No. 2

CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA
TOPICAL REPORT NO. 21

YUKON RIVER DRAINAGE BASIN
DAM SITE INVESTIGATION

SITE NO. 14

LOWER OGILVIE DAM SITE

(MAP AND PRELIMINARY REPORT)

BY

E. B. OWEN

OTTAWA
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Lower Ogilvie Dam Site

General Description

Lower Ogilvie dam site is located on Yukon River about 23 miles downstream from the junction of Stewart and Yukon Rivers. The mouth of Sixty Mile River, which drains a large area west of Yukon River, is immediately upstream from the southwest corner of the area shown on the accompanying geological map. An alternative site, designated as Upper Ogilvie, is located about 7 miles upstream from the Lower Ogilvie site. Upper Ogilvie site is described in Topical Report No. 20, site no. 13. The elevation of the water surface at Lower Ogilvie is about 8 feet lower than that at Upper Ogilvie.

At the site Yukon River flows north within a valley bounded by steep rock bluffs. The valley is about 4,100 feet wide but the main flow of the River occurs in a channel 1,200 feet wide along the west side of the valley. A smaller channel, 250 feet in width, along the east side of the valley is separated from the main channel by a large, wooded island upon which seismic lines Nos. 4, 5 and 6 are located.

The right abutment of the proposed power dam will be located in a steep bluff which rises abruptly to a height greater than 500 feet above the River. Bedrock is exposed in about 20 per cent of the abutment slope; the remainder is concealed beneath a thin covering of talus and residual soil. The left abutment will be located in a similar bluff, 280 feet in height, which rises steeply from the west side of the River. Above this bluff a level, bedrock terrace, covered with a thin deposit of Tertiary and Recent stream deposits, extends westward along the north side of the valley of Sixty Mile River. The elevation of the terrace is about 1,360 feet or 240 feet above Yukon River. A second terrace with the same

elevation can be seen along the south side of Sixty Mile River near its mouth.

Information from the 3 seismic lines indicates the thickness of the overburden beneath the island varies from 24 to 57 feet. It is believed these figures give a fair indication of the thickness of overburden between the abutments. However, it is possible a buried stream channel, eroded into bedrock, exists beneath the River close to the left abutment. Such a channel would be in the form of a depression in bedrock surface. It would be filled, in part, with permeable, glacio-fluvial sand and gravel.

There is a lack of overburden suitable for construction purposes in the site area. Frozen ground was encountered in many of the test pits put down on the island separating the two River channels (July 10, 1960). It was also encountered in the upper part of the left abutment beneath the area mapped as silt.

Unconsolidated Deposits

Four types of unconsolidated deposits were identified in the area about Lower Ogilvie dam site. These are as follows:

1. Recent Alluvium: This is material that has been deposited by the present River. It consists chiefly of a fine-grained, compact, silty sand with scattered cobbles up to 6 inches in diameter. Shallow unimportant deposits of this material occur along both sides of the island and at the downstream end.

2. Alluvium (silty sand): This material consists of a compact, silty sand containing very little gravel-size fragments. Similar material was encountered at Britannia dam site where it covered a wide area south of

Yukon River. At Lower Ogilvie site it covers all of the island but does not occur in the abutment area. It was usually frozen when encountered and consequently the quality of the underlying material is unknown. The thickness of the material, as observed along the sides of the island in banks cut by lateral erosion of Yukon River, is at least 8 feet. It is commonly interstratified with alternating beds of silt and fine-grained sand up to 1 inch in thickness.

3. Alluvium (silt): This material was encountered only in the upper part of the left abutment slope. It consists of an unstratified, yellow silt overlying residual soil in thicknesses varying between 6 inches and 3 feet. The dry strength of the silt is low. The deposit probably covers much of the terrace which extends west from the top of the abutment slope along the north side of Sixty Mile River valley.

4. Talus and Residual Soil: These materials occur on about 80 per cent of the surface of the abutments. The deposits, however, are thin and are nowhere believed to be greater than 10 feet in thickness. Talus is spalled material derived from adjacent bedrock. It usually occurs in the lower part of the abutment slopes or directly beneath bedrock exposures. The talus consists of rock fragments ranging in size from sand to boulders 4 feet in diameter. At Lower Ogilvie site, the larger boulders consist of gneiss and would make excellent rip rap. The quantity available, however, is not large.

