No. 2

CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

TOPICAL REPORT NO. 20

YUKON RIVER DRAINAGE BASIN
DAM SITE INVESTIGATION

SITE NO. 13

UPPER OGILVIE DAM SITE

(MAP AND PRELIMINARY REPORT)

BY

E. B. OWEN

OTTAWA
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Contents

Illustrations

Upper Ogilvie Dam Site

General Description

Upper Ogilvie dam site is located on Yukon River about 16 miles downstream from the junction of Stewart and Yukon Rivers. It is approximately one and a half miles upstream from the mouth of Rosebute Creek. An alternative site, designated as Lower Ogilvie, is located about 7 miles downstream from the Upper Ogilvie site. Lower Ogilvie site is described in Topical Report No. 21, Site No. 14.

At the site, the River is flowing in a northerly direction between two steep, rock bluffs, some 3,900 feet apart, which form the abutments of the proposed power dam. Bedrock exposed in the bluffs consists of metamorphic rocks of the Yukon Group described by Bostock [1] as Precambrian or Later.

The River at the site is divided into three channels by two low, sparsely-wooded islands upon which three seismic lines were located in 1956. The exact location of the seismic lines could only be assumed at the time the site was visited. Each spring the islands are almost completely inundated and all evidence of the lines has been destroyed.

Bedrock is exposed on about 15per cent of the right abutment slope; the remainder is covered with a thin layer of talus and residual soil. On the left (west) side a steep, bedrock bluff ascends from the River's edge to a height of approximately 280 feet. Above the bluff a fairly level terrace covered with Tertiary and Recent stream deposits extends westward for several miles.

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1 Bostock, H.S.: Yukon Territory; Geol. Surv., Canada, Ogilvie Map 711A, 1942.

Information from 3 seismic lines located on the two islands in the River indicates the thickness of overburden beneath the islands varies from 41 to 69 feet. These figures are probably correct and give a fair indication of the thickness of overburden beneath the River. There is a possibility a buried stream channel eroded into bedrock exists close to one or the other of the abutments. Such a channel would be in the form of a depression in bedrock surface. It would be filled, in part, with permeable,glacio-fluvial material.

There is a lack of overburden suitable for construction purposes in the area. Frozen ground was not encountered although many test pits were dug to depths as great as 4 feet on the islands and in the residual soil on the right abutment (July 15, 1960).

Unconsolidated Deposits

1. Recent Alluvium: This material has been deposited by the present River. It consists of a fine-grained, compact, silty sand overlying a sandy gravel with cobbles up to 2 inches in diameter. The islands in the River at the proposed site consist entirely of these materials. On the downstream ends of the islands the silty sand overlies the gravel in thicknesses from 6 inches to 4 feet whereas on the upstream parts gravel is exposed on ground surface. If sufficient quantities were available the gravel could possibly be used as aggregate or filter material. The large quantities which will be excavated during construction of the impervious core of the earth-fill dam could readily be stock-piled for future use.

2. Talus and Residual Soil: Most of the surface of the right abutment is covered with these materials. Talus is spalled material derived from adjacent bedrock. It usually occurs in the lower part of the abutment slope along the edge of the River and, to a lesser extent, immediately below bedrock

exposures. The talus consists of rock fragments ranging in size from sand to boulders two feet in diameter. The residual soils, which have been derived by weathering from the underlying bedrock, occur chiefly on the downstream part of the right abutment slope. The material consists of clay, silt and fine sand with numerous, angular, weathered fragments of bedrock up to 2 inches in diameter. The average thickness of the residual soil is about 2 feet. Excellent sections are visible in several, recent, slide scars on the right abutment slope where the soil has moved downward along bedrock surface.

Bedrock

General Description

Three rock types were identified at the Upper Ogilvie dam site. These are as follows:

1. Schist: This is a soft, light coloured rock which consists chiefly of quartz and biotite. It is extensively weathered and is the chief source of the residual soil found on the right abutment slope. Schist is the most common rock in the dam site area. It constitutes almost all the rock in the right abutment and about 70 per cent of that exposed in the steep bluff forming the left abutment.

