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REPORT ON
RECONNAISSANCE OF
LAKE CHACKACHAMNA, ALASKA

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Tacoma, Washington
January, 1950

ALASKAN GEOL. BR.
WASH. D. C.
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SUMMARY

Lake Chackachamna drains an area of approximately 900 square miles of very rugged mountain terrain in which are found many large and active glaciers. No data is available on precipitation and run-off but in view of the high altitude of much of the basin it is believed to be fairly heavy. The run-off pattern is believed to be similar to that of streams near Anchorage and on the Kenai Peninsula which show that the run-off is concentrated during the summer months and very low during winter months. A large storage capacity is therefore necessary for any satisfactory power development. Construction of a dam at the lake outlet is not possible as the left bank is formed by the terminus of the Barrier Gladier. It is believed that the only possible location for a dam which would control the lake is in the canyon section about 6 miles downstream from the lake outlet where a dam about 350 feet in height would be required, Neither topographic or geologic data is available to evaluate the feasibility of such a site. Storage development by drawing the lake below its normal level, thus obviating the necessity of building a dam, is a possibility that should be considered. A gross head of about 850 feet between the lake and where the outflowing stream, the Chackachatna River, emerges from the mountains is believed susceptible of development. Using an assumed value of stream flow the potential power is in the magnitude of 125,000 horsepower or more. In view of its remoteness and inaccessibility development of Lake Chackachamna is undoubtedly very far in the future and there seems little reason for including it in any early program of surveys and investigations.

INTRODUCTION

Purpose and Scope

The purpose of this brief investigation was to obtain general information on Lake Chackachamna and its water-power possibilities which would serve as a guide in planning and executing future studies. Field investigation consisted of a flight to the lake in a small float plane (see Plate I-B) by the writer on August 3, 1948, landing on the lake near the outlet, making a brief study of conditions there and taking a number of pictures of which several are included in this report with appropriate descriptions. The flight was made with Jack Carr of Anchorage from whom the plane was chartered. It was rather windy at time of landing on the lake and as the wind velocity was increasing Mr. Carr recommended that the stay there be made as short as possible and was consequently less than an hour.

Previous Investigations

As far as known no other investigations from the viewpoint of water-power potentialities have been made. At least two Geological Survey Bulletins deal with the area in which Lake Chackachamna is located. These are Bull. 810-C, The Mount Spurr Region, Alaska, and Bull. 862, The Southern Alaska Range, both by Stephen R. Capps.

Maps and Aerial Photographs

Lake Chackachamna and adjacent areas are shown on the following maps:

The Mount Spurr Region, Alaska
Scale 1:250,000
Contour Interval 200 feet
Published in 1933
By U. S. Geological Survey

World Aeronautical Chart
Mt. McKinley, Alaska (118)
Scale 1:1,000,000
Contour Interval 1,000 feet
Sixth Edition, March 1949
By U. S. Coast & Geodetic Survey

The Lake Chackachamna basin is partially covered by AAF Trimetrogon Photographs as listed below:

Project 41, Alaska,	Flight 32X,	Roll 1,	Exposures 60-90
	Flight 40X,	Roll 1,	Exposures 123 to 145 and 153 to 170
Project 2011	Flight 38,	Roll 1,	Exposures 40-60

GEOGRAPHY

The outlet of Lake Chackachamna is located 85 miles (airline) almost due west of Anchorage at latitude 61°12, longitude 152°22. Capps _/ describes the lake as follows: "Chakachamna Lake, in

_/ Capps, Stephen R., The Southern Alaska Range, U. S. Geological Survey Bulletin 862, 1935

which the Chakachatna River has its source, lies in a great east-west glacial valley, the headward portion of which is dammed by Barrier Glacier, a vigorous ice stream that descends the southwest slope of Mount Spurr. ***The lake is a superb body of water 15 miles long and on the average 2 miles wide, enclosed to the north and south by steep, rugged, lofty mountains that rise precipitously from the shores. It is separated by the snout of Shamrock Glacier from Kenibuna Lake, which is 7 miles long and occupies a part of the same deep glacial trough. Several glaciers from tributary valleys descend into Chakachamna Lake, or almost to it, and nearly every valley of the surrounding mountains contains a glacier at its head. The water of Chakachamna Lake is slightly turbid in summer for all the streams that flow into it are glacial streams.

The steep cliffs that in most places rise from the shores of the lake on its north and south sides render land travel along its shores difficult or impossible, though by boat all points on the lake could be reached with ease."

