No. 2

CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

TOPICAL REPORT NO. 68



MACKENZIE RIVER DRAINAGE BASIN
DAM SITE INVESTIGATION

SITE NO. 7

# SUMMIT LAKE DAM SITE

(MAP AND PRELIMINARY REPORT)

BY

E. B. OWEN

OTTAWA

1963

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CONTENTS



Illustrations

# SUMMIT LAKE DAM SITE

## General Description

Summit Lake is located in Yukon Territory at approximate latitude 67°13' and longitude 136°28'. It is one of several small lakes situated at the west end of McDougall Pass on the divide separating the drainage basins of Yukon and Mackenzie Rivers. The boundary between Northwest Territories and Yukon Territory is less than one mile east of the lake. The area about the lake drains easterly through the pass into the Mackenzie via Rat River and westerly by means of Bell and Porcupine Rivers, the latter a major tributary of the Yukon.

As indicated on the accompanying geological map the proposed dam extends in a northerly direction across the east end of Summit Lake. It would be a low-head structure designed to control the flow of water to several proposed power dams located in McDougall Pass between the lake and Mackenzie Delta some 40 miles to the east. To increase the amount of water available in the pass it is proposed to construct a dam on Porcupine River near the Alaska-Yukon Territory boundary. The reservoir so created would extend easterly to Summit Lake and the water would flow through McDougall Pass to the Mackenzie under a gross head of about 1,000 feet.

At the site Summit Lake occupies almost the entire floor of McDougall Pass which here trends in an easterly direction. Narrow, irregular, talus-covered terraces, 50 feet in width and about 10 feet above the level of the lake, occur along the north and south sides of the lake. The terraces extend to the toes of steep, rock bluffs which

rise well beyond the limits of the area mapped. It is proposed to utilize the bluffs as abutments for the dam. Talus covers most of the surface of the bluffs. However, there are sufficient bedrock exposures present to indicate the talus deposits are thin and in most places are probably less than 10 feet in thickness.

The floor of McDougall Pass immediately east and west of Summit Lake is covered with a thick layer of moss and decayed vegetation overlying an alluvial deposit of silty clay with some fine-grained sand. The frost surface varies between 12 and 36 inches below ground surface. Ice lenses up to 4 inches in thickness are common in the silt.

## Unconsolidated Deposits

Two types of unconsolidated deposits occur in the area about Summit Lake. These are as follows:

1. Talus: Talus is material resulting from the mechanical disintegration of adjacent bedrock. It occurs on the bluffs north and south of the lake as fragments of fine-grained, grey sandstone ranging from sand-size particles to boulders 6 feet in diameter. The sandstone exposed on the bluff south of the lake is thicker bedded than that on the north side and consequently the talus associated with it contains the larger rock fragments. Much of the talus north of the lake consists of small, platy fragments due to local shearing in the parent rock. The larger fragments in the talus are roughly squared and fairly flat faced and should provide satisfactory riprap. A few rounded sandstone and quartzite boulders up to 24 inches in diameter are scattered throughout the talus.

These have slumped from thin deposits of coarse-grained sandy gravel, probably of glaciofluvial origin, which occur on the bluff above the limit of the area mapped.

2. Alluvium and/or glaciolacustrine: This material consists of grey, silty clay with minor quantities of fine-grained sand which underlies the moss and decayed vegetation covering the floor of McDougall Pass at the site. The material is indistinctly stratified and is believed to be of similar origin to the clay and silt occurring on the low terraces east along Rat River between the lake and Mackenzie Delta. Exposures of the silty clay do not occur in the site area. It was observed only in the shot holes for the seismic line located immediately east of the lake.

