. 15	2.16	173			
18	.92	14.6	Oct. 15	1.08	46			

[a] Control and measuring section frozen over.

Daily discharge, in second-feet, of Gold Creek at Juneau for 1919.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	16	12	......	......	48	88	158	167	78	42	16	20
2	22	11	......	......	39	109	153	147	70	93	15	21
3	19	11	......	......	32	137	231	140	63	410	14	20
4	18	11	......	......	27	118	270	169	63	320	14	19
5	20	10	......	......	22	109	255	198	63	615	14	19
6	45	10	......	......	......	95	300	158	63	725	13	19
7	71	10	......	......	......	95	330	132	70	304	13	17
8	86	10	......	......	......	97	246	174	70	114	13	16
9	62	10	......	......	......	114	270	216	151	73	13	14
10	55	10	......	......	59	147	285	180	240	50	12	14
11	46	......	......	......	55	158	285	162	111	47	12	12
12	34	......	......	......	62	161	264	141	147	39	12	12
13	31	......	......	......	62	170	309	162	920	35	20	12
14	27	......	......	......	77	143	340	285	295	30	18	12
15	25	......	......	......	118	137	276	228	188	46	18	12
16	21	......	......	......	137	143	208	202	165	30	18	16
17	19	......	......	......	109	147	185	162	289	37	46	41
18	19	......	......	......	109	137	216	174	273	32	230	72
19	19	......	......	......	147	161	210	365	154	42	125	33
20	19	......	......	......	152	215	198	285	135	57	134	22
21	16	......	......	......	118	240	205	174	490	93	99	19
22	14	......	......	......	99	225	195	140	183	73	63	17
23	14	......	......	......	92	210	195	130	172	42	45	25
24	14	......	......	......	106	210	180	130	470	32	30	42
25	14	......	......	......	122	210	162	130	320	30	29	53
26	14	......	......	......	102	222	198	115	165	28	30	93
27	14	......	......	......	84	225	225	158	109	31	29	49
28	13	......	......	......	77	198	255	174	93	26	27	36
29	13	......	......	......	72	180	300	198	91	22	25	29
30	13	......	......	......	71	167	255	140	60	21	22	25
31	12	......	......	......	77	......	190	115	......	20	......	27

NOTE.—Water-stage record lost for following periods; discharge estimated from three discharge measurements, from climatic records for Juneau, and by comparison with hydrographs or other stations: Feb. 11-28, 9 second-feet; Mar. 1-31, 5 second-feet; and Apr. 1-30, 35 second-feet. Operation of water-stage recorder unsatisfactory for following periods, discharge estimated by comparison with records for Sheep Creek: May 6-9, 50 second-feet; Aug. 11-20, as shown in table.

Monthly discharge of Gold Creek at Juneau for 1919.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
January	86	12	26.6	1,640
February	......	......	9.54	530
March	......	......	5	307
April	......	......	35	2,080
May	152	22	79.8	4,910
June	240	88	159	9,460
July	340	153	237	14,600
August	365	115	176	10,800
September	490	60	192	11,400
October	725	20	115	7,070
November	230	12	59.0	2,320
December	93	12	27.0	1,660
The year	725	......	92.2	66,800

FALLS CREEK AT NICKEL, NEAR CHICHAGOF.

LOCATION.—One-eighth mile above beach, on stream that enters tidewater half a mile northeast of camp of Alaska Nickel Mines Co., 20 miles by water northwes of Chichagof, on west coast of Chichagof Island.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—May 6, 1918, to December 31, 1919.

GAGE.—Stevens water-stage recorder on left bank one-eighth mile above beach.

DISCHARGE MEASUREMENTS.—At medium and high stages, made from cable across stream 500 feet above gage; at low stages, made by wading in channel exposed at beach at low tide.

CHANNEL AND CONTROL.—The gage is 20 feet upstream from rectangular weir, the crest of which is 2 feet above bed of stream, 2 inches wide, and 40 feet long. At the cable section the bed is smooth, the water is deep, and the current is regular and sluggish.