2. Gneiss: This rock varies considerably in texture and composition. In the steep, left abutment it is a massive, grey to pink, indistinctly banded rock interbedded with the schist as irregular lenses one inch to 25 feet in thickness. From a distance gneiss can easily be distinguished from schist by its lighter colour. On the right abutment slope it is a massive, grey, medium-grained rock with well-defined banding. Because of the irregularity of its occurrence only the larger masses of gneiss have been included on the accompanying geological map. Many small, irregular, pegmatite dykes are associated with the gneiss. The presence of the dykes, however, has not

lowered the competency of the rock.

3. Quartz Vein: Numerous white quartz veins are visible in both abutments. The veins are exceedingly irregular and vary in width from a few inches up to 3 feet. They intrude both the gneiss and the schist. One such vein, 36 inches in width, occurs near the centre of the right abutment a few feet above the River. Another is located in the rock bluff on the left side of the River a short distance upstream from the map-area. The latter vein is very distinctive, ascending from the edge of the River almost to the top of the bluff.

Bedrock Structures

The foliation of bedrock at Upper Ogilvie dam site intersects the proposed centre line at angles varying from zero to 40 degrees. The average dip is about 30 degrees downstream.

Jointing is common. One prominent joint set intersects the centre line at about 30 degrees and has an average upstream dip of 45 degrees. A second set is nearly at right angles to the first. It intersects the centre line at about 60 degrees and dips steeply upstream at approximately 80 degrees.

Faulting was observed in both abutments. In the left abutment a large fault zone, 5 feet in width, is visible in the face of the bluff about 100 feet upstream from the centre line. This fault zone intersects the centre line at 35 degrees and dips upstream at 85 degrees. Many of the bedrock fragments scattered throughout the zone are stained brown due to the deposition of iron carbonate by ground water. There is no doubt this fault zone is a potential aquifer and could cause considerable leakage beneath the dam. However, as there is very little clayey, fault gauge associated with the zone, it could be readily grouted. A second prominent fault which intersects the centre line at about 65 degrees is visible about 50 feet downstream from the

first. This fault has an upstream dip of 65 degrees.

A large fault is visible at the base of the right abutment slope about 300 feet upstream from the centre line. This fault is parallel to the centre line and dips upstream at 45 degrees.

The strike of the faults observed in the dam-site area vary by as much as 60 degrees. The dips, however, are always southerly, i.e. upstream relative to the centre line. In every instance except one they are reverse faults. The amount of displacement on the larger faults is not known. Numerous minor faults with vertical displacements up to 3 inches occur in the rock exposed in both abutments.

Quality of Bedrock

The schist, which constitutes most of the rock in the two abutments, is not believed to be satisfactory as foundation or abutment material. It is a soft, easily weathered rock which tends to separate readily along the planes of schistosity. It is suggested the schist should be thoroughly investigated regarding its shear strength and durability before a decision is reached as to its competency. The gneiss is an excellent rock which, if present in sufficient quantity, would provide satisfactory abutments and foundations.

Engineering Considerations

Depth of Overburden

Overburden on both abutment slopes consists of talus and residual soil and is believed to be less than 10 feet in thickness. Information from 3 seismic lines located on the islands indicates the depth of overburden between the abutments varies from 41 to 69 feet. These figures are slightly greater than those for Lower Ogilvie site but are probably correct for the greater part of the overburden beneath the River. The material probably

consists of permeable, glacio-fluvial sand and gravel overlain by several feet of recent alluvium.

There is no evidence at present to indicate the existence of a former course of Yukon River in the area and consequently 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 Ogilvie site. As a result, a relatively great thickness of glacio-fluvial sand and gravel could exist beneath 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 one of the abutments. It is suggested test borings be put down along the proposed centre line to determine the quality of overburden and to accurately contour bedrock surface.

Abutments and Foundations

The schist, which constitutes the greater part of bedrock at Upper Ogilvie site, is a soft, easily weathered rock which tends to separate readily along the planes of schistosity. Considerable rock will have to be removed before fresh, solid material, against which concrete or dyke material can be placed, will be obtained. The dip of the foliation, which is about 30 degrees downstream, is detrimental to construction as there is a possibility of sliding caused by the thrust of the dam. The presence of faulting at the site would

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

decrease the competency of bedrock and increase the danger of leakage beneath the dam or through the abutments.