## Bedrock

### General Description

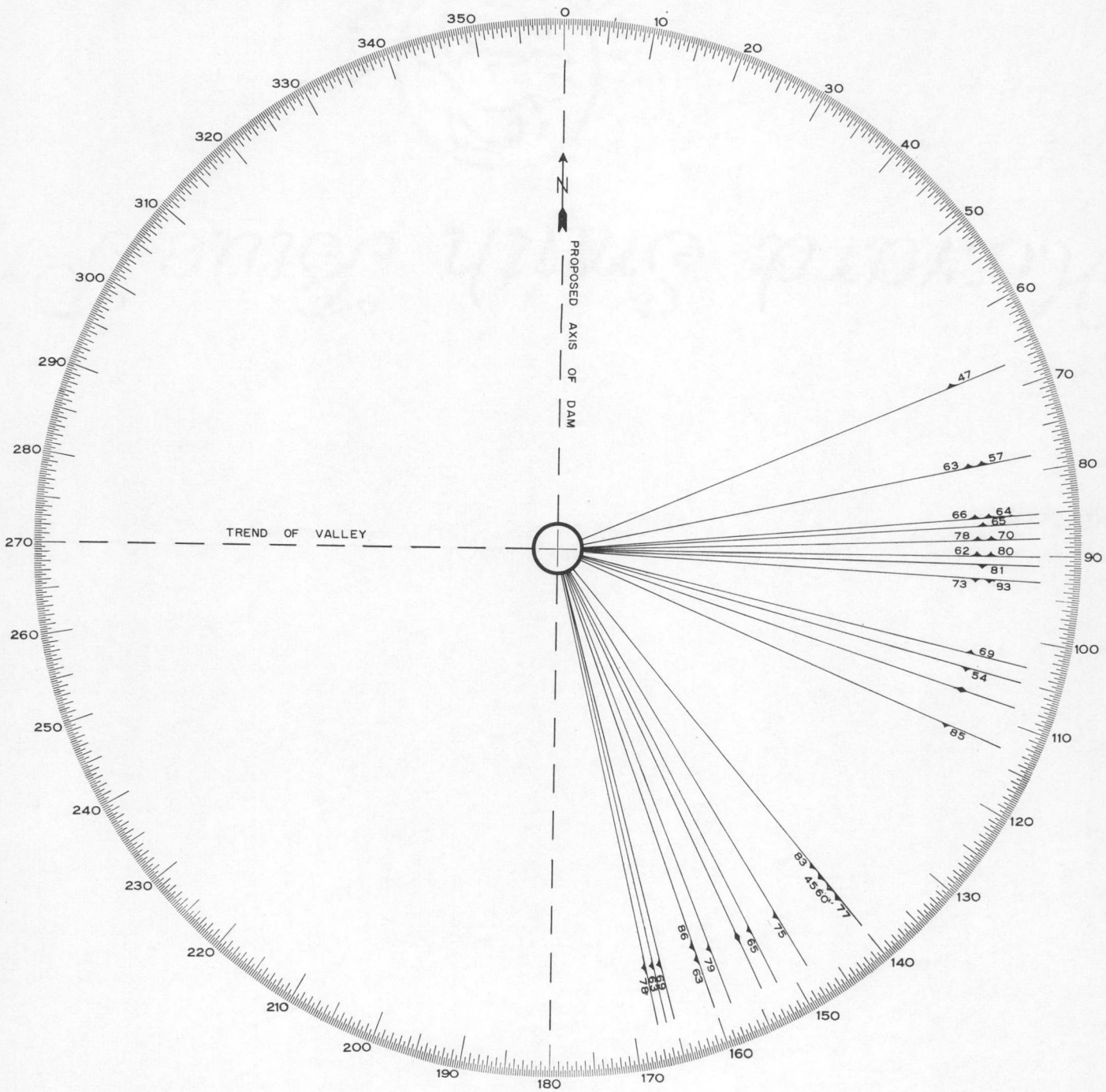
Bedrock exposed on the bluff south of Summit Lake consists of massive, fine-grained, grey, noncalcareous sandstone. The thickness of the individual beds ranges up to 8 feet. Weathering is negligible. A similar type rock occurs north of the lake. However, here the sandstone is slightly sheared resulting in a less competent and durable rock. Two other rock types are exposed close to the site area. One is a massive, fine-grained, grey quartzite which outcrops along the crest of the bluff south of the lake and extends to the base of the bluff at its east end. The other is a fine-grained, dark grey limestone which is exposed on the bluff north of the lake a few hundred feet west of the limit of the

area mapped. The limestone is separated from the sandstone included on the accompanying geological map by a vertical fault zone, 200 feet in width, which strikes north 20 degrees east or almost at right angles to the face of the bluff. Several, narrow, irregular, quartz veins up to 1 inch in width occur in the sandstone close to the fault but do not extend east into the area mapped.