EXTREMES OF STAGE.—Maximum stage recorded during period, 3.45 feet at 3 p. m. September 26, 1918; minimum stage recorded, 0.18 foot March 12, 1919.

ICE.—Stage-discharge relation affected by ice forming on crest of weir.

ACCURACY.—Stage-discharge relation permanent; affected by ice January 18, February 25 to March 4, 1918. Sufficient discharge measurements not yet available to define rating curve. Operation of water-stage recorder satisfactory except for following periods; November 24–30, December 29, 1918, January 18, to February 8, March 23 to April 3, April 28 to May 3, May 4 to 17, July 22–27, August 11–15, September 24, and December 17–27, 1919. Mean daily gage height determined by inspecting gage-height graph, or, for days of considerable fluctuation, by averaging mean gage heights for regular intervals of the day.

COOPERATION.—The gage and weir were installed by the Alaska Nickel Mines Co., and the cable and car by the United States Geological Survey in cooperation with the company which also furnished the gage-height record and most of the discharge measurements.

Discharge measurements of Falls Creek at Nickel during 1918–19.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
1918.		*Feet.*	*Sec.-ft.*	1919.		*Feet.*	*Sec.-ft.*
June 10	G. H. Canfield	0 92	90	Jan. 19	Kimball	[b] 0.70	23
11	do	.96	100	Feb. 21	do	[b] .44	24
July 8	F. S. Fleming [a]	.52	38				
Dec. 30	Kimball [a]	.56	48				

[a] Employee of Alaska Nickel Mines Co.
[b] Stage-discharge relation affected by ice.

Daily gage height, in feet, of Falls Creek at Nickel for 1918–19.

Day	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1918.								
1	....	1.07	1.01	0.59	1.60	0.62	1.15	1.70
2	....	.94	.86	.55	1.10	.60	.89	1.42
3	....	.86	.77	.51	.70	.76	.73	1.07
4	....	.81	.71	.48	.55	.78	.87	.87
5	....	.81	.65	.46	.50	.69	2.70	.79
6	1.10	.84	.59	.53	.45	.62	2.25	.98
7	.92	.91	.56	.67	.43	.67	1.48	.70
8	.87	.99	.54	.60	.40	.60	1.07	.61
9	....	1.00	.52	.63	.83	.65	.84	.57
10	.87	.93	.49	.53	.68	.52	.70	.52
11	.94	.95	.66	.50	.60	.50	.73	.48
12	.98	.93	.68	.48	.55	.95	.88	.45
13	.98	.87	.60	.62	.52	.87	.75	.42
14	.97	.83	.55	.97	.48	1.10	.70	.43
15	.92	.81	.51	.75	.60	.88	.60	.41
16	.88	.75	.48	.75	.70	.75	.59	.67
17	.82	.70	.46	.92	1.39	.88	.54	.75
18	.83	.67	.44	.78	1.70	.98	.46	.68
19	.77	.63	.42	.75	1.30	.80	.43	.62
20	.70	.67	.42	.78	.97	.78	.57	.54
21	.75	.65	.40	1.03	.78	.72	.75	1.23
22	.70	.61	.38	1.20	.65	.62	.83	1.20
23	.70	.60	.37	1.33	.93	.59	.85	1.30
24	.70	.66	.37	1.61	.75	.65	....	1.08
25	.73	.71	.36	1.43	1.36	.62	....	1.16
26	.76	.73	.35	1.15	2.48	1.07	....	1.07
27	.77	.75	.46	1.00	1.87	.88	....	.85
28	1.54	.75	.63	1.26	1.27	1.30	....	.70
29	1.81	1.07	.50	1.30	.95	1.18	....	....
30	1.51	1.33	.55	2.24	.73	1.28	....	.56
31	1.34	....	.66	2.46	....	1.20	....	.52