The residual soils which have been derived by weathering from the underlying bedrock occur chiefly on the upper parts of the abutment slopes. The material consists of clay, silt and fine sand with numerous, angular, weathered fragments of bedrock up to 2 inches in diameter. The thickness of the residual soil varies from 2 to 3 feet. On the steeper slopes bedrock is sometimes exposed in slide scars where residual soil has moved

downward along the rock surface.

Bedrock

General Description:

Four rock types were identified at Lower Ogilvie dam site. These are as follows:

1. Gneiss: This rock is similar to the gneiss which occurs at the Upper Ogilvie site. It is a grey, fine- to medium-grained, indistinctly banded rock which consists chiefly of quartz and biotite. At the Lower Ogilvie site gneiss is only exposed on the right abutment slope. Irregular, schist strata, 2 to 4 inches thick, are sporadically interbedded with the gneiss. These are too narrow to be shown on the accompanying geological map.

2. Schist: Considerable schist occurs in the left abutment where it is interbedded with limestone. It is a soft, light coloured, quartz-mica schist which has weathered extensively into a clayey, residual soil.

3. Limestone: Several limestone beds, varying in thickness from 1 to 25 feet, are exposed on the left abutment slope. The durability of the limestone is higher than that of the schist with which it is interbedded; consequently several prominent knobs on the abutment are composed of this rock. The limestone is a light grey to buff, crystalline rock with no visible solution cavities. It constitutes about 25 per cent of bedrock exposed on the left abutment.

4. Porphyry: This rock consists of phenocrysts of quartz and pink to white feldspar imbedded in a soft, greenish, chloritic matrix. The feldspar phenocrysts range up to three-quarters of an inch in length and are frequently decomposed. Porphyry is exposed near the top of the bluff in

the downstream part of the left abutment area and along the edge of the River about 500 feet upstream from the Sestak Placers Company road. Large, porphyry boulders were uncovered at the top of the bluff during construction of the road suggesting there is more porphyry present in the abutment than is indicated by the bedrock exposures. Fragments of schist included in the porphyry outcropping at the River's edge indicate its intrusive character.

Bedrock Structures

The strike of bedrock strata at the site as indicated by the attitude of the limestone beds exposed on the left abutment slope is nearly parallel to the River. The dip is 35 degrees west, i.e. into the left abutment. As a consequence, none of the limestone visible in the left abutment should occur beneath the River. Schistosity is well developed along one plane which intersects the strata at about 90 degrees. The average dip of the schistosity is 25 degrees upstream.

Minor jointing is common and probably contributes greatly to the excessive weathering of the schist. One prominent joint set intersects the centre line at about 65 degrees and dips steeply to the east. There are no visible evidences of faulting in the rocks exposed at the site.

Quality of Bedrock

The gneiss exposed on the right abutment slope should provide excellent foundation material. Test borings should be put down to determine the extent of the irregular, schist strata interbedded with the gneiss which could decrease the competency of the rock.

The schist exposed in the left abutment slope is relatively incompetent. It is soft, easily weathered and readily breaks into thin slabs.

The limestone may be of the soluble type. The absence of solution cavities is probably due to lack of ground water rather than insolubility of the rock. Evidence of solution is visible in a similar type of limestone occurring at Gerc dam site (Topical Report No. 25, site no. 20). Porphyry, a massive durable rock, would provide satisfactory rip rap or rock fill. The quantity available, however, is not large and the long, narrow shape of the rock mass would hinder any method of large scale excavation.

Engineering Considerations

Depth of Overburden

Overburden on both abutment slopes consists of talus and residual soil and is everywhere believed to be less than 10 feet in thickness. Information from 3 seismic lines located on the island separating the two River channels indicates the depth of overburden here varies from 24 to 57 feet. These figures are probably correct for the greater part of the overburden beneath the River. The elevation of the water surface in the reservoir will be about 1,280 feet. There is no evidence at present to indicate the existance of a former course of Yukon River in the area through which water from the reservoir could escape. It is believed the River was flowing in its present channel prior to the last glaciation. Upper and Lower Ogilvie sites were not covered by ice during the last glaciation[1]. The limit of the ice-sheet is upstream near the community of Fort Selkirk at the junction of Yukon and Pelly Rivers. As the ice disintegrated, large quantities of melt water probably flowed down Yukon River past Upper and Lower Ogilvie sites. As a result a relatively great thickness of glacio-fluvial sand and gravel

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[1] Bostock, H.S., "Carmacks District, Yukon"; Geol. Surv., Canada, Memoir 189, 1936, p. 10.

could exist beneath the River at the site.

