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UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

P. O. Box 1827
Great Falls, Montana

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Memorandum

To: Regional Geologist, Great Falls, Montana

From: A. F. Bateman, Jr., Geologist, Great Falls, Montana

Subject: Progress Report on the geology of Big Bottom dam site, Lewis River, Washington

Introduction

Big Bottom dam site is on the Lewis River, 52 miles from its mouth, in section 26, T. 7 N., R. 5 E., W.M., Skamania County, Washington. Geology of the left [right] abutment was mapped by C. E. Erdmann and A. F. Bateman, Jr., September 12 to 20, 1951, and approximately 25 per cent of the left abutment was mapped by A. F. Bateman, Jr., September 24 to 27, 1951. Topography and geology are shown on the accompanying map, figure 1.

General

Purpose of a dam at this site would be primarily the development of electric power and secondarily flood control. Altitude of the low water surface is about 700 feet. Maximum pool level is not controlled by topography. Stream flow records from October 1924 to September 1950 show that a usable storage capacity of 500,000 acre-feet would have given complete yearly regulation of flow for 17 of the 26 years, and that a capacity of 600,000 acre-feet would have given complete regulation for all but three years. Consequently, a tentative pool level has been selected at altitude 1,050 feet. The impounded reservoir would store about 650,000 acre-feet of water, thus allowing some dead storage and providing a minimum head of slightly more than 100 feet. A dam to this altitude would stand approximately 360 feet above the stream bed.

Topography and Geology

Minimum valley section is between C-C' and D-D', figure 1. At this locality, Lewis River valley has been modified by alpine glaciation. It now is over-deepened and partly refilled, resulting in the inharmonious combination of a wide, flat floor and smooth, extremely steep walls. Width of the valley is approximately 1,700 feet at the surface of the valley fill and 2,735 feet at an altitude of 1,050 feet. Depth to bedrock foundation is not known, but is estimated to be in the neighborhood of 300 to 350 feet below river level. Little is known of the character and arrangement of the valley fill below stream level, since its surface is covered by a veneer of alluvial gravels and sands. However, it no doubt consists predominantly of unconsolidated glacial deposits. Glacial clays, till, and sands overlain by outwash gravels and sands are exposed in cuts beneath a terrace level developed on the right bank about altitude 840 feet.

Character and attitude of rock beneath the valley floor is unknown.

Rock in the right abutment consists of a series of older volcanic rocks unconformably overlain by a series of younger volcanic rocks. The older volcanics include andesites, basalts, agglomerates, and tuffs. All are cut by joints and small shear zones. Exposures are limited to two small areas at water level on the right bank where these rocks dip steeply to the west and northwest and to several small areas along the bottom of the creek in the northeast corner of the map area where they are folded into a sharp syncline. The younger volcanics appear to have covered the right wall of a broader stream valley cut into the older rocks. The younger series consists of more than 50 feet of agglomerates and tuff overlain by two thick lava flows. The lower flow, a dense, massive, moderately-jointed andesite, varies in thickness from 90 to 120 feet. Its upper surface is extremely irregular and is separated from the overlying lava flow by 20 to 40 feet of coarse agglomerate. The upper flow is a light gray, hard, dense andesite that is considerably jointed and in its upper part is separated into thin plates by a sheeting developed roughly parallel to the flow surface. Total thickness of this lava sheet is probably a little more than 200 feet. Both of the flows dip into the valley. The amount and direction of dip varies greatly from one locality to another, as is shown by the individual determinations plotted on figure 1.

The left abutment is underlain by coarse, clastic sedimentary rocks, with some interbedded lava flows and flow breccias. These beds are separated into two unconformable series. At the eastern margin of the dam site, the lower series dips southeastward at an angle of 9 degrees, whereas the upper series dips southeastward at an angle of 17 degrees. At the western margin of the dam site map area, only the upper series is represented. In this locality the beds dip southeastward at angles varying from 12 to 23 degrees. The intervening area has not yet been mapped. The exact relationship of these sediments to the volcanic rocks in the right abutment is not known. However, they are no doubt more closely related to the older series of volcanic rocks because they underlay the left wall of the old valley whose north wall was covered by lava flows and flow breccias of the younger volcanic rocks.

