UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Unevaluated Reconnaissance Report (December 1948) on Geology of Lower Eagle River Valley, Alaska

By A. F. Bateman, Jr.

Open-File Report 80-275

1980

This report has not been edited for conformity with
U.S. Geological Survey editorial and technical standards

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SUMMARY AND RECOMMENDATIONS

Summary

1. Lower Eagle Valley is a wide, deep, glaciated, trough-like valley partially filled with unconsolidated glacial deposits.

2. Foundation conditions are incompletely known, but geologic reconnaissance has indicated the following:

   a. Any dam must be founded on unconsolidated glacial sediments. Bedrock is probably at considerable depth below stream bed.

   b. The glacial sediments probably have adequate bearing capacity to support a dam of necessary height.

3. Two areas have been selected that appear to merit further study as sites for a dam of flexible, earth-embankment type. They are designated on figure 1 as dam site area No. 1 and dam site area No. 2. Adequate control of the stream can probably be obtained by a dam located in either area with a pool level at 450 feet altitude.

   a. The character and arrangement of the glacial deposits in the foundation and abutments at either site are imperfectly known. However, a potentially dangerous condition involving seepage of water along a rather short path and under comparatively high hydraulic gradient was noted in the left abutment, dam site area No. 2. This condition might be avoided by an auxiliary dam across the valley behind the left abutment.

Recommendations

I recommend that:

1. Dam site maps of both areas No. 1 and No. 2 be prepared on a scale of 1:9,600, with topography carried to an altitude of 500 feet.

2. "Area A" on figure 1 be mapped on same scale as the reservoir to aid in studying the potentially dangerous condition behind the left abutment, dam site area No. 2.

3. A detailed geologic examination of the glacial sediments in both areas be made.

INTRODUCTION

Purpose of investigation

The investigation outlined in this report was requested by Mr. Arthur Johnson, hydraulic engineer, Tacoma, Washington, in a memorandum to Mr. B. E. Jones, Chief, Water and Power Branch, dated August 20, 1948, and was authorized by a memorandum from Mr. J. D. Northrop, Chief, Mineral Classification Branch, to Mr. C. E. Erdmann, regional geologist, Great Falls, Montana. Its purpose was to determine whether or not a feasible dam site exists in the lower part of Eagle River valley, Alaska.

Field work

The geologic reconnaissance on which this report is based was carried out during the period September 9 to 20, 1948, in company with Mr. Thomas A. Kimbro, rodman, U. S. Geological Survey, Tacoma, Washington. Known points of position and altitude, and details on the stream gradient were provided by a plane table traverse made by Mr. F. F. Lawrence, hydraulic engineer, Tacoma, Washington.

A photostatic enlargement, scale 1:24,000, made from portions of the Corps of Engineers, U. S. Army, Knik and Eklutna quadrangles, scale 1:62,500, was used as a base map for field work.

Accessibility

Figure 1 shows the relationship of the area investigated to the Alaska Railroad and to the Anchorage-Palmer Highway. An unsurfaced road, passable to the average car, extends up the right bank of Eagle River for 1.8 miles. By Spring of 1949, this road will be extended 1.5 miles to a point approximately opposite the mouth of South Fork Eagle River. A branch leaves this road 0.6 mile from the highway and extends in a general southeast direction to a cabin near R.P. 21. This branch is passable in good weather. A road extending up the left bank from B.M. 470 to R.P. 6 is passable only to vehicles with four-wheel-drive, except for the first 0.5 mile.

Vegetation

The valley fill that chokes the lower Eagle River valley is covered with a dense growth consisting chiefly of birch, but with alder, aspen, and poplar. Underbrush is rather thick and consists of high bush cranberry and other shrubby plants. Plate 1A shows a typical stand of this growth. Dam site mapping would be on ground with this type growth except for the river bottom where there is considerable black spruce. The reservoir area is flat and swampy, and for the most part is covered with black spruce.

Acknowledgments

Mr. C. E. Erdmann reviewed the mauscript and offered many helpful suggestions.

A. TYPICAL FOREST COVER ON FILL SURFACE, LOWER EAGLE VALLEY

B. OBLIQUE AERIAL VIEW OF RESERVOIR AREA LOOKING UPSTREAM FROM ABOUT 1,000 FEET OVER A POINT OPPOSITE MOUTH OF SOUTH FORK EAGLE RIVER.
In foreground is upstream end of mass of glacial debris that partially fills lower valley. Eagle Glacier can barely be seen at upper end of valley.

