CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA
TOPICAL REPORT NO. 7

YUKON RIVER DRAINAGE BASIN
DAM SITE INVESTIGATION

SITE NO. 1

SWIFT RIVER DAM SITE

(MAP AND PRELIMINARY REPORT)

BY

E. B. OWEN

OTTAWA
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Introduction

This geological report is the first of several describing dam sites in the Yukon River drainage basin. The investigation is being conducted by the Geological Survey of Canada at the request of the Water Resources Branch, Department of Northern Affairs and National Resources. It is part of a large scheme to assess the entire power potential of the Yukon River and its main tributaries.

The following is a brief description of the sequence of events in this dam site investigation.

Stage 1: A study in the office of all available geological reports and maps, topographic maps and aerial photographs of the Yukon River drainage basin by engineers of the Water Resources Branch, Department of Northern Affairs and National Resources. This is followed by an aerial reconnaissance of the drainage basin with landings made as some potential sites noted during the office study.

Stage 2: Preliminary ground investigations are conducted by Water Resources Branch engineers during this stage. Contour plans based on barimetric elevations are prepared for each site decided upon in stage one. Preliminary seismic investigations and reservoir surveys are likewise conducted. At the same time accurate elevations are carried into each potential site by the Topographic Survey of Canada and bench marks established on the river bank usually immediately below the proposed centre line.

Stage 3: Preliminary layouts for each potential site surveyed in stage two are prepared by Water Resources Branch personnel in their home office and an interim report prepared for internal use.

Stage 4: A preliminary engineering-geology investigation of the materials exposed at each potential site is made by the Geological Survey of Canada. A geological map of each potential site is drawn using the base plans prepared by the Water Resources Branch during stage two. In this investigation

comparisons are made between alternative sites and the more favourable from the geological viewpoint indicated.

Stage 5: The elimination of some sites by the Water Resources Branch engineers and the start of extensive subsurface investigations and material testing at other sites. The result of this program would be the further elimination of some sites and the final choice of others. A detailed geological report would be prepared following completion of stage five.

Stage 6: Final construction drawings would be prepared by the design engineers of the Department of Northern Affairs and National Resources with the possibility further subsurface information would be required as this work progresses.

This preliminary report as well as similar reports on other sites in the Yukon River drainage basin are the result of the geological investigation described in stage four. At the time of writing the dam site investigation had not advanced beyond stage four at any site.

General Description

The Swift River dam site is located on Teslin River about 23 miles downstream from Johnson's Crossing at which point the Alaska Highway crosses the river.

From Teslin Lake, about 2 miles above Johnson's Crossing, to its junction with Yukon River at Hootalinqua, Teslin River moves through a wide drift-filled valley bordered by high rock ridges. In the area adjacent to the site the valley is about 7,500 feet wide. Here the river is located along the northwest side of the valley where it has cut a channel some 280 feet into the overburden.

At the proposed centre line of the dam the left (west) abutment is steep with bedrock exposed about 128 feet above the river. The right abutment consists entirely of overburden which rises abruptly to a height of about 250

feet above the river and extends back as a wide terrace some 6,600 feet to the rock ridge which constitutes the right side of Teslin Valley.

Unconsolidated Deposits

Except for the higher mountain tops the valley of the Teslin has been subject to glaciation in late Pleistocene time. The direction of ice movement is assumed to be in a northeasterly direction. At the dam site the melt waters appear to have flowed south as opposed to the present northward drainage. This is indicated by the shallow, southerly dip of the lacustrine silts believed to have been deposited in a temporary lake impounded during the final melting of the ice.

Three main types of soils have been identified in the area adjacent to the proposed dam site. These are as follows:

1. Glacio-Lacustrine: This material consists almost entirely of silt. It constitutes most of the wide terrace which extends northeasterly from the right abutment to the edge of Teslin Valley. The silt is assumed to have been deposited in a lake which existed in Teslin Valley following the withdrawal of the last ice sheet from the area. Silt laden streams flowing into the lake could easily build up a large silt deposit. On the right abutment the silt deposit is more than 200 feet in thickness and 6,600 feet wide. The bedding has a shallow upstream dip.