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1919.												
1	0.57	....	0.76	....	....	0.61	0.45	0.36	0.78	0.58	0.63	0.39
2	1.07	....	.68	....	....	.66	.44	.35	.62	1.73	.51	.36
3	.90	....	.63	....	....	.69	.48	.34	.54	2.6	.46	.36
4	.82	....	.56	0.71	0.53	.67	.52	.34	.48	2.3	.43	.37
5	.92	....	.26	.75	....	.66	.52	.42	.42	2.3	.38	.45
6	1.64	....	.30	.75	....	.65	.63	.37	.39	2.8	.35	.65
7	1.57	....	.31	.68	....	.62	.60	.35	.38	2.00	.33	.49
8	1.45	....	.33	.65	....	.58	.57	.55	.36	1.32	.40	.47
9	1.15	0.37	.45	.64	....	.58	.60	.75	1.02	.95	.33	.70
10	.96	.45	.37	.57	....	.57	.76	.65	1.05	.94	.30	.72
11	.86	.37	.33	.55	....	.57	.78	....	.80	.77	.30	.60
12	.71	.34	.23	.52	....	.57	.76	....	1.48	.68	.33	.50
13	.65	.35	.35	.52	....	.60	.88	....	2.73	.64	.64	.44
14	.60	.39	.55	.52	....	.62	.88	....	1.95	.56	.52	.34
15	.52	.38	.65	.49	....	.62	.76	....	1.25	.50	.67	.55
16	.48	.36	.70	.46	....	.58	.66	.78	1.00	.55	.71	1.12
17	.82	.37	.67	.59	....	.56	.62	.70	1.28	.53	1.00	....
18	....	.62	.68	.67	.81	.55	.63	.80	1.40	.72	1.54	....
19	....	.66	.57	.75	.96	.56	.59	1.20	1.05	.70	1.34	....
20	....	.52	.80	.75	1.24	.60	.61	1.15	.93	1.29	1.50	....
21	....	.46	1.07	.72	1.04	.60	.63	.85	1.65	1.16	1.09	....
22	....	.45	.81	.66	.89	.60	....	.70	1.19	.88	.87	....
23	....	.39	....	.74	.78	.60	....	.60	1.08	.72	.70	....
24	....	.35	....	.71	.80	.58	....	.55	....	.64	.59	....
25	....	.34	....	1.41	.88	.56	....	.46	1.60	.57	.52	....
26	....	.29	....	1.68	.80	.53	....	.42	1.13	.59	.48	....
27	....	.45	....	1.65	.74	.51	....	.58	.85	.62	.46	....
28	....	.65	....	....	.74	.51	.40	.75	.85	.56	.45	.66
29	....	....	....	....	.69	.49	.37	1.02	.75	.57	.46	.60
30	....	....	....	....	.64	.47	.36	1.08	.66	1.10	.41	1.34
31	....	....	....	....	.61	....	.36	.98	....	.70	....	....

NOTE.—For following periods water-stage recorder did not operate satisfactorily, but maximum and minimum stages were recorded: Nov. 24–30, 1918: Maximum stage, 1.90 feet; minimum, 0.83 foot. Jan. 18 to Feb. 8: Maximum stage, 0.88 foot; minimum, 0.83 foot. Mar. 23 to Apr. 3: Maximum stage, 0.90 foot; minimum, 0.22 foot.

PORCUPINE CREEK NEAR NICKEL.

LOCATION.—Half a mile above beach, on stream that enters tidewater at head of Porcupine Harbor, 4 miles northwest of camp of Alaska Nickel Mines Co., which is 20 miles by water northwest of Chichagof, on west coast of Chichagof Island.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—May 20, 1918, to December 31, 1919.

GAGE.—Stevens water-stage recorder on left bank of stream half a mile above beach.

DISCHARGE MEASUREMENTS.—At medium and high stages, made from cable across stream 150 feet above gage; at low stages, made by wading near control.

CHANNEL AND CONTROL.—The gage is located at edge of deep pool formed by contraction of channel where stream passes over exposed bedrock and descends in a series of small falls. The head of these falls forms a well-defined and permanent control. At the cable section the bed is rough, the water is deep, and the current is sluggish and irregular, because 15 feet above cable the stream widens into a small lake.

EXTREMES OF STAGE.—1918–19: Maximum stage recorded during period, 3.35 feet at 10 a. m. November 6, 1918; minimum stage recorded, 0.37 foot March 19 and 28, 1919.