TOPOGRAPHY AND DRAINAGE

Eagle River

The chief source of Eagle River is melt water from Eagle Glacier. Flow is augmented by melt waters from eleven smaller glaciers that feed Eagle River and its two principal tributaries, Raven Creek and South Fork Eagle River.

Eagle River enters Knik Arm of Cook Inlet approximately 35 miles below its source.

Topography of Eagle Valley

Eagle Valley is a straight, steep-walled, trough-like valley, from 1 to 2 miles wide, whose smooth open course is the result of erosion by one or more glaciers that have moved down the valley. Through the reservoir area, extending from a point about 11½ miles below the glacier to a short distance below the mouth of South Fork, the valley has a broad, flat bottom, over which the river meanders widely. (See plate 1B.) Downstream from the mouth of South Fork, the valley is partially filled with a mass of glacial debris deposited by Eagle Glacier and its melt water. (See plate 2A.)

The fill surface is relatively flat and smooth except for a number of low ridges elongated parallel to the axis of the valley, and a depression lying between the mass of fill and the left wall of the valley. (See plate 2B.) This depression, which narrows gradually as the lower end of the valley is approached, was probably occupied by the last ice remnant, and so was not filled with outwash. Eagle River now occupies this depression from about the mouth of South Fork to the vicinity of R.P. 5 (see figure 1), where it turns and breaches the mass of glacial debris. This breach and that part of the depression not occupied by Eagle River are shown on plate 3.

Drainage area

The approximate drainage area of Eagle Valley upstream from the railroad bridge is 206 square miles, of which 13 square miles are occupied by glaciers.

Discharge

No flow measurements have ever been made on Eagle River. Arthur Johnson has estimated the approximate annual discharge of Eagle River at 350,000 acre-feet, assuming runoff characteristics similar to those of Eklutna Creek. Adequate regulation of Eagle River probably could be obtained by a dam not over 150 feet high.

A. OBLIQUE AERIAL VIEW UP EAGLE RIVER VALLEY FROM ABOUT 1,000 FEET ABOVE RAILROAD BRIDGE.
Glacial debris that partially fills lower end of valley makes up foreground and middle ground. Steep valley walls are underlain by bedrock.

B. OBLIQUE AERIAL VIEW DOWN EAGLE RIVER VALLEY FROM ABOUT 1,000 FEET ABOVE A POINT 6.6 MILES UPSTREAM FROM RAILROAD BRIDGE.
Notice large mass of glacial debris in right middle and background and depression between this mass and left valley wall. Eagle River occupies this depression in foreground (dam site area No. 1), but in middle ground leaves it to cut through the debris mass. Dam site area No. 2 is in this cut. Knik Arm is in background.

OBLIQUE AERIAL VIEW DOWN THAT PART OF DEPRESSION NOT OCCUPIED BY EAGLE RIVER. VIEWPOINT ABOUT 1,000 FEET ABOVE THE RIVER, 3.9 MILES UPSTREAM FROM THE RAILROAD BRIDGE.
Note breach in glacial deposits made by Eagle River in right middle gound. This is dam site area No. 2.

GEOLOGY

Bedrock

Lower Eagle Valley is underlain by a series of highly metamorphosed rocks, of both sedimentary and igneous origin.1/ Evidence of bedding

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1/ Capps, Stephen R., The Turnagain--Knik Region, Alaska: U. S. Geol. Survey Bull. 642-E, p. 153-155, 1916.

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and structure is obscure. Distribution of surface exposures is shown on figure 1. Inasmuch as the problems at the dam sites did not involve bedrock, no detailed study was made.

Valley fill

Character. - The valley fill materials consist of unconsolidated glacial deposits laid down either by Eagle Glacier or by its melt waters. At the mouth of the valley these deposits intermingle with similar deposits left by the great glacier that filled Knik Arm or by its melt waters.

Heavy forest cover and lack of time prevented the detailed mapping necessary to delineate the various types of glacial deposits. Hence, on figure 1, one pattern is used to show the areal extent of all glacial deposits, except for a series of silts and clays shown by a second pattern.