The rugged character of the terrain in which Lake Chakachamna is located is clearly shown by the photographs in Plate I. The Barrier Glacier is shown in Plate IV-A.

The Chackachatna River is 38 miles long, emptying into Cook Inlet 20 miles southwest of the Indian village of Tyonek. For the first 15 miles downstream from the lake it flows in an easterly direction through the mountains with a very steep gradient. After emerging from the mountains it flows in a southeasterly direction across a flat, marshy lowland. The following table gives an idea of the approximate gradient of the stream.

Distance from lake outlet, miles	Altitude feet	Fall in feet per mile
0	1170	42.5
4.0	1000	91.0
6.2	800	87.0
8.5	600	55.5
12.1	400	35.1
17.8	200	9.9
38.0	0	

Between about mile 5 and mile 7, downstream from the lake, there is a pronounced canyon section, in which any dam for controlling the lake would apparently have to be located.

The drainage area tributary to Lake Chackachamna is not complete on the map of the Mount Spurr Region. Using an assumed drainage area boundary in the incomplete portions of the map the area tributary to the lake was found to be 900 square miles. This figure could easily vary as much as 100 square miles either way but at the same time does give a good idea of the size of the basin. The area of Lake Chackachamna, as measured on the above mentioned map was found to be 24 square miles and of Kenibuna Lake 4.5 square miles. The altitude of Lake Chackachamna is shown as 1170 feet. The 1200 foot contour is shown as crossing the channel between Lake Chackachamna and Kenibuna Lake but it is not known just how much the latter lake is above 1200.

At present the only practicable means of reaching Lake Chackachamna is by float plane. Horses were used by the exploratory expeditions in 1927 and 1928 but required considerable trail building and entailed many other difficulties. At present it is believed that the transportation problem can best be solved by the use of float plane, small wheel plane, or helicopter.

GEOLOGY

The general geology of the area surrounding Lake Chackachamna is described in Geological Survey Bulletin 862 and is also shown on a map, Plate 2, accompanying this bulletin. This information is mainly of an exploratory nature, pointing out only the main features. A geologic examination of any probable dam site would be a prerequisite to any evaluation of the water-power possibilities of Lake Chackachamna.

WATER SUPPLY

Climate

In view of its isolated location and absence of settlements no climatic data is available within the Lake Chackachamna basin. The nearest settlement is the Indian village of Tyonek on the west shore of Cook Inlet, 40 miles southeast from the outlet of Lake Chackachamna. Incomplete records available during the period 1898-1909 show a mean annual precipitation of 22.80 inches at this station. A record at Susitna, 65 miles northeast from the outlet of Lake Chackachamna, during the period 1933-1945 shows a mean of 27.75 inches per year. The high altitude of the area tributary to the lake would undoubtedly result in a much heavier precipitation than at the two foregoing stations which are at low altitudes. The presence of numerous vigorously active glaciers in the basin would also indicate a heavy precipitation. The exact amount of this precipitation and resulting run-off is a matter of conjecture but probably would be well in excess of 30 inches annually.

Run-Off

As far as known no data is available for the run-off from Lake Chackachamna. Using the area of 900 square miles and assuming 30 inches run-off the total yield would be 1,440,000 acre-feet. This is the equivalent of a mean annual discharge of approximately 2000 second-feet. If the run-off was 24 inches over the basin the equivalent discharge would be 1600 second-feet or if it was 36 inches it would be 2400 second-feet.

The variation in stream flow throughout the year would be very pronounced and would undoubtedly be similar to the conditions observed on Eklutna Creek. As shown by Johnson[1] over half the

[1] Johnson, Arthur, Preliminary Report on Water-Power Resources of Eklutna Creek, Alaska, August, 1947

annual run-off on Eklutna Creek occurred during July and August and about three-fourths during the four month period June to September.

It is believed that Lake Chackachamna exhibits a phenomena similar to that of Lake George as described by Lawrence.[2]

_/ Lawrence, F. F., Knik River Flood of July - August 1948, February, 1949

This belief is brought about by the following observations. Just upstream from the lake outlet and on the right side there is a gravel area that is practically flat and had the appearance of water having passed over it at a high velocity. This gravel area is seen as the light colored area at the lake outlet in Plate I-A. Plate III-A shows the upstream end of the gravel area along the right bank and upstream therefrom is clearly visible a high water shore line on practically the same level as the top of the gravel area. Plates III-B and IV-A also show this gravel area. The top of the gravel area was 20 feet above lake surface at time observed. Plate III-B particularly brings out the flatness of this area as above referred to. The explanation of this condition is believed to be as follows. As previously pointed out the left bank of Lake Chackachamna is formed by the terminus of the Barrier Glacier. During the winter months when the outflow from this lake is low the terminus moves across and blocks or dams the channel in much the same way as the glacier does at the outlet of Lake George on the Knik River. In the late Spring and early Summer this ice dam holds the water in the lake until a stage is reached where it begins to overflow the ice barrier after which it is quickly worn through and releases the entire storage in the lake in a very short time. During this period the lake surface drops around 20 feet or more, releasing over 300,000 acre-feet of water. Due to the fact that there are no settlements along the Chackachatna River this phenomena probably has not been observed but conditions above described strongly indicate its occurrence.