ICE.—Stage-discharge relation not affected by ice.

ACCURACY.—Stage-discharge relation permanent, affected by ice only February 25. Sufficient discharge measurements not yet available to define rating curve. Operation of water-stage recorder satisfactory except for following periods: July 22 to August 4, November 30 to December 23, 1918, May 10–13, July 26–30, October 5–8, 24–31, and December 1–17, 1919. Mean daily gage heights determined by inspecting gage-height graph, or, for days of considerable fluctuation, by averaging mean gage heights for regular intervals of the day.

COOPERATION.—The gage was installed by the Alaska Nickel Mines Co., and the cable and car by the United States Geological Survey in cooperation with the company, which also furnished gage-height graph and 4 discharge measurements.

Discharge measurements of Porcupine Creek near Nickel during 1918–19.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
1918.		*Feet.*	*Sec.-ft.*	1919.		*Feet.*	*Sec.-ft.*
June 12	G. H. Canfield	1.60	140	Jan. 16	Kimball	1.30	112
Aug. 5	F. S. Fleming	.96	68	25	.....do	.94	69
				Mar. 1	.....do	.53	36

Daily gage height, in feet, of Porcupine Creek near Nickel for 1918–19.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1918.								
1	....	1.88	1.59	....	2.35	1.70	1.83	....
2	....	1.78	1.54	....	2.05	1.60	1.73	....
3	....	1.70	1.50	....	1.84	1.62	1.60	....
4	....	1.64	1.45	....	1.69	1.62	1.53	....
5	....	1.59	1.40	0.96	1.57	1.55	2.47	....
6	....	1.59	1.35	.98	1.47	1.48	3.25	....
7	....	1.59	1.33	1.07	1.37	1.44	2.8	....
8	....	1.63	1.30	1.10	1.29	1.43	2.40	....
9	....	1.64	1.27	1.08	1.24	1.38	2.10	....
10	....	1.62	1.25	1.05	1.35	1.32	1.85	....
11	....	1.62	1.28	1.02	1.31	1.28	1.72	....
12	....	1.60	1.30	1.08	1.30	1.41	1.67	....
13	....	1.55	1.26	1.25	1.25	1.47	1.58	....
14	....	1.53	1.22	1.22	1.20	1.53	1.52	....
15	....	1.52	1.20	1.22	1.14	1.51	1.45	....
16	....	1.48	1.18	1.32	1.23	1.46	1.40	....
17	....	1.44	1.15	1.32	1.50	1.45	1.33	....
18	....	1.41	1.13	1.29	1.80	1.55	1.25	....
19	....	1.37	1.10	1.32	1.80	1.52	1.20	....
20	....	1.36	1.08	1.40	1.68	1.48	1.22	....
21	1.24	1.34	1.04	1.55	1.57	1.43	1.27	....
22	1.23	1.30	....	1.65	1.48	1.35	1.38	....
23	1.22	1.28	....	1.86	1.52	1.30	1.38	....
24	1.20	1.28	....	1.91	1.45	1.30	1.42	1.46
25	1.20	1.30	....	1.85	1.70	1.27	1.43	1.49
26	1.20	1.30	....	1.75	2.6	1.37	1.57	1.57
27	1.21	1.30	....	1.81	2.9	1.39	1.63	1.49
28	1.50	1.32	....	1.90	2.45	1.52	1.62	1.42
29	1.91	1.45	....	2.37	2.15	1.60	1.82	1.34
30	2.03	1.64	....	3.0	1.90	1.72	1.85	1.29
31	1.96	....	....	2.75	....	1.80	....	1.22