1. Silts and clays. - These beds underlie the other glacial deposits and are found in banks along Eagle River from 2.65 to 3.3 miles, and at mile 6.5, upstream from the railroad bridge. They consist of light bluish-gray, fine-grained, thinly-bedded, lean, silty clays, containing interbedded layers of fine silt and of fine, clean, even-grained sand from ½ to 2 inches thick. In one exposure, a 1-inch bed of volcanic ash was observed.

2. Other glacial deposits. - The glacial deposits exposed in cuts along the Anchorage-Palmer Highway and in cut banks along Eagle River are predominantly washed drift, although beds of till do occur. For the most part, these deposits consist of more or less lenticular beds of well-stratified, compact, cobbly gravels that vary in thickness from a few feet to 25 or 30 feet.

These gravels vary in texture from coarse to fine; appear to be fairly well-graded; have a silty sand matrix; and in attitude are horizontal or dip at low angles toward the center of the valley and downvalley. Beds of till from 2 to 10 feet thick are interbedded with the gravels in several exposures. Lenticular beds of cleaner, more permeable gravels and of clean, even-grained sands varying in texture from coarse to fine fill channels cut into the gravels. Plate 4A shows these gravels with an interbedded till layer and a channel filled with sands and clean gravels.

From 3.2 to 3.4 miles above the railroad bridge in the right bank of the river are some deposits of gravels and sands that are slumped and contorted, contain interbedded masses of till and show extreme range and abrupt changes in grain size (plate 4B). These are interpreted as ice-contact deposits.

In the main mass of debris which lies between the river and right wall of the valley, exposures are few and scattered. However, all that were observed showed a light-grayish-brown, very compact, massive, impervious, stony till, containing cobbles up to about 6 inches and occasional boulders to several feet. The matrix is a lean, clayey silt or rock flour. In most exposures, the matrix makes up too high a percent of the whole for the till to be well graded.

Depth to bedrock. - Bedrock crops out near the center of Eagle Valley in the abutments of the Anchorage to Palmer Highway bridge at an altitude of 250 feet. (See figure 1.) However, since Eagle Glacier at its maximum extent was more than 2 miles wide, it very probably deepened the valley below this level, and possibly even below sea level. Altitude and location of the low point in the bedrock floor is unknown. Between this rock exposure and bedrock underlying the right valley wall there is a distance of more than 1 mile, which is wide enough for a rather deep channel. Between this rock and bedrock in the left valley wall there is a distance of about three-fourths mile.

A. LOOKING DOWN EAGLE RIVER FROM LEFT BANK, 3.55 MILES ABOVE RAILROAD BRIDGE.
Note cliff of glacial deposits. This is at upper end of dam site area No. 2.

B. GLACIAL DEBRIS IN RIGHT BANK EAGLE RIVER, 3.25 MILES UPSTREAM FROM RAILROAD BRIDGE, DAM SITE AREA NO. 2.
Several feet of thinly laminated, nearly horizontal, bluish-gray clays are exposed just above the water level in left middle ground. Remainder of deposit is mostly folded and faulted gravels with interbedded masses of sand, silts, and till.

DAM SITES

From ground and air reconnaissance, two areas were selected that appeared to warrant further consideration as possible dam sites. These are designated on figure 1 as dam site area No. 1 and dam site area No. 2.

Valley profile

A gelogic cross section of Eagle Valley through each area is shown on figure 2.

Foundation

In either area, a dam would have to be founded on unconsolidated glacial deposits. The probable general relationship of these deposits to a possible dam and to the valley as a whole is shown on the cross sections of figure 2.

Dam site area No. 1. - Views of each abutment are shown on plate 5A and B, and a general view of area No. 1 in the center of plate 2B, from one-fourth to one-half of an inch below the horizon. Glacial sediments exposed in cut banks along the river consist of silty gravels with minor amounts of interbedded sands and silts in small lenticular beds. A view of these deposits is shown in plate 6A. Permeability of these deposits as a whole is probably medium to low. The extent of these gravels back into the abutments is unknown, but the fact that till was found on the fill surface between the river and the right valley wall, plus the smooth form of the fill surface that is entirely lacking in kettle and kame topography, suggests that this mass might be largely till. Extensive drilling will be required to establish the relationship and extent of these deposits and to establish their permeability characteristics.