Construction Materials

Aggregate

The alluvial sand and gravel exposed on the two islands in the River are the only deposits of natural aggregate within the area mapped at the site. Grain size analyses curves for 2 samples of this material are included at the end of this report.

A potential source of natural aggregate is believed to be the gravel covering the floor of the valley of Rosebute Creek which joins the right side of Yukon River about 2 miles below the site. However, at the time of the investigation, the valley was very wet and it was impossible to ascertain the quality of the material. An abandoned road which follows the Creek valley was impassible although it could probably be used during the winter.

Potential sources of natural aggregate are the Tertiary and Modern stream deposits occurring on the terraces bordering the valley of Rosebute Creek and on the wide terrace west of Yukon River above the left abutment. The material is a sandy gravel containing numerous weathered cobbles and boulders. It is usually overlain by 2 to 3 feet of silt. The areal extent of these gravel deposits is great although their thickness is unknown. A program of test pitting and sampling will be required to determine the quantity of silt and weathered gravel that would have to be removed before fresh material can be obtained. The large proportion of schist in bedrock at the site would make it unsatisfactory as a source of aggregate.

Impervious Material

Sufficient quantities of material suitable for the impervious core of the proposed earth-fill dam were not found in the area about Upper Ogilvie

dam site. The permeability of the silty sand covering part of the islands between the abutments has been calculated to be in the order of 10^{-6} cm. per second. The quantity of material available, however, is small. It is suggested other islands, both upstream and downstream from the site, should be investigated for similar material. The problems involved in obtaining sufficient impervious material from the islands would be considerable. Many are very low and consequently are inundated during the spring and early summer and, in others, the water table is close to ground surface.

Pervious Material

Material suitable for the pervious shells of the proposed earth-fill dam can be obtained from the gravel deposits described under the aggregate heading. The gravel in the upper parts of these deposits is generally highly weathered and may have to be removed before satisfactory material can be obtained.

Riprap and Rock Fill

The gneiss exposed on both abutment slopes should provide excellent riprap and rock fill. The quantity available, however, is not large and some process would have to be developed to separate it from the schist with which it is interbedded. The presence of schist decreases the durability of the rock and also results in smaller fragments when it is broken by blasting. The talus would not be a source of suitable riprap as the rock fragments are too small.

Ground Water

There is little information concerning ground-water conditions in the area about the proposed dam site. Water was encountered within 3 feet of ground surface in several test pits put down on the islands. Seepages of ground water were not observed in either abutment although many of the rock

fragments in the fault zones have a brown coating of iron carbonate probably deposited by circulating ground water. Accurate information concerning the water table can only be obtained by installing ground-water observation holes.

Frozen Ground

Frozen ground was not encountered in the area about the Upper Ogilvie dam site although many test pits were dug to maximum depths of 4 feet on the islands and on the right abutment slope (July 15, 1960). The Upper Dawson and Upper Ogilvie sites are the only sites on the main stem of Yukon River below Fort Selkirk where frozen ground was not encountered in test pitting. There is no indication on ground surface that frozen ground underlies Upper Ogilvie site. However, it is believed to exist in the abutments and possibly also beneath the River.

Further Investigations

The following test boring program is suggested as a result of this preliminary geological investigation. All borings should be located along the proposed centre line and on the abutments as indicated on the accompanying geological map. The borings should penetrate 15 feet below the lowest elevation of bedrock surface encountered; soil samples should be taken every 5 feet or where there is a change in material; permeability tests should be conducted; ground-water table elevations and the presence of frozen ground should be noted.

Boring Number	Location
1	Left abutment; 160 feet west of River
2	Earth-fill dam; 155 feet east of left bank of River
3	Earth-fill dam; 570 feet east of left bank of River
4	Earth-fill dam; 985 feet east of left bank of River
5	Earth-fill dam; 1,390 feet east of left bank of River