The possibility of a buried stream channel, eroded into bedrock, beneath the River should be investigated. Such a channel would be in the form of a depression in bedrock surface probably close to the left abutment. It is suggested test borings be put down along one or more lines crossing the River between the abutments to determine the quality of the overburden and to accurately contour bedrock surface.

Abutments and Foundations

Schist constitutes the greater part of bedrock exposed on the left abutment slope. It is a soft, easily weathered rock which tends to separate readily along the planes of schistosity. Considerable weathered schist may have to be removed in order to expose fresh, solid material, against which concrete or dyke material can be placed. The dip of the schistosity is 25 degrees upstream which is more favourable to construction than the low, downstream dip of the foliation at Upper Ogilvie site.

The gneiss exposed on the right abutment slope is competent. However, the presence of narrow, irregular, schist strata interbedded with the gneiss may lower its competency. Bedrock exposed on both abutments should be thoroughly investigated before any decision is reached regarding its ability to provide satisfactory abutments or foundations.

Construction Materials

Aggregate

Deposits of natural aggregate do not occur within the area mapped at the site. A potential source of aggregate is the sand and gravel which covers much of the floor of the valley of Sixty Mile River. One extensive

deposit occurs about 8 and one half miles west of Yukon River on the Sestak Placers Company property. It can be reached by a road which follows the terrace extending along the north side of Sixty Mile River. During the summer of 1960 this road was in such poor condition that trucks could not have been operated on it.

The Tertiary and Modern stream deposits occurring on the terraces extending along both sides of Sixty Mile River are also a potential source of natural aggregate. These gravels are frequently overlain by 2 to 3 feet of silt. As the upper few feet are usually highly weathered it is believed about 6 feet of material would have to be removed before fresh gravel suitable for aggregate would be exposed. Grain size analyses curves for representative samples of the gravel from the Sestak Placers Company's property and from the terrace north of Sixty Mile River are included at the end of this report.

Gravel also occurs on several relatively low terraces along both sides of Yukon River downstream from the site. One such terrace, 60 feet in height and one mile in length, is located on the left side of the River about 10 miles downstream. The material consists of graded, sandy gravel ranging from sand-size particles to cobbles 6 inches in diameter. The majority of cobbles consist of unweathered quartz and quartzite. A few weathered, granitic boulders up to 10 inches in diameter are scattered throughout the material. About 2 per cent of the pebbles were black chert.

Impervious Material

Material suitable for the impervious core of an earth-fill dam was not found in the area covered by the accompanying geological map. The permeability of the silty sand covering the island separating the two River channels has been calculated to be in the order of 10^{-6} cm. per second.

The quantity of material available, however, is unknown as it was frozen close to ground surface at the time of the investigation (July 10, 1960).

The residual soil in the abutment areas contains an appreciable quantity of clay but it is not believed this material would be satisfactory even if sufficient quantities were available.

A depression, the floor of which is covered with a dark brown, silty clay, occurs on the terrace about 6 and one-half miles west of the River. The depression is about one-quarter mile wide and one-half mile long. Numerous slate fragments were found on the slopes leading down into the depression but bedrock was not exposed. It is possible the clayey material is residual soil derived from the slate. A grain size analysis curve for the material is included at the end of this report.

Pervious Material

Material for the graded filter of a rock-fill dam could be obtained from the sandy gravel deposits described under the "aggregate" heading. The gravel would have to be washed, screened and reblended to obtain the coarse, granular material required. The upper 2 to 3 feet of the gravel on the terraces along Sixty Mile River contains a high percentage of weathered pebbles and cobbles which may have to be removed before satisfactory material can be obtained.

Rip rap and Rock Fill

The gneiss exposed on the right abutment slope should provide excellent rip rap and rock fill. It is a tough, durable rock and relatively resistant to normal weathering processes. The specific gravity of gneiss is also higher than for most rocks. The presence of narrow, schist strata interbedded with the gneiss may decrease its durability and also reduce the

size of rock fragments formed by blasting. Most of the boulders in the talus consist of gneiss but are usually too small to make satisfactory rip rap.

Ground Water

There is little information concerning ground-water conditions in the area about Lower Ogilvie dam site. Several small swamps occur on the island separating the two River channels. The underlying material, however, is frozen and the wet areas are probably the result of a perched water table.

Accurate information regarding the ground-water table can only be obtained by installing many ground-water observation holes. The presence of frozen ground would greatly increase the cost of such a program.