Bedrock Structures

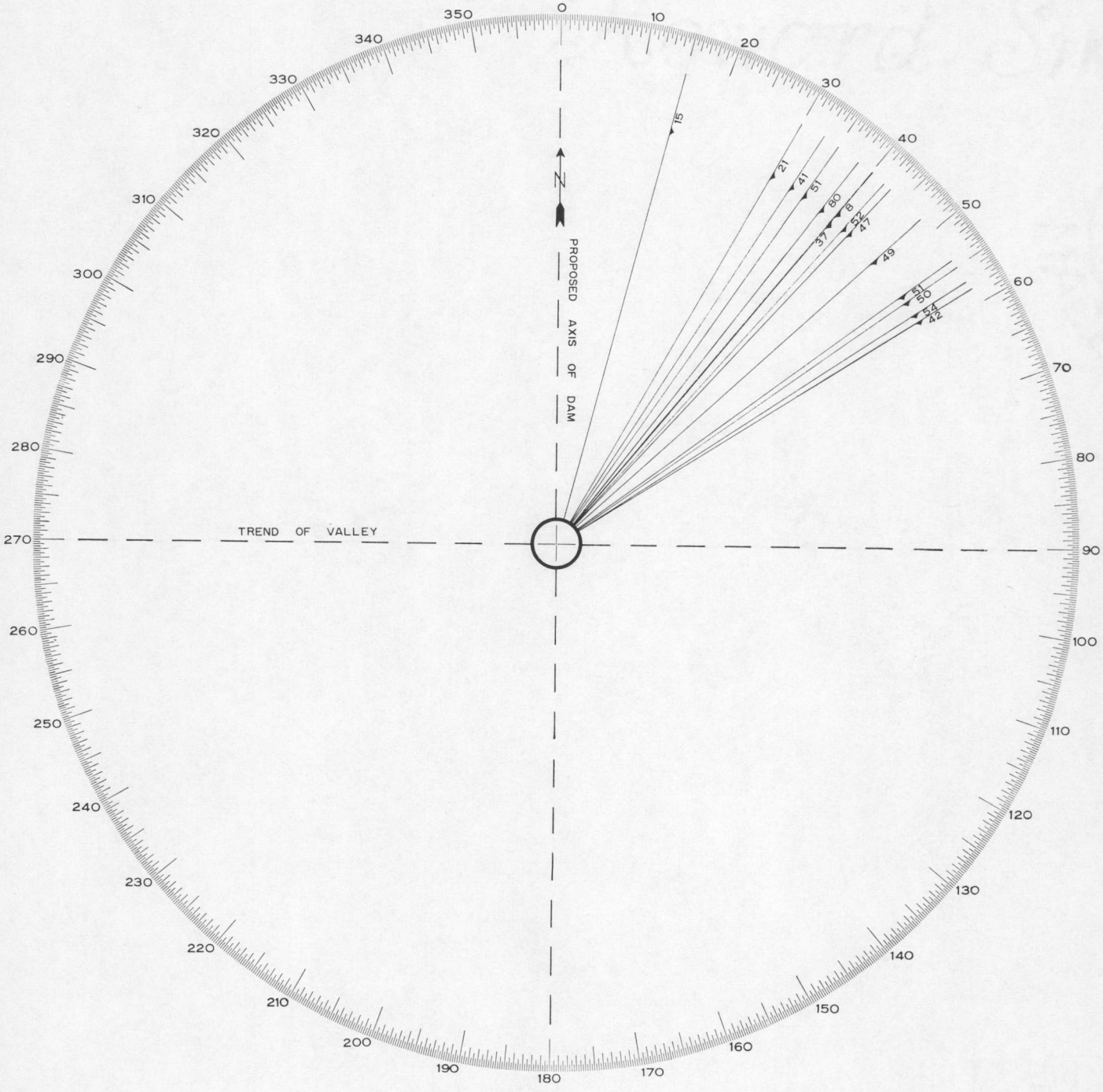
The trend of McDougall Pass in the site area is close to east. Consequently the direction of the proposed centre line of the dam is north-south. The bedding intersects the centre line at angles between 33 and 58 degrees and dips consistantly east or into the south abutment at angles varying between 37 and 54 degrees. The attitudes of the quartzite and limestone beds exposed near the area mapped are similar.