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1919.												
1	1.20	0.80	0.50	0.68	1.39	1.23	1.07	0.96	1.50	1.63	1.33	....
2	1.36	.77	.49	.71	1.33	1.23	1.04	.94	1.45	2.05	1.32	....
3	1.37	.75	.48	.74	1.28	1.25	1.04	.92	1.37	2.86	1.33	....
4	1.33	.73	.45	.73	1.23	1.22	1.07	.91	1.30	3.18	1.28	....
5	1.38	.70	.43	.78	1.21	1.20	1.07	.92	1.24	....	1.28	....
6	1.67	.68	.45	.81	1.21	1.18	1.09	.92	1.16	....	1.23	....
7	1.90	.67	.45	.81	1.22	1.16	1.13	.80	1.12	....	1.18	....
8	1.95	.65	.46	.81	1.23	1.14	1.13	.85	1.08	....	1.05	....
9	1.91	.65	.52	.81	1.26	1.12	1.14	.98	1.25	2.50	1.13	....
10	1.80	.67	.49	.80	....	1.12	1.17	1.00	1.40	2.28	1.11	....
11	1.71	.65	.47	.80	....	1.11	1.27	1.00	1.32	2.02	1.04	....
12	1.60	.63	.50	.81	....	1.11	1.28	.98	1.45	1.38	1.01	....
13	1.50	.61	.45	.81	1.21	1.10	1.34	1.08	2.75	1.69	1.09	....
14	1.45	.62	.43	.81	1.23	1.10	1.39	1.18	2.98	1.61	1.06	....
15	1.37	.62	.40	.80	1.29	1.11	1.38	1.16	2.52	1.54	1.11	....
16	1.29	.60	.40	.79	1.33	1.10	1.36	1.26	2.23	1.46	1.11	....
17	1.23	.57	.40	.81	1.31	1.10	1.33	1.23	2.15	1.40	1.24	....
18	1.16	.70	.39	.83	1.30	1.10	1.31	1.22	2.35	1.38	1.47	1.44
19	1.10	.75	.38	.88	1.35	1.10	1.28	1.43	2.15	1.37	1.60	1.39
20	1.05	.69	.42	.90	1.50	1.11	1.26	1.50	1.95	1.57	1.72	1.36
21	1.05	.66	.50	.92	1.50	1.13	1.26	1.46	2.35	1.71	1.70	1.36
22	1.03	.64	.46	.92	1.48	1.13	1.25	1.40	2.15	1.73	1.65	1.41
23	.98	.63	.45	.94	1.44	1.15	1.21	1.33	2.10	1.58	1.88	1.43
24	.95	.60	.44	.94	1.41	1.15	1.19	1.27	2.50	1.46	....	1.58
25	.94	1.44	.42	1.19	1.44	1.15	1.14	1.20	2.70	1.43	....	1.66
26	.87	.55	.40	1.37	1.42	1.13	....	1.16	2.35	1.32	....	1.81
27	.90	.53	.39	1.55	1.38	1.12	....	1.18	2.08	1.29	....	1.78
28	.88	.52	.38	1.54	1.34	1.11	....	1.25	1.96	1.27	....	1.69
29	.87	....	.41	1.49	1.32	1.11	....	1.36	1.88	1.24	....	1.61
30	.85	....	.46	1.44	1.26	1.09	....	1.50	1.70	1.44	....	1.51
31	.82	....	.61	....	1.22	....	.97	1.55	....	1.35	....	1.61

MISCELLANEOUS MEASUREMENTS.

Miscellaneous discharge measurements in southeastern Alaska in 1919.

Date.	Stream.	Tributary to—	Locality.	Discharge.
				Sec.-ft.
Apr. 11	Spruce Creek	Windham Bay	Mouth of creek	15.6
July 12	do	do	At bridge near mill of Alaska Peerless Gold Mining Co., half a mile above mouth of creek.	28.6

WATER POWER ON CERTAIN STREAMS IN SOUTHEASTERN ALASKA.

Owing to the great variation in flow of streams in southeastern Alaska, storage is an important factor in determining the power that can be developed and the cost of development. The amount of possible storage is generally estimated, because few local maps or sketches of river basins are available.

In the following table the estimates of annual flow at gaging stations are based on records prior to October 1, 1918. The flow at the point of diversion to the power plant is estimated from the records for gaging stations, by comparison with records for other streams, or from precipitation data. The "annual flow" is that for the climatic year ending September 30. The effective head is the elevation of the lake or dam site above high tide plus two-thirds of the head created by the dam minus 10 feet (elevation of nozzles of impulse turbines). The estimates of available power are based on continuous and complete utilization of a plant having an efficiency of 80 per cent.