Frozen Ground

Frozen ground was encountered (July 10, 1960) within 8 to 40 inches of ground surface on the island and in the upper part of the left abutment. It probably exists in the right abutment area also, although direct evidence of its occurrence was not observed. Localities where frozen ground was encountered have been noted on the accompanying geological map.

Further Investigations - Conclusions

The results of this preliminary geological investigation indicate bedrock conditions at Lower Ogilvie site, especially in the left abutment area, are not favourable for construction of a dam. It is believed a better site exists immediately upstream from the mouth of Sixty Mile River where more competent bedrock is exposed. It has been suggested consideration be given to swinging the centre line of the dam upstream about the right

abutment so that the left abutment would be above Sixty Mile River. This, however, would almost double the length of the dam and, at the same time, decrease the storage capacity of the reservoir because it would no longer extend up the valley of Sixty Mile River.

If it is decided more information is required at Lower Ogilvie site, the following test borings are suggested as part of the program:

1. Between the abutments: Borings should be put down along one or more lines extending across the River between the abutments. The borings should be at approximate 200-foot centres and should penetrate at least 15 feet of bedrock. Soil samples should be taken at 5-foot intervals or where there is a change in material; permeability tests should be conducted and the elevation of the ground-water table noted.

2. Abutments: Borings should be put down at regular intervals into each abutment to depths 15 feet below the lowest elevation of bedrock surface encountered beneath the River; soil samples should be taken where possible; permeability tests should be conducted and the elevation of the ground-water table noted.

Comparison between Upper and Lower Ogilvie dam sites

Lower Ogilvie site is an alternative to Upper Ogilvie site. A comparison between the two sites is included in the report on Upper Ogilvie site (Topical Report No. 20, site No. 13).

Chemical Analyses of Yukon River Water

Chemical analyses of Yukon River water are included in the report on Upper Ogilvie site.

Grain Size Analyses Curves

The grain size analyses curves included in this report were prepared in the Soils Laboratory of the Water Resources Branch in Vancouver. The permeability of sample No. 18 was computed in the field using a Soiltest Permeameter, Model K-620.

Each grain size sheet for potential aggregate shows the following information:

(a) Limits of fine and coarse aggregate based upon a 6-inch maximum size.

(b) A cumulative grain size curve for each sample.

(c) Curves showing individual percentages of the coarse and fine fraction retained on each screen or sieve size. For these purposes the sample is divided at the No. 4 sieve into coarse and fine fractions. Samples Nos. 20 and 21 were analysed as potential aggregate and samples Nos. 18 and 19 as potential impervious material.

Description of Potential Aggregate for the following Grain Size Analyses Curves

Sample Number	Location	Field Description of Material	Field Description of Overburden	Thickness of Deposit	Areal Extent (Estimated)	Remarks
20	Sixty Mile River valley floor; 8½ miles west of Yukon River; 3 feet below ground surface	Sandy gravel; no weathering; 25 per cent of gravel consists of rounded to semi-rounded pebbles; a few granitic boulders up to 10 inches	None	No information	Large	Water table at 6 feet; accessible by road from Yukon River; on Sestak Placer Company's property
21	On Sestak Placers Company road; ½ mile west of Yukon River; 5 feet below ground surface	Fine-grained, sandy gravel; considerable weathering; a few cobbles up to 6 inches	3 feet of silt	10+ feet	"	Material mapped as Tertiary and Modern deposits