There are two prominent joint sets in bedrock occurring in the site area. In the surface exposures they are represented by open fractures up to 6 inches in width and 50 feet in length. The jointing exerts considerable influence on the extent of weathering and the manner in which bedrock disintegrates to form talus. The spacing is exceedingly variable ranging from 1 inch to several feet in the more massive beds. The prominent sets intersect one another at approximately 65 degrees. One set dips 63 to 82 degrees west or into the south abutment while intersecting the centre line at angles between 15 and 45 degrees. The second set intersects the centre line at 70 to 90 degrees and dips into the north abutment at 47 to 80 degrees. A less prominent set parallel to the second dips steeply into the south abutment.




JOINT ROSETTE

The above illustration presents diagrammatically the direction and dip of jointing in bedrock exposed at Summit Lake site




BEDDING ROSETTE

The above illustration presents diagrammatically the direction and dip of bedding in bedrock exposed at Summit Lake site

Minor shearing parallel to the large fault west of the site area occurs in the sandstone exposed in the west part of the bluff north of the lake. The strike of the shearing is such that it would not occur in the bedrock forming the south abutment but rather should intersect the bluff west of the site area.

Quality of Bedrock

Bedrock occurring at the Summit Lake site is believed suitable for the abutments and foundations of the low-head structure proposed for this area. The rock exposed in the south abutment is a fairly massive to massive sandstone which is believed competent and should provide satisfactory abutment material. The thickness of the individual beds ranges up to 8 feet. Weathering is negligible and little surface rock would have to be removed to obtain fresh surfaces against which concrete or dyke material could be placed. The large size of the fragments in the talus derived from this rock is an excellent indication of its quality.

Weathering is more common in the sandstone exposed in the west part of the bluff in which the north abutment will be located. This is due to the more thin-bedded character of the rock and to the presence of local shear zones where the rock is frequently shattered into relatively small fragments. Further east along this bluff the rock is more competent and is comparable to that in the south abutment.

Bedrock underlying the Pass in the site area is probably similar to that exposed in the south abutment. In which case it should provide satisfactory foundation material.

## Engineering Considerations

### Depth of Overburden

Overburden on both abutment slopes is nowhere believed to be greater than 10 feet in thickness. It consists of a thin deposit of talus mixed with small quantities of sand and gravel; the latter materials have slumped from shallow, irregular, glaciofluvial deposits situated in the bluff above the limit of the area mapped.

There is no information concerning the thickness of overburden beneath the floor of McDougall Pass at the site. The only knowledge presently available from the shot holes along the seismic line east of the lake is that the overburden consists of a minimum of 3 feet of silty clay underlying 18 to 24 inches of moss and decayed vegetation.

### Proposed Centre Line

It is suggested the dam axis be moved as far east in the site area as possible to take advantage of the better bedrock conditions. The proposed location of the axis indicated on the accompanying geological map is considered to be the farthest west that the dam should be constructed. Beyond this the competency of the rock in the north abutment decreases sharply. If required a diversion tunnel could most easily be constructed in the south abutment or in the east part of the north abutment.

## Construction Materials

### Aggregate

Deposits of natural aggregate such as the glaciofluvial sand and gravel which exists in large quantities at the power dam sites further east along McDougall Pass do not occur at Summit Lake site. The quantity of glaciofluvial material present on the bluff above the south abutment is extremely limited and it is not believed there is sufficient material available to warrant consideration.

Artificial aggregate can be obtained by crushing the quartzite or limestone which are exposed in the continuations of the bluffs forming the abutments. Both materials are easily accessible from the site. The quartzite would provide the most satisfactory aggregate. It contains no deleterious materials whereas the considerable shale interbedded with the limestone decreases its suitability. Very little shale is combined with the limestone. In most instances it occurs as distinct interbeds and could be removed from the crushed rock without too much difficulty.

### Impervious Material

The silty clay which directly underlies the moss covering the floor of McDougall Pass at the site is a possible source of impervious material for an earth or rock-fill dam. Like most materials in McDougall Pass the silty clay is frozen but readily thaws and becomes fluid when the overlying layer of moss has been stripped. Unlike other areas in the Pass, however, the silty clay does not occur at elevations higher than the

dam. Consequently the fluid material could not be moved to the site by gravity but would necessarily have to be pumped.

### Pervious Material

There are no materials suitable for the pervious shells, filters or drains of an earth dam available at the Summit Lake site. The small deposits of sand and gravel occurring at the Fish Creek, Bear Creek and Horn Lake sites, 6, 9 and 12 miles east respectively may provide satisfactory material. The gravel would have to be washed, screened and reblended to obtain the coarse, granular material required.