The following abbreviations are used in the table:

A. B. S., Alaskan Boundary Survey maps.
U. S. G. S., U. S. Geological Survey topographic maps.
U. S. F. S., U. S. Forest Service topographic maps.
U. S. F. S. R., U. S. Forest Service timber reconnaissance maps.

Data concerning certain streams in southeastern Alaska on which power may be developed.

Stream and location.	Drainage area.	Map used.	Records available.	Mean annual flow.		Elevation of lake or dam site above high tide.	Storage required to equalize flow, or storage available.	Area of lake or basin.	Height of dam above or depth of tunnel below lake surface for obtaining required storage.	Length of conduit.	Mean static head.	Continuous horsepower at 80 per cent efficiency.
				At gaging station.	At point of diversion.							
	Square miles.			*Sec.-ft.*	*Sec.-ft.*	*Feet.*	*Acre-feet.*	*Acres.*	*Feet.*	*Miles.*	*Feet.*	
Mainland:												
Endicott River on west shore of Lynn Canal (reconnaissance by Alaska Gastineau Mining Co., 1913; lake gone).			None			175	53,000 (50-foot dam 18 miles from beach).		250-foot dam for head only.		(a)	10,000
Small stream on west shore of Taiya Inlet; mouth of Skagway.	1.8	A. B. S.	do		11	3,000				1.75	3,000	3,000
Sherman Creek at Comet; on east side of Lynn Canal.	3.65	U. S. G. S.	September, 1914, to December, 1917.	31	34 (storage for only 7 sec.-ft.)	500	2,000		100	1	560	350
Davies Creek, Berners Bay.	16.0	U. S. G. S.	Measurement, Sept. 8, 1916.		145	200	40,000		150	1.7	290	4,000
Peterson Lake outlet near Eagle River Landing.	5.7	U. S. G. S.	None		40	650	10,000	85	50	(b)	675	3,000
Montana Creek at elevation 250 feet; tributary to Mendenhall River; power house at elevation 50 feet.	10.9	U. S. G. S.	do		110	250	30,000		150	3	300	3,000
Nugget Creek, Mendenhall Glacier.												[c] 3,500
Salmon Creek near Juneau.	[d] 5.34											[c] 6,000
Gold Creek at Juneau	[d] 9.47											[c] 1,000
Sheep Creek at Thane	[d] 4.57		July 26, 1916.	52	41 (storage for only 30 sec.-ft.).	640	7,000	150 (at 710-foot contour).	70		680	2,000
Grindstone Creek at Taku Inlet.	[d] 3.6		May 6, 1911.	41	32 (storage for about 20 sec.-ft.).	220						
Carlson Creek at Taku Inlet.	[d] 22.3		July 18, 1916.	358	283 (storage for only 100 sec.-ft.).	350	20,000	300 (at 470-foot contour).			420	3,800
Annex Creek at Taku Inlet.	[a] 6.4											[b] 5,000