Several feet of fine, pumiceous sand covers portions of the surface of all deposits represented in the dam site area except active and inactive alluvium. This ash was ejected from Mt. St. Helens during a comparatively recent period of explosive activity.

Ground Water Conditions

A series of springs discharge through surficial deposits on the steep slope below the road on the right abutment. Total flow was estimated at 3 to 5 cubic feet per second during September 1951 near the end of one of the longest periods of dry weather on record. Flow from these springs represents drainage of an area considerably larger than that of the mountain slope behind the right abutment. From the geologic structure of the right abutment, it is concluded that the water comes from the small stream in the northeast corner of the map area. It enters the pervious agglomerate between the upper and lower lavas of the younger volcanic rocks in the bed of this stream at an altitude estimated to be between 1,300 and 1,400 feet. The water travels under gravity down dip through the agglomerate until it emerges at the wall of the main valley. From this point the water moves down the bedrock surface of the valley wall until it is deflected by a small rock-cut bench and discharges through unconsolidated surficial deposits.

The permeable agglomerates between the lower flow and the older volcanic rocks furnishes a similar hydraulic system with intake area in the bed of the same creek at an altitude of 1,050 to 1,150 feet. In this case, however, water emerges from bedrock below the level of fill in the main valley and does not appear at the ground surface as springs.

Suitability of Site for a Dam

The sediments in the left abutment, the older volcanic rocks in the right abutment, and the two thick lava flows in the right abutment are adequate to support any load required by a dam of the desired height. All of these rocks are relatively impermeable except for the upper lava flow. In it, the sheeting oriented roughly parallel to the wall of the old valley furnishes seepage paths through the right abutment. However, they could be closed by grouting. Materials making up the two agglomerate zones have sufficient strength to support a dam and are insoluble, but they are quite permeable.

Selection of the type of dam best suited for this site will be influenced by the following factors:

1. Since the depth to rock foundation in the center of the valley is probably 300 feet or more, any dam that might be built will rest on valley fill.

2. The fill materials may be rather permeable, making desirable a dam with a wide base so as to provide the maximum length of the path of percolation through the foundation.

3. The fill materials will probably suffer considerable settlement under load. This factor would no doubt eliminate a dam of gravity concrete type.

In view of these limiting conditions, probably an earth or a composite rock-fill dam would be most suitable.

Conclusions and Recommendations

1. Since the "Big Bottom" offers the only reservoir area on Lewis River of adequate storage capacity for stream control, and since this site appears to be the only one capable of supporting a dam of the required height to make use of this reservoir area, Big Bottom dam site warrants further investigation. The principal problems that need further work are:

A. Depth to bedrock floor of the valley at the dam site.

B. Character and arrangement of the valley fill materials in the foundation.

C. Possibility of leakage through the agglomerate zones in the right abutment.

D. Completion of geologic mapping of the left abutment.

2. The following recommendations are made:

A. Depth to bedrock floor of the valley be determined by geophysical methods. Either seismic or electrical resistivity methods could be used, but in view of the expected depth, seismic methods would probably prove more effective. Approximate center locations for 21 proposed determinations are shown on figure 1. It is estimated that it would take one field party 4 to 6 weeks to do this work. For a complete picture of foundation conditions, all of these determinations are desirable. However, in case all could not be made, they are separated on figure 1 into 3 categories; 8 that are most desirable are given first priority; 9 are given second priority; and 4, third priority. In each case, direction of shooting or of electrode spread is shown. In general, this is parallel to the axis of the valley, to obtain as uniform geologic conditions in the foundation as possible.

B. Investigation of the character and arrangement of the valley fill materials and of the possibility of leakage through the right abutment would involve considerable drilling. This work is not within the scope of the present investigation, and should be done by the organization contemplating construction of a dam at this site.

C. Geologic mapping to be completed during 1952 field season.

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Geologist.

cc - J. D. Northrop
- A. Johnson
- L. L. Bryan