### Riprap and Rock Fill

The quartzite and sandstone exposed in the bluff in which the south abutment of the dam is located are relatively thick bedded, durable rocks which should provide satisfactory riprap or rock fill. The fine-grained, dark grey limestone which is exposed in the bluff northwest of the site area is also a likely source of suitable material.

## Groundwater

There is little information concerning groundwater conditions in the area about the proposed site. Groundwater does exist above the frost line because most seismic shot holes filled with water flowing down their sides immediately after they had been blasted. A few small seeps issuing from the talus at the toes of the bluffs are believed to be surface water flowing down the bluffs along the surface of bedrock.

## Frozen Ground

At the time of the investigation (July 24, 1962) the frost line beneath the floor of the Pass ranged from 12 to 36 inches beneath ground surface. Frozen ground was encountered within a few feet of Summit Lake around the entire east side of the lake. There is no information regarding the presence of frozen ground beneath Summit Lake. It is believed to exist, however, but at a greater depth. The frost line probably extends up into the abutments of the dam. Ice lenses were not visible either in the talus or in the open joint fractures in bedrock exposed on the abutment slopes.

## Further Investigations - Conclusions

It should be remembered this geological investigation is a preliminary one designed to furnish the engineer with general geological information regarding the proposed dam site. The report is based upon a rapid field examination of the bedrock exposed in the steep bluffs bordering the north and south sides of Summit Lake and of the material exposed in several seismic shot holes located on the floor of the Pass immediately east of the lake.

The results of the investigation indicate the site is suitable for construction of a dam. Bedrock exposed is sufficiently competent to provide satisfactory abutment and foundation material. Test borings will be required to accurately determine the elevation of bedrock surface between the rock exposures in the abutment slopes and the depth of the frost line beneath Summit Lake. The presence of large quantities of

suitable rock suggests a rock-fill type dam should be considered. The clayey silt deposits covering the floor of McDougall Pass at the lake may provide impervious material for the dam although the presence of frost would make the excavation of this material very costly.

## Chemical Analyses of Rat River Water

During the 1962 field season samples of Rat River water were taken at Fish Creek dam site and at the point where Rat River leaves McDougall Pass and enters Mackenzie Delta. The samples were analyzed for their mineral content by the Industrial Waters Section, Mines Branch, Department of Mines and Technical Surveys, Ottawa. The results of the analyses are included in the report on the Fish Creek site.

Plate 1

South abutment, Summit Lake site.

G.S.C. 32-3-62.