WATER UTILIZATION

No use is being made at present of the water-power possibilities of Lake Chackachamna.

Any development on Lake Chackachamna is considered to be a long way in the future due to its inaccessibility and remoteness from centers of population.

STREAM REGULATION

The regulation of the flow from Lake Chackachamna could, in theory at least, be accomplished by either construction of a dam to raise the lake level or by drawing it below its natural level to develop the required storage. Using an assumed value of 1,500,000 acre-feet as the annual run-off and further assuming that 35% of this would have to be stored to accomplish complete regulation, the lake would have to be raised 34 feet. The draw-down below natural lake level to develop this storage would be somewhat more but probably would not exceed 50 feet.

The construction of a dam at the lake outlet is not possible as the left bank of the channel at this point is formed by the terminus of the Barrier Glacier. From the available information there does not appear to be any possible location for a dam until the canyon section starting about 5 miles downstream from the lake outlet and extending for 2 miles is reached. Assuming a site at the mid point of the canyon section, 6 miles downstream from the lake outlet, the channel elevation would be about 850, thus requiring a dam 320 feet high just to reach the lake elevation. To develop any appreciable volume of storage a dam about 350 feet in height would be required. It is not known whether topographic or geologic conditions would permit the construction of such a dam.

In the draw down method the natural dam or barrier causing the lake would serve as the dam, thus obviating the construction of one. The lake would be tapped by outlet works at some distance below its natural level and water diverted by tunnel therefrom to a selected power house location. The diversion would be on the south side of the lake, probably about one mile upstream from the outlet.

An alternative method that at first may seem preposterous could well be mentioned in a report of this kind which seeks to present the general conditions and possible plans of utilization. As previously pointed out, the lake outlet is apparently dammed by the terminus of the Barrier Glacier each winter and holds the water in storage the following spring or early summer until a lake stage is reached which overtops the ice and the outflow then quickly cuts through the ice until the natural channel level is reached. If proper spillway provisions could be made so as to prevent water from going over the ice, the latter could then serve as a permanent dam. Just how high this dam would become if annual overflow was prevented and how stable and impervious it would be is a matter of speculation. It is believed to be a possibility, however, that should not be completely ignored but should merit further study and consideration. It is possible that a combination of the "ice dam" and "draw down" methods could be used so that the necessary storage could be developed by raising and lowering the lake above and below its natural level instead of entirely by raising or lowering. With the above thought in mind it would be desirable to obtain observations on conditions at the outlet of Lake Chackachamna prior to the time of overflow as well as during overflow. Among the points to look for would be these.

1. Is there any outflow from the lake prior to the time the ice dam is overtopped or does it completely block the flow?

2. Maximum stage reached by lake to be correlated with stage following the break through and emptying to determine the raise caused by the ice dam.

3. Events following overtopping-does the channel through the ice increase gradually due to erosion only, or does the flowing stream quarry out large blocks of ice?

4. Time elapsed from overtopping until lake has been emptied.

There is no developed power in the basin.

The potential power can only be very roughly estimated in view of the lack of stream flow as well as other data. In estimating potential power it is assumed that storage can be developed to provide complete regulation of the stream flow. In view of the pronounced variation in the distribution of flow throughout the year this is considered as a prerequisite. Actual development could be accomplished by several different methods.

One plan would contemplate the construction of a dam in the canyon section of sufficient height to not only reach the lake level but raise it sufficiently to provide the necessary storage for stream regulation, a power house at the dam, and development of the head between the dam and where the stream emerges from the mountains by diversion and conduit methods, either in one or more stages. As previously pointed out such a dam would be in the magnitude of 350 feet or more.