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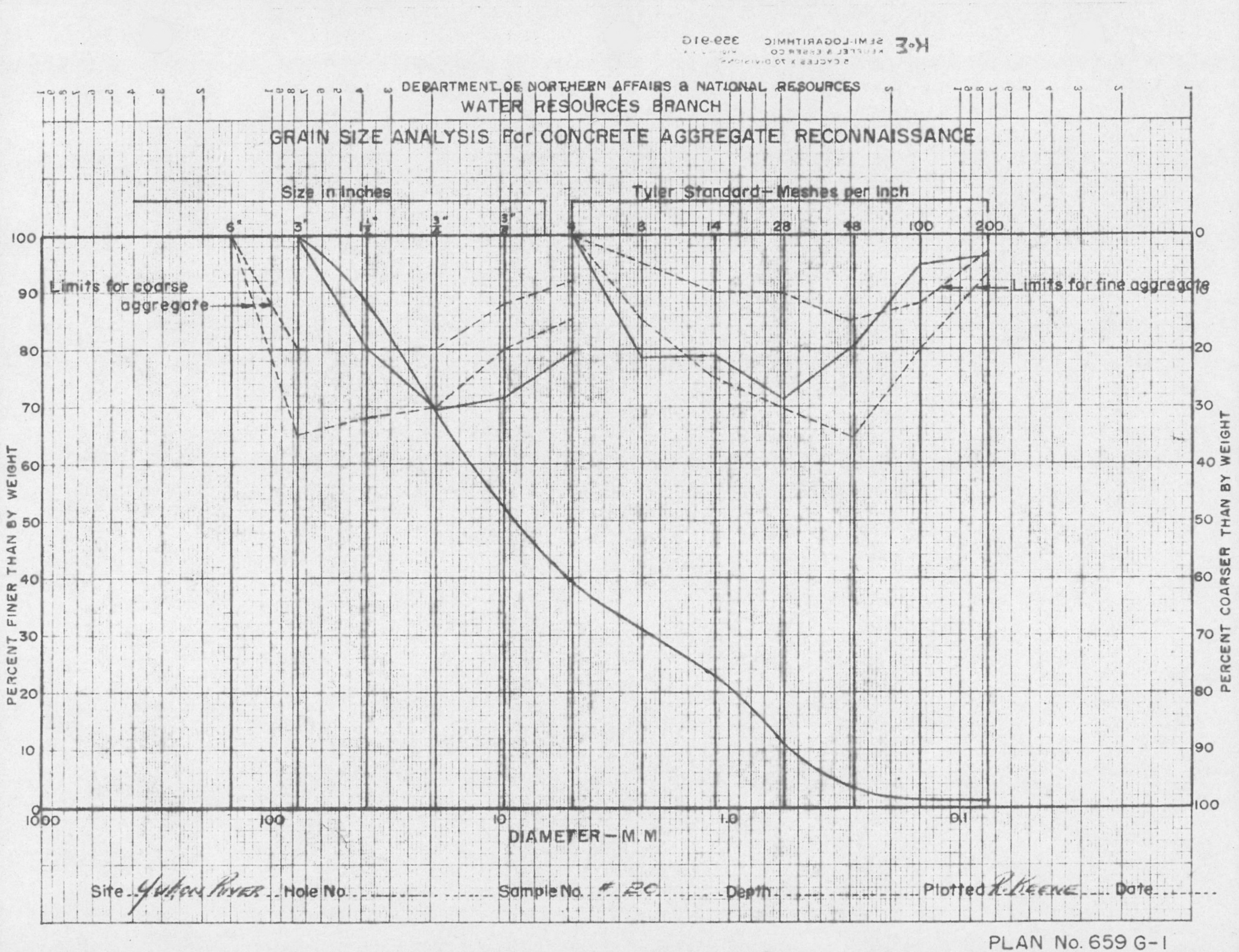