A. LOOKING ACROSS AND SLIGHTLY DOWN EAGLE RIVER VALLEY TOWARD RIGHT BANK FROM POINT ON LEFT WALL OF VALLEY 0.4 MILE UPSTREAM FROM R.P. 16 AT 428 FEET ALTITUDE.
Note abrupt change in slope between fill surface and right wall of valley.

A. GRAVELS EXPOSED IN CUT, RIGHT BANK OF EAGLE RIVER 5.27 MILES ABOVE RAILROAD BRIDGE, DAM SITE AREA NO. 1.

B. OBLIQUE AERIAL VIEW UP EAGLE RIVER VALLEY FROM ABOUT 1,000 FEET ABOVE RIVER, 2.6 MILES UPSTREAM FROM RAILROAD BRIDGE.

Dam site area No. 2. - A general view of this area is shown on plate 6B. The glacial sediments exposed in the right abutment consist of the clays and silts previously described overlain by contorted and slumped gravels containing interbedded sands, silts, and masses of till. The deposit as a whole is suggestive of ice-contact sediments. Small seeps emerge from the gravels at their contact with the clays, but on the whole the deposit does not appear highly permeable.

The left abutment is also underlain by gravels, but they are poorly exposed in the dam site area. At the upper end of the area, across the river from R.P. 21 (see figure 1), a series of gravels is exposed in a 90-foot cut bank. These gravels are heavily bedded, slightly silty, probably of medium and low permeability, and dip gently northward. They contain one interbedded till layer 2 feet thick and a channel filled with rather permeable gravels and clean sands in lenticular beds. Plate 4A shows this cut bank. Before a dam site in this area is considered, extensive drilling will be necessarey to establish the permeability of the various materials and to outline the downstream extent of this channel. This exposure would provide an excellent intake for reservoir waters to enter the glacial sediments, and the channel might provide a rather short and highly permeable conduit throughout the dam site.

Behind the ridge making up the left abutment is the depression described under "Topography." Water backed into this valley would bypass the dam site and have a short path of percolation either back into Eagle River or into Fossil Creek. The area through which seepage could take place is designated on figure 1 as "Area A." It should be mapped and permeability studies made of the sediments underlying it. From the topographic mapping now available, it appears that the minimum percolation path would be in the neighborhood of 1,000 feet under a maximum head of 150 feet with reservoir level at 450 feet altitude. This situation could be avoided by construction of an auxiliary dam across this valley as an extension of the main dam.

Apparent possible height of dam

In dam site area No. 1, the maximum height of dam is limited by:

1. Permeability of the glacial sediments.

2. Economic considerations that will limit the length and volume of embankment that can be constructed.

3. The foundation. Storage dams with a height of more than about 200 feet are commonly considered impracticable when built on a foundation of valley fill materials.

A dam with maximum pool level at altitude 450 feet would rise 161 feet above present stream level, and would probably control the stream. However, if the value of increased storage and the extra power produced by increased head justified, and careful studies of the glacial sediments making up the foundation and abutments permitted a higher dam, topography would allow a dam with a pool level at 500 feet altitude or possibly even higher.

In dam site area No. 2, topography limits the maximum pool level to an altitude not over 450 feet, unless, in addition to the main dam across the river channel, a secondary dam is built across the depression between the ridge making up the left abutment and the left wall of the valley. (See figure 1, and cross section CD, figure 2.) With an auxiliary dam, the pool level might possibly be raised to an altitude of 500 feet. However, permeability of the glacial sediments in the abutments may limit the pool level to a lower altitude.

Type and length of possible dam

Foundation conditions in both areas would require a dam of flexible earth-embankment type. The approximate crest length for various heights is shown in the following table:

Pool level	Dam site area No. 1		Dam site area No. 2			
			Main dam		Auxiliary dam	
Altitude above sea level (feet)	Height above streambed (feet)	Length (feet)	Height above streambed (feet)	Length (feet)	Height above streambed (feet)	Length (feet)
350	---	---	84	740	---	
400	111	2,000	134	900	37	950
450	161	2,650	184	1,600	87	1,400
500	211	3,000	234	2,300	137	1,750
550	261	4,000	---	---	---	---