Norris Creek at Norris Glacier.	9.0	A. B. S.	None.		100	[e]350				2.5	400	3,600
Turner Lake Outlet, Taku Inlet.	66	A. B. S.	May, 1908, to April, 1909.	450	550	80	180,000	2,400	75	6	130	6,500
Carlson Lake outlet at Taku Harbor.			Measurement, Sept. 3, 1916.		8.6	[e]1,100			25			850
Crater Lake outlet at Port Snettisham.	11.9	A. B. S.	Jan. 23, 1913.	197	190	[f]1,012	54,000	700	Dam, 50; tunnel, 50.	.9	1,012	17,500
Long Lake outlet at Speel River.	33.2	A. B. S.	do	75	465	[f]803	151,000	2,000	Dam, 50; tunnel, 35.		[g]515	22,000
Speel River at Port Snettisham.			July 15, 1916, to Sept. 30, 1918.	2,700	2,700 (storage for only 1,875 sec.-ft.).	[f]150	370,000 (above elev. 192 feet).		157		262	45,000
Tease Lake outlet at Port Snettisham.	10.3	A. B. S.			125	[f]1,010	35,000	240	Dam, 50; tunnel, 100.	1.1	1,000	11,500
Sweetheart Falls Creek at Port Snettisham.	27	A. B. S.	July 31, 1915, to Mar. 31, 1917; May 21, 1918.	319	325	[e]520	90,000	1,500	50	2	545	15,000
Stream entering salt lake at head of Hobart Bay.	40	A. B. S.	None.		Storage for only 160 second-feet.	250	45,000 (between 300 and 400 foot contours).		150	2	360	5,000
Below fork of stream entering head of Port Houghton.	73	A. B. S.	do		Storage for only 300 second-feet.	50	50,000 at lake; 50,000 (between 100 and 200 foot contours).	440	Lower dam, 150 feet; dam at lake or storage only 50 feet.	125	165	5,400
Farragut River tributary to Farragut Bay; dam at lake on north fork, 12 miles from beach.			do		Storage for only 125 second-feet.	250		500	100	12	[h]267	5,200
Cascade Creek, Thomas Bay.	21	A. B. S.	Oct. 27, 1917.	304	At dam site, 220 (storage for only 80 sec.-ft.).		10,500		150	1.95	1,690	12,300
Stream tributary to west shore of Thomas Bay; 1.4 miles north of West Point.	10	A. B. S.	Measurement, Aug. 9, 1917.		50	[e]400	14,000	300	40	1.25	416	1,900
Stream tributary to north shore of Bradfield Canal, 2 miles east of Blake Channel.	15.5	A. B. S.	None.		90	[i]150				2	[a]175	1,400

[a] Elevation of power house, 95 feet.
[b] Three miles to Pearl Harbor; 4,000 feet of tunnel and 1,500 feet of pipe line to Tee Harbor.
[c] Developed.
[d] Determined by Alaska Gastineau Mining Co.
[e] Elevation determined by aneroid barometer.
[f] Reported by Speel River Project (Inc.).
[g] Elevation of power house, 300 feet.
[h] Elevation of power house, 50 feet.
[i] Estimated.

Data concerning certain streams in southeastern Alaska on which power may be developed—Continued.

Stream and location.	Drainage area.	Map used.	Records available.	Mean annual flow.		Elevation of lake or dam site above high tide.	Storage required to equalize flow, or storage available.	Area of lake or basin.	Height of dam above or depth of tunnel below lake surface for obtaining required storage.	Length of conduit.	Mean static head.	Continuous horsepower at 80 per cent efficiency.
				At gaging station.	At point of diversion.							
	Square miles.			*Sec.-ft.*	*Sec.-ft.*	*Feet.*	*Acre-feet.*	*Acres.*	*Feet.*	*Miles.*	*Feet.*	
Mainland—Continued.												
Stream tributary to north shore of Bradfield Canal, 11 miles east of Blake Channel; three-fourths mile from beach.	80	A. B. S.	None		700	a50	200,000 (between 100 and 200 foot contours; estimated).	3,000 (at 250 foot contour).	150	4.5	165	10,000
Stream tributary to north shore of Bradfield Canal, 1 mile west of the head; 1 mile from beach.	42	A. B. S.	do		300	a75	80,000 (between 150 and 250 foot contours).	1,100 (at 250 foot contour).	175	.75	200	5,500
Stream tributary to south shore of Bradfield Canal, 1 mile west of the head.	14	A. B. S.	do		100	1,100	25,000	500	Dam, 25; tunnel, 25.	2	1,100	10,000
Stream tributary to south shore of Bradfield Canal, 11 miles east of Blake Channel; at lake 5 miles from beach.	36	A. B. S.	do		Storage for 250 second-feet.	a300	65,000	300	130	5	376	8,500
Stream entering south shore of Bradfield Canal, 2 miles east of entrance.	27	A. B. S.	do		150	a150	39,000		100	2	210	3,800
Stream tributary to east bank of Chickamin River, 4 miles upstream from mouth.	23	A. B. S.	do			a150				.5		
Shelockum Lake outlet, Bailey Bay.	18	A. B. S.	June 4, 1915	211	200	344	52,000	350	Dam, 60; tunnel, 100.		340	6,000
Revillagigedo Island:												
Orchard Lake outlet, Shrimp Bay.		U. S. F. S.	May 28, 1915	600	600	134	130,000	1,400	70		175	9,500
Mahoney Creek, George Inlet.		U.S.F.S.R.	Measurement, Sept. 13, 1917		At lake, 35; at beach, 58.	2,000	7,000	180	Tunnel, 60	.75	b1,890	6,000
Beaver Falls Creek, George Inlet, at Upper Lake outlet.	3.6		Three measurements in 1917.		55	1,100		234	Dam, 25; tunnel, 25.	2.1	1,100	5,500
Beaver Falls Creek, George Inlet, at Lower Lake outlet.	4.9	U. S. F. S.			75	792	10,000	62				