2. Post-Lacustrine Alluvium: This material consists of clean, graded, fine- to coarse-grained sand with fine gravel in the upper part. The sand grains are well rounded. It overlies the silts exposed on the right abutment and which constitute the terrace extending northwest from the river. It is an extensive deposit but relatively shallow in depth. The post-lacustrine alluvial material is thought to have been deposited subsequent to the draining of the lake in which the silt beds were formed and during the early formation of Teslin River.

3. Recent Alluvium: This material consists of fine- to medium-grained, silty sand. It is a thin deposit of the present Teslin River and is unimportant.

Bedrock

General Description.

Bedrock at the site outcrops only along the left side of the river. The outcrop areas are shown in the accompanying plan along with a general line indicating the relative thickness of the overburden across the left abutment. Bedrock consists of fairly massive, thin-bedded, argillaceous sandstone with few beds more than 1 inch in thickness. It is not a hard rock but should have a fairly high compressive strength. Its durability is thought to be low.

The lowest elevation at which bedrock outcrops is 2,330 which is about 118 feet above the river. Along the proposed centre line of the earth-fill dam the lowest bedrock outcrop occurs at elevation 2,340. Bedrock apparently drops off rapidly between the outcrops and the river. Bedrock was not reported along seismic line no. 1 which crossed the centre line in this area. It is suggested talus may exist beneath seismic line no. 1 which may account for the unsatisfactory results obtained. Information is not available regarding the elevation of bedrock surface beneath the river or the right abutment. Test borings would be necessary to obtain this information.

An examination of the bedrock exposed in the area outside that included in the accompanying site plan indicated narrow beds of conglomerate are sometimes interbedded with the argillaceous sandstone. One such conglomerate bed, four feet in width, occurs about 3,000 feet south of the proposed dam axis. Considerable fine-grained greywacke was noted on the rock ridge extending along the right side of Teslin Valley about 6,700 feet northeast of the site.

Bedrock Structures

Bedrock in the area which consists almost entirely of sedimentary rocks has been subjected to considerable folding. The strike of the bedding is approximately parallel to the river. The dips vary, in some places being almost vertical and in others dipping steeply away from the river. Three strong shear zones each with a different strike are indicated on the accompanying geological map.

The argillaceous sandstone tends to break in two directions. One is along the bedding planes which roughly parallel the river and the other is along a consistent joint plane which is vertical and strikes at right angles to the bedding.

Engineering Considerations

Abutments and Foundations

Bedrock at the proposed site consists almost entirely of argillaceous sandstone with a few narrow interbeds of conglomerate. It is exposed only in the vicinity of the left abutment. The rock should make an adequate abutment and also provide a satisfactory foundation for the power-house and spillway structures. About four feet of weathered and broken rock will have to be stripped from bedrock surface before concrete can be placed against it. The westerly dip of the bedding away from the river is not important because the rock is considered to be impermeable and no leakage should occur along the bedding planes.

Large faults were not observed in the vicinity of the proposed dam site but minor faulting will probably be encountered during excavation for the diversion and intake channel and for the forebay. Broken rock zones associated with faults are frequently capable of carrying large quantities of water. If necessary, the water can usually be controlled by grouting. The durability of these rocks is relatively low and it is suggested if a concrete lining is to be poured against the rock exposed in the excavation for the diversion and

intake channel a protective coating over the fresh rock face might be required to prevent deterioration of the rock before the concrete is poured.

Depth of Overburden

The greater part of the area about the proposed dam site is covered with overburden. The thickness of overburden varies from less than ten feet in the vicinity of the rock outcrops on the left abutment to greater than 241 feet on the right abutment. The latter depth was indicated by seismic line no. two. It is possible a steep, rock bluff with considerable talus exists between the outcrop area and the river. The presence of talus in this area would make it difficult to excavate for the proposed diversion and intake channel. The thickness of overburden increases from 90 plus feet along the right edge of the River (seismic line no. 3) to 218 plus feet approximately 500 feet to the northeast (seismic line no. 2). There is nothing to indicate the presence of a buried stream channel eroded into bedrock surface beneath the present river.