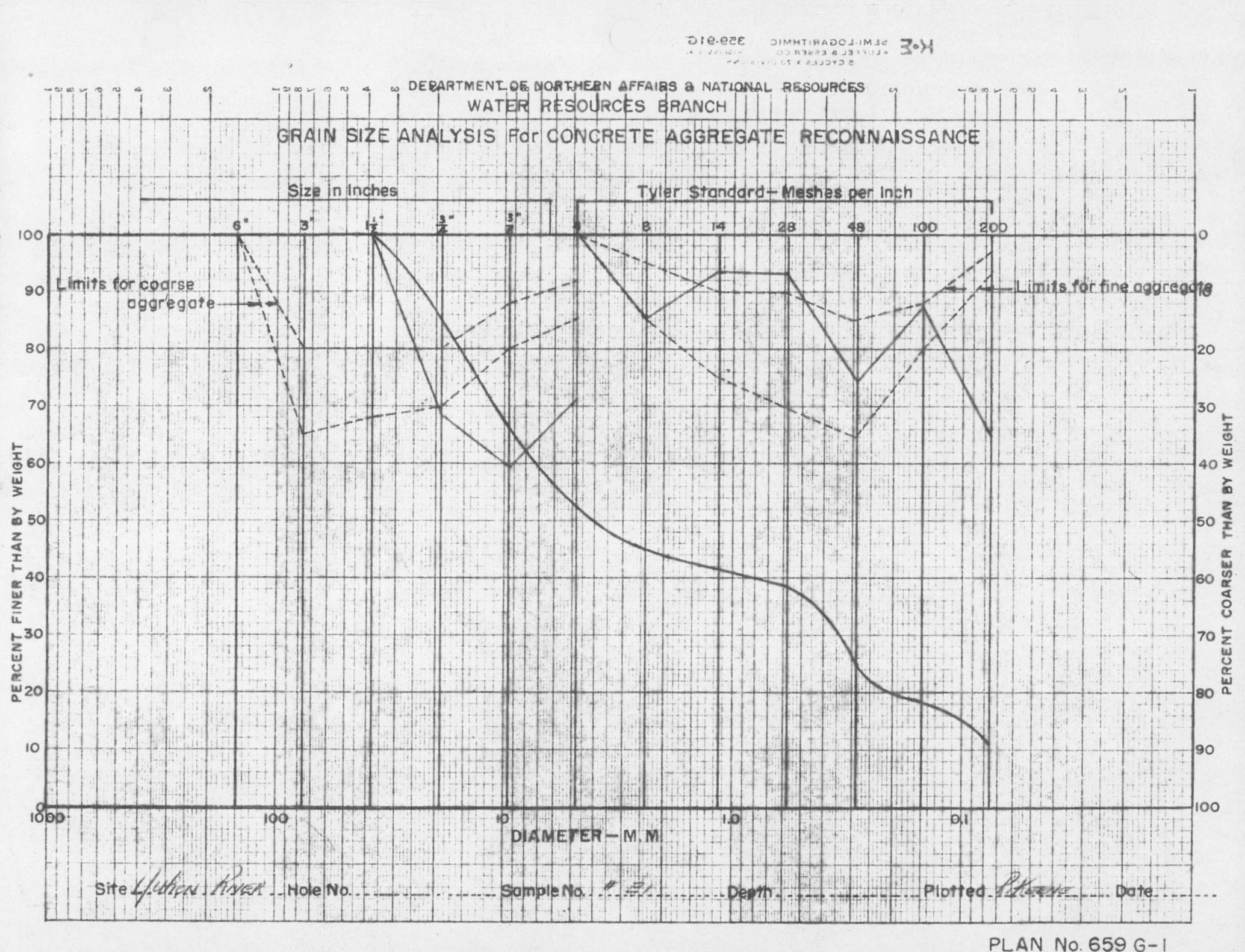
WATER RESOURCES BRANCH