Swan Lake outlet, Carroll Inlet.			Aug. 24, 1916	440	435	[c]225	75,000	300[a]	150	1.25	3.5	12,000
Fish Creek near Sealevel mine.		U.S.F.S.R.	May 19, 1915	429	400	[c]275	66,000	1,700	35	1.5	290	10,500
Annette Island:												
Tamgas Lake	5.9	Chart	None		60	[a]150			50			1,000
Chester Lake	6.0	do	do		60	825	10,000	64	Dam, 50; tunnel, 100.		815	4,500
Deep Lake	10	do	do		100	[a]150						2,000
Millanson Lake	6.1	do										1,500
Admiralty Island:												
Hasselborg Lake outlet, entering Mitchell Bay, Kootznahoo Inlet.	[d]90		None		800	247		3,500[d]	60	6–7	247	18,000
Chichagof Island:												
Porcupine Creek near Nickel; west coast.												5,000
Falls Creek near Nickel; west coast.												3,000
Baranof Island:												
Green Lake outlet at Silver Bay.			Aug. 22, 1915	30.6	270 (storage for 210 sec.-ft.).	[a]240	42,	175[a]	165	0.4	340	6,500
Barnanof Lake outlet, Warm Spring Bay.		U. S. F. S.	June 28, 1915	411	365	134	90,000	700	100	.3	200	6,500
Second Lake on large stream at head of Cascade Bay.			Measurement, Aug. 14, 1917		420	[a]185	100,000		Dam, 50; tunnel, 50.		190	7,000
Patterson Bay near south entrance.			Measurement, Aug. 15, 1917.		60	[a]350	18,000	600[a]	Dam, 25; tunnel, 15.	.2	360	2,000
Small stream 500 feet south of entrance to Patterson Bay.			do		35							1,000
Stream at head of west arm of Patterson Bay.			Measurement, Aug. 16, 1917.			[a]120			40	.06	145	850
Big Port Walter	3.7	U. S. F. S.	Measurement, Aug. 17, 1917.	30	480	9,000	9,000	365	Dam, 10; tunnel, 25.	.08	460	1,200
Kosciusko Island: Stream entering Davison Inlet.	3.6	Chart		30	520[a]	6,000	6,000		do	1	510	1,400
Prince of Wales Island:												
Karta River, Karta Bay	49.5	U.S.F.S.R.	July, 1915	493	465	104	90,000	1,600[a]	50	.8	137	5,800
Myrtle Creek at Niblack Lake outlet.			July 30, 1917	92	53	450	10,000	383	Tunnel, 40		427	2,000
Myrtle Creek at Myrtle Lake outlet.					80	95	15,000	122	Dam, 20; tunnel, 10.		105	750
Reynolds Creek at Coppermount.	5.05	U. S. G. S.	Measurement, Sept. 14, 1915.		64	876	12,000	185	Dam, 15; tunnel, 60.	1	856	5,000
Mill Creek near Wrangell	50	Chart	June 17, 1915, to Sept. 30, 1917.	412	440	[c]100	112,000	500	125	1	166	6,500
Douglas Island:												
Treadwell mine ditch												[e]4,000

[a] Estimated. [b] Elevation of powerhouse, 80 feet. [c] Elevation determined by aneroid barometer. [d] Reported by Treadwell Mining Co. [e] Developed.