Construction Materials

Aggregate

A potential supply of coarse aggregate occurs on the floor of Swift River Valle less than 3 miles downstream from the proposed site. The material consists of coarse sand and gravel with boulders up to twelve inches in diameter. A bluff of gravel approximately 100 feet high occurs about three miles upstream from the mouth of Swift River. This deposit could readily be worked by a power shovel.

The sand occurring on the surface of the terrace extending along the right side of the river is a possible source of fine aggregate. The thickness of the deposit is not great but a sufficient quantity of fine aggregate might be located by test pitting. The low durability of bedrock exposed on the left abutment prohibits its use as aggregate.

Impervious Material

Impervious materials, such as clay or till, were not found within a radius of about two miles of the site. It is possible the silt occurring along the right side of the river may be the only material available for the impervious core of the earth dam. The silt has a low to medium density. It is dry and devoid of clay-size particles. This would indicate a relatively high permeability and resistance to appropriate compaction. A rough field test indicated the disturbed silt has a permeability ~~of~~ 1,000 times smaller than that of a clean, fine to medium grained sand. A vertical (downward) capillarity test of the silt in place gave a value of 0.01 cm./sec.

Geological reports of other glaciated areas in Yukon Territory describe till deposits lying directly upon bedrock and beneath glacio-fluvial sand and gravel. Most of the material underlying the present river is glacio-fluvial. Test borings would be required here to determine if till is present.

It is noted the main earth-fill dam is to be constructed in the dry between two cofferdams extending across the river. The sand and gravel directly underlying the cofferdams are probably very permeable and consequently considerable pumping will be required to keep the excavation dewatered during the placing of the earth fill. The absence of large boulders in the glacio-fluvial sand and gravel suggests a steel sheet pile cut-off wall could be driven to strengthen the cofferdams and prevent excess piping through the glacio-fluvial material.

Pervious Material

Material for the pervious shell of the earth dam can be readily obtained from the Swift River area described in the aggregate section.

Riprap

The low durability of the argillaceous sandstone would prevent its being used as riprap. However, a sufficient supply of satisfactory riprap can be obtained from easily accessible outcrops of greywacke about 6,700 feet ~~to~~ to the northeast across the terrace.

Ground Water

The ground-water table is low throughout the area of the proposed dam site. In the right abutment area it is thought to be at approximately the same elevation as the water in the river. The rock exposed on the left abutment is not the soluble type and, although the dip of the bedding planes is not favourable, there should be no leakage problem in this area.

Further Investigations

It should be remembered the present geological investigation of the proposed Swift River dam site is a preliminary one designed to furnish the engineers with as much information as possible before any money is spent on an expensive subsurface investigation. If it is decided more information is required at the Swift River site it is suggested test borings be put down in the following localities as part of the test-boring program:

No.	Location	Elevation (Approx.)	Depth	Remarks
1	Right abutment, on centre line, 250' northeast of River	2,400	15 feet into bedrock	Soil samples taken every 5 feet or where there is a change in material, permeability tests conducted, ground-water table noted.
2.	Right abutment, River's edge.	2,220	"	"
3.	Left abutment, River's edge	2,220	"	"
4.	Left abutment, on centre line, 240' southwest of River.	2,320	"	"
5.	Diversion and Intake channel, 820' upstream from centre line, 210' southwest of River's edge.	2,280	15 feet below grade of channel excavation.	"

No.	Location	Elevation (Approx.)	Depth	Remarks
6.	Power-House site, 900' downstream from centre-line, 210' southwest of River's edge.	2,295	15 feet below grade of power house excavation	Soil samples taken every 5 feet or where there is a change in material, permeability tests conducted, ground-water table noted.
7.	Spillway Section, 1,250' downstream from centre line, 470' southwest of River's edge.	2,360	15 feet below grade of spill-way excavation	"

It is also suggested more refractive seismic work be done in the area between the river and the outcrop area forming the left abutment.