GRAIN SIZE ANALYSIS For CONCRETE AGGREGATE RECONNAISSANCE



Site Yukon River Hole No. Sample No. # 20 Depth Plotted K. Keene Date

PLAN No. 659 G-1

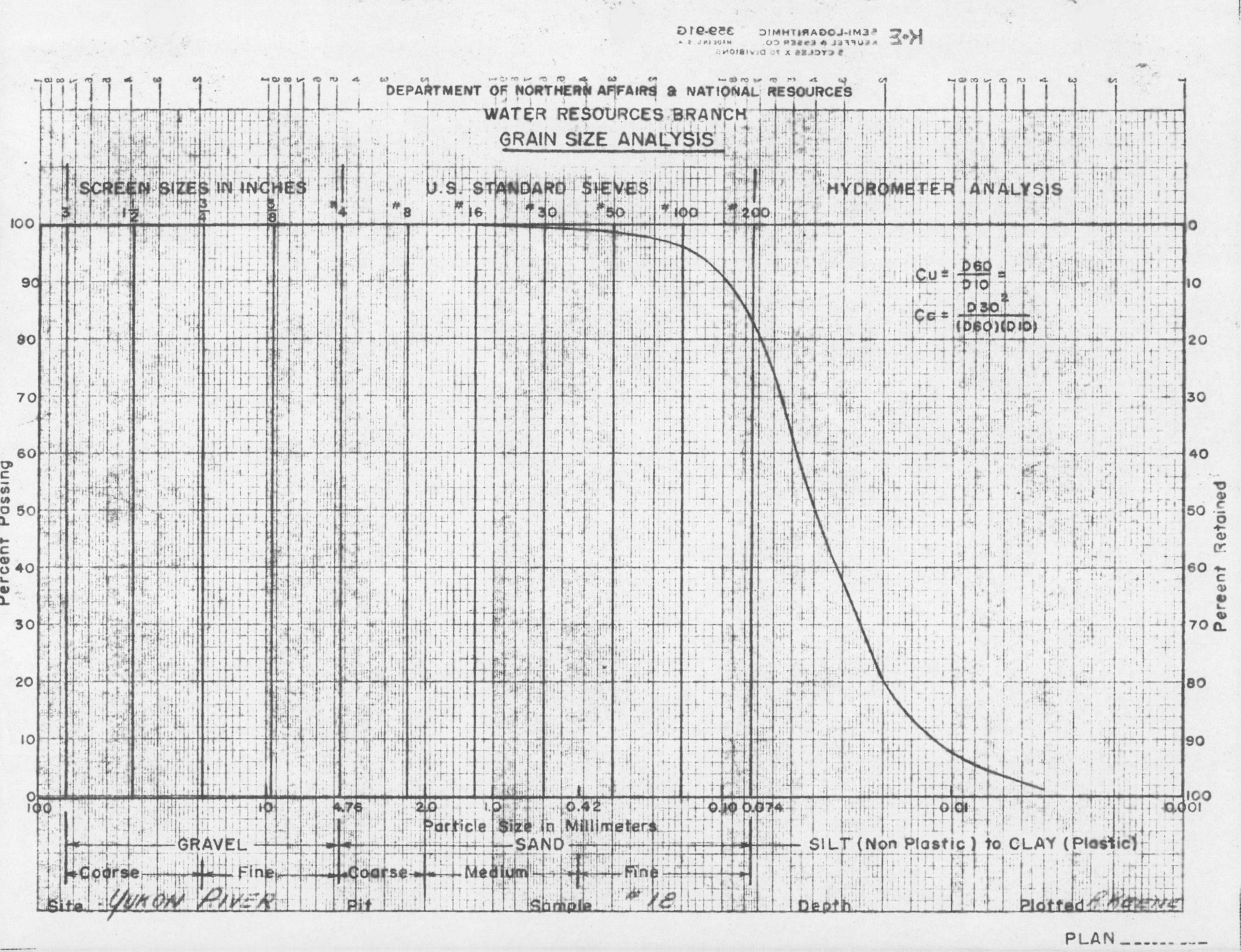


PLAN No. 659 G-1

Description of Potential Impervious Material for the following Grain Size Analyses Curves

Sample Number	Location	Field Description of Material	Field Description of Overburden	Thickness of Deposit	Areal Extent (Estimated)	Permeability* (cm./sec.)
18	At hub No. 2; 3 feet below ground surface	Dense, silty sand; frozen from 8 to 40 inches below ground surface (July 10, 1960)	none	10+ feet	2,000 feet wide, 1 mile long	10^{-6}
19	Floor of a depression on a level terrace above and north of Sixty Mile River Valley; $6\frac{1}{2}$ miles west of Yukon River; on Sestak Placers Company road	Silty clay, very little sand; may be residual resulting from weathering of underlying shale	none	Shallow	$\frac{1}{4}$ mile wide, $\frac{1}{2}$ mile long	-

* Permeability computed in the field using a Soiltest Permeameter, Model K-620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WATER RESOURCES BRANCH
GRAIN SIZE ANALYSIS
SCREEN SIZES IN INCHES
U.S. STANDARD SIEVES
HYDROMETER ANALYSIS
3
1 1/2
3/4
3/8
#4
#8
#16
#30
#50
#100
#200
Cu = D60 / D10 =
Cc = D30² / (D60)(D10)
Percent Passing
Percent Retained
100
90
80
70
60
50
40
30
20
10
0
100
10
4.76
2.0
1.0
0.42
0.10
0.074
0.01
0.001
Particle Size in Millimeters
GRAVEL
SAND
SILT (Non Plastic) to CLAY (Plastic)
Coarse
Fine
Coarse
Medium
Fine
Site - YUKON RIVER
Pit
Sample #12
Depth
Plotted
PLAN