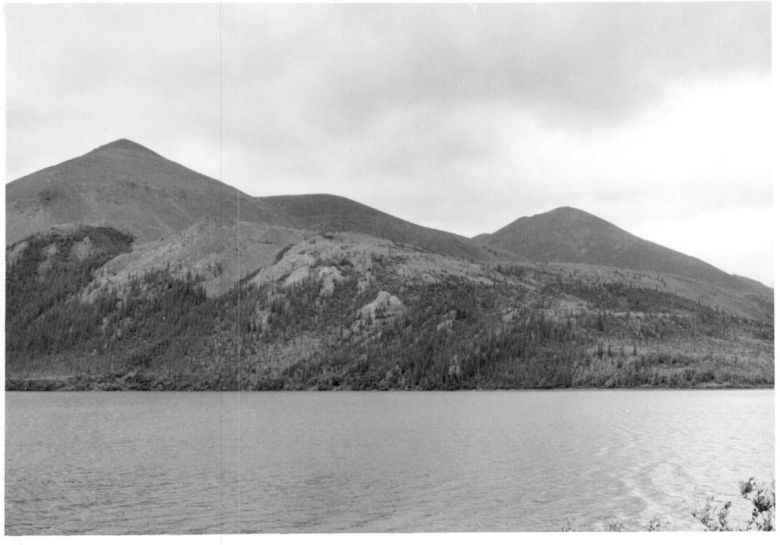
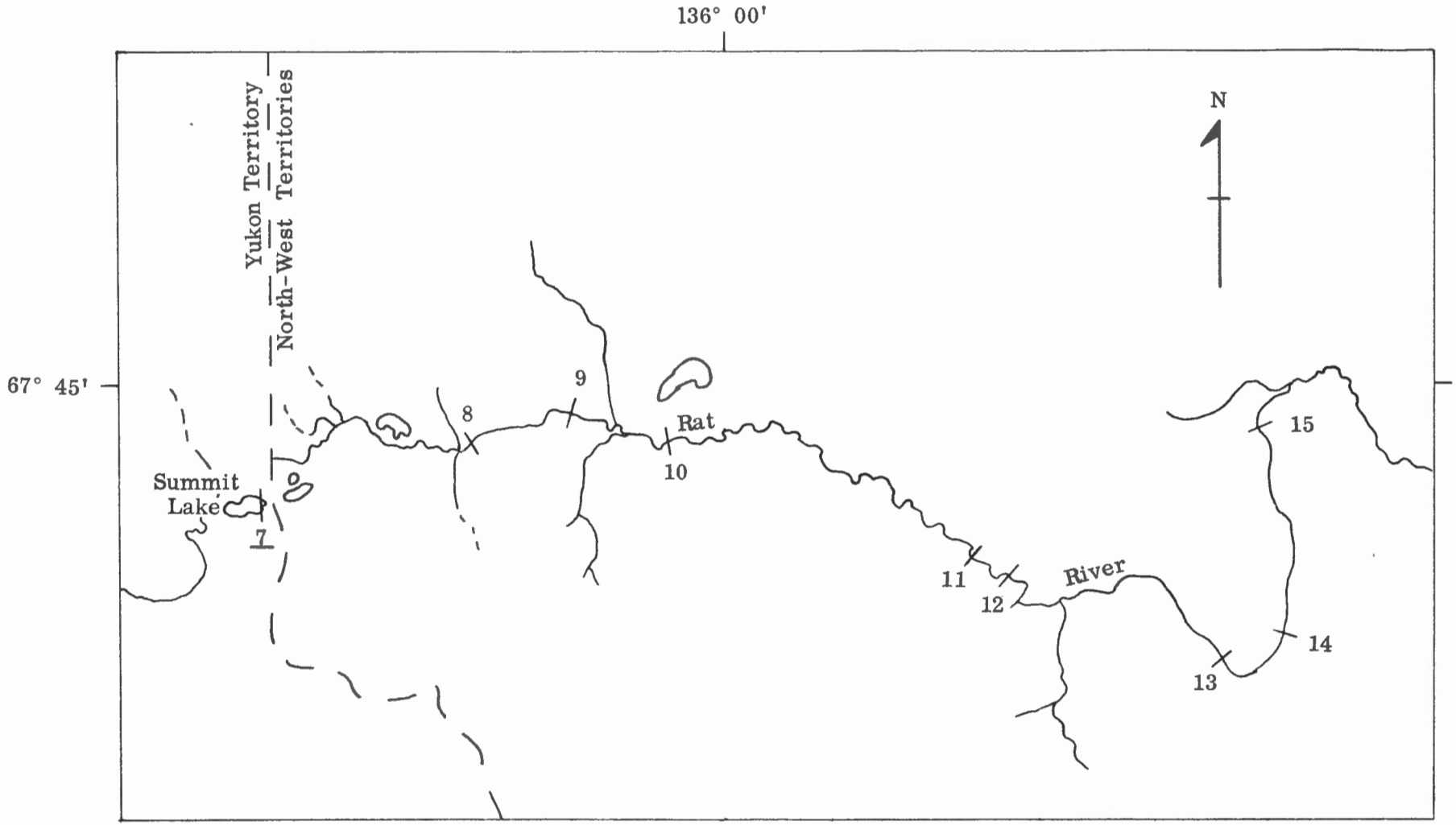


Plate 2

North abutment, Summit Lake site.

G.S.C. 32-7-62.




LOCATION OF PROPOSED DAM SITES
MACKENZIE RIVER DRAINAGE BASIN
Scale: 1 inch to 4 miles (approx.)

| Site No. | Name | Site No. | Name | Site No. | Name |
|---|---|---|---|---|---|
| 7 - | Summit Lake | 10 - | Horn Lake | 13 - | Barrier |
| 8 - | Fish Creek | 11 - | Rat Canyon (Upper) | 14 - | Longstick |
| 9 - | Bear Creek | 12 - | Rat Canyon (Lower) | 15 - | Delta |