Another plan would be to develop the required storage by drawing the lake below its natural level, diverting the flow by a tunnel through the right bank to a power house site along the Chackachatna River near where it emerges from the mountains, thus developing the entire head in one stage, or first to a site about 7 miles downstream from the lake and then a second diversion to the site first mentioned. The first scheme would require a tunnel between 13 and 14 miles in length. If two stages were used the aggregate length of tunnels would be essentially the same. Another scheme would be to have the tunnel emerge in the creek valley draining southward to the McArthur River, or in the McArthur River valley, or at some point along the foot of the slope between these two streams. This plan would require a tunnel from 12 to 13 miles in length.

To arrive at some idea of the potential power available it has been assumed that the entire head between the lake, elevation 1170, and edge of the mountains, at elevation about 300, is susceptible of development. A value of 850 feet has been assumed. Using a value of 2000 second-feet as the mean annual flow would give a value of 136,000 horsepower using the formula H.P. = 0.08 Q.H. The assumed value for stream flow is more likely to be too low than too high so the foregoing figure would be on the conservative side.

In evaluating the power resources of this basin the problem of transmission must be considered. Although the outlet of Lake Chackachamna is only 85 miles (air line) from Anchorage it would require close to 150 miles of transmission line to reach it. Much of this distance would be over low, swampy terrain making construction difficult. Maintenance, especially during winter months, would also be difficult.

Although Lake Chackachamna appears to have a fairly high potential power value its remoteness and inaccessibility seem to make any consideration of its development a matter far in the future.

RECOMMENDATIONS AND CONCLUSIONS

From the above it is seen that the basic data for a true evaluation of the power possibilities does not exist. In further study of these possibilities the following information should be obtained.

1. Traverse from lake downstream through canyon section to obtain stream profile and enough topography to show any likely dam sites.

2. Rough map or cross sections of possible dam sites to determine whether or not a dam of sufficient height could be constructed to control the lake.

3. If the foregoing is possible, then follow with enough of a geologic study to determine the feasibility of any possible sites.

4. If the above is favorable, then initiate a program of stream gaging. The most desirable location for a station would be near the lake outlet. Whether or not this would be possible would have to be investigated. As shown on Plates I-A, and IV-B channel conditions are by no means favorable for the installation of a gaging station. The next alternative would probably be a location near the mouth of the Chackachatna River well above influence of high tides. Such a location would be more readily accessible than one near the lake outlet.

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5. If topographic and geologic conditions at dam sites are favorable then plans should be made for a reservoir site survey of the lake and river downstream therefrom to the dam site areas and the usual detailed mapping of the possible dam sites. The mapping should also include possible tunnel routes. In view of the inaccessibility and rugged terrain as much as possible of this work should be done by photogrammetric methods.

6. Following completion of the above maps make geologic investigations of the various sites.

7. With maps, stream flow data and geologic reports available prepare a complete report on water-power possibilities.

As previously stated the remoteness and inaccessibility of Lake Chackachamna will unquestionably make any consideration of its development a matter far in the future. For the present, therefore, it is believed that the field surveys and investigations of water-power possibilities in other areas will be more beneficial than on Lake Chackachamna.

A

J-48-30, Aug. 3 - Outlet of Lake Chakachamna. The low ridge on the right side of the picture is the terminus of the Barrier Glacier. The lighter colored spots showing on this ridge are ice faces. The light colored area at the lake outlet is an area of gravel and is practically flat and with no vegetation on it. It appears as if it may have been scoured off by water running over it. This may result from the terminus moving across the channel and blocking it up during the winter months and then during the summer it may cut through rather fast and let out a large volume of water in a comparatively short time.

B

J-48-44, Aug. 3 - View looking up Lake Chakachamna. Note dust clouds in right center of picture originating from gravel bar at mouth of valley entering from right.

A

J-48-35, Aug. 3 - Terminus of the Barrier Glacier which forms the left bank of Lake Chakachamna at the outlet.

B

J-48-36, Aug. 3 - View down valley from gravel area just above outlet of Lake Chakachamna. Ridge on left is terminus of the Barrier Glacier.

PLATE III

A

J-48-41, Aug. 3 - South bank of Lake Chakachamna just above outlet and looking upstream. Note gravel bank in left part of picture and the high water mark on the right side of the picture which coincides quite closely with the top of the gravel.

B

J-48-46, Aug. 3 - Edge of gravel bank just above outlet of Lake Chakachamna. The top of this bank was 20 feet above lake level on above date.

A

J-48-42, Aug. 3 - View of Barrier Glacier. Note the amount of the shore line on the left bank formed by the terminus of this glacier.

B

J-48-28, Aug. 3 - Tributary stream entering Chakachatna River on right bank three miles downstream from outlet of Lake Chakachamna.

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