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GRAIN SIZE ANALYSIS

SCREEN SIZES IN INCHES | U.S. STANDARD SIEVES | HYDROMETER ANALYSIS

3 | 1½ | ¾ | ⅜ | #4 | #8 | #16 | #30 | #50 | #100 | #200

$$Cu = \frac{D60}{D10} =$$

$$Cc = \frac{D30^2}{(D60)(D10)}$$

Percent Passing: 100, 90, 80, 70, 60, 50, 40, 30, 20, 10, 0

Percent Retained: 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100

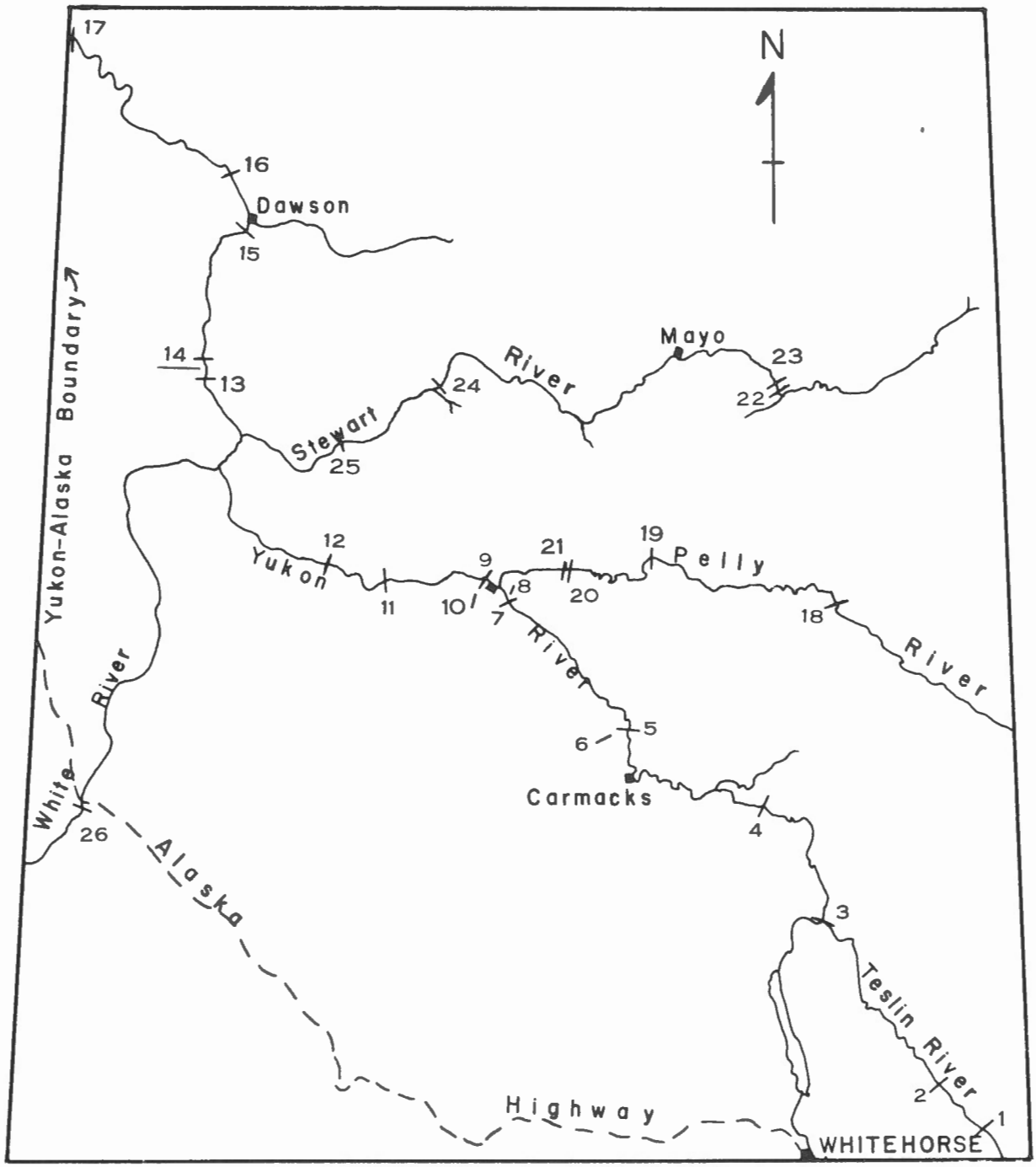
100 | 10 | 4.76 | 2.0 | 1.0 | 0.42 | 0.10 | 0.074 | 0.01 | 0.001

Particle Size in Millimeters

GRAVEL — Coarse — Fine | SAND — Coarse — Medium — Fine | SILT (Non Plastic) to CLAY (Plastic)

Site - YUKON RIVER Pit Sample #19 Depth Plotted

PLAN



LOCATION OF PROPOSED DAM SITES
YUKON RIVER DRAINAGE BASIN
Scale: 1 inch = 40 miles

Site No.	Name	Site No.	Name	Site No.	Name
1	Swift River	10	Fort Selkirk Draw	19	Granite Canyon
2	Northwest Power	11	Selwyn	20	Gerc
3	Hootalinqua	12	Britannia	21	Bradens Canyon
4	Big Salmon	13	Ogilvie no.1	22	Five Mile Rapids
5	Five Finger Rapids	14	Ogilvie no.2	23	Fraser Falls
6	Five Finger Draw	15	Upper Dawson	24	Independence
7	Wolverine	16	Lower Dawson	25	Porcupine
8	Wolverine Draw	17	Boundary	26	Lower Canyon
9	Fort Selkirk	18	Detour		