Boring Number	Location
6	Earth-fill dam; 1,800 feet east of left bank of River
7	Concrete Gravity dam; 1,650 feet west of right bank of River
8	Concrete Gravity dam; 1,330 feet west of right bank of River
9	Concrete Gravity dam; 810 feet west of right bank of River
10	Spillway; 410 feet west of right bank of River
11	Spillway; right bank of River
12	Right abutment; 200 feet east of right bank of River
13	Right abutment; 210 feet north of hole No. 12
14	Right abutment; 400 feet north of hole No. 12
15	Right abutment; 600 feet north of hole No. 12
16	Right abutment; 180 feet south of hole No. 12
17	Left abutment; 385 feet north of hole No. 1
18	Left abutment; 795 feet north of hole No. 1
19	Left abutment; 415 feet south of hole No. 1

It is further suggested hole No. 16 be drilled north at an angle of 76 degrees to the horizontal and hole No. 17 drilled at an angle of 63 degrees with an azimuth of 47 degrees. These holes are designed to intersect the fault zones indicated on the accompanying geological map. The remaining holes should be drilled vertically unless during the drilling program there is an indication of other vertical fractures caused by open jointing or faulting not visible on surface; in which case angle holes should be drilled to intersect these fractures.

Comparison between Upper and Lower Ogilvie dam sites

The following comparisons are based entirely upon a preliminary geological examination of the two sites and an investigation into possible sources of construction materials in the immediate areas about the sites.

1. Location:

At both sites Yukon River is flowing in a northerly direction between steep, rock bluffs which rise abruptly from the water. It is proposed to utilize the bluffs as abutments for the dams. At Upper Ogilvie the distance between the abutments is about 3,900 feet and at Lower Ogilvie it is 4,100 feet.

2. Quality of Bedrock:

Schist constitutes most of the rock exposed at both sites. It is a soft, easily weathered rock which tends to separate readily along its planes of schistosity. The schist should be thoroughly investigated before a decision is reached regarding its suitability as abutment or foundation material.

3. Bedrock Structures:

The foliation at Upper Ogilvie site dips downstream; this increases the possibility of sliding caused by the thrust of the dam. Several large faults were noted at the Upper Ogilvie site whereas visible faulting at the Lower Ogilvie site is limited to minor slips. Joint planes at Upper Ogilvie are more open and prominent than at the Lower site.

4. Depth of Overburden:

Information from seismic lines indicates the thickness of overburden between the abutments at each site is approximately the same. Except for this data little is known concerning the elevation of bedrock surface beneath the River. The figures obtained from the seismic work are reasonably accurate. A thin layer of talus and residual soil overlies much of bedrock forming the

abutments. Everywhere it is believed to be less than 10 feet in thickness.

5. Aggregate:

Sufficient quantities of natural aggregate do not occur within the areas mapped at either site. Potential sources of aggregate for both sites are recent, alluvial deposits on the valley floors of streams tributary to Yukon River or weathered Tertiary material occurring on terraces high above the River.

6. Impervious Material:

Deposits of suitable impervious material were not located at either site during this preliminary survey.

7. Riprap and Rock Fill:

Suitable riprap and rock fill can probably be obtained from bedrock at each site.

8. Frozen Ground:

Frozen ground was encountered in test pits put down at Lower Ogilvie site but not at the Upper site. It is believed frozen ground occurs at the Upper site but exists at a lower elevation.

9. Ground Water:

Little is known concerning the ground-water table in the abutments at the two sites. On the islands it is within 3 feet of ground surface.

Conclusions

The results of the investigation indicate that, geologically, there is little difference between Upper and Lower Ogilvie dam sites. From the information presently available neither site is believed to be satisfactory. However, if laboratory tests indicate the schist is a competent rock the Upper site is probably the better. The fault and open joint planes present there can be grouted to prevent excessive leakage.

It is suggested consideration be given to a third site located immediately above the mouth of Sixty Mile River. Bedrock here consists of schist and gneiss as at Upper and Lower Ogilvie sites. The relative proportion of gneiss present, however, is considerably greater. Bedrock structures such as faulting and jointing are not excessive and the attitudes of the foliation would not adversely effect the foundations of the dam structures.

Chemical Analyses of Yukon River Water

On July 7, 1960, a sample of Yukon River water was taken at a point about 1 mile upstream from the mouth of White River. The sample was analysed for its 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 Britannia dam site (Topical Report No. 19, Site No. 12).

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. 23 was computed in the field using a Soiltest Permeameter, model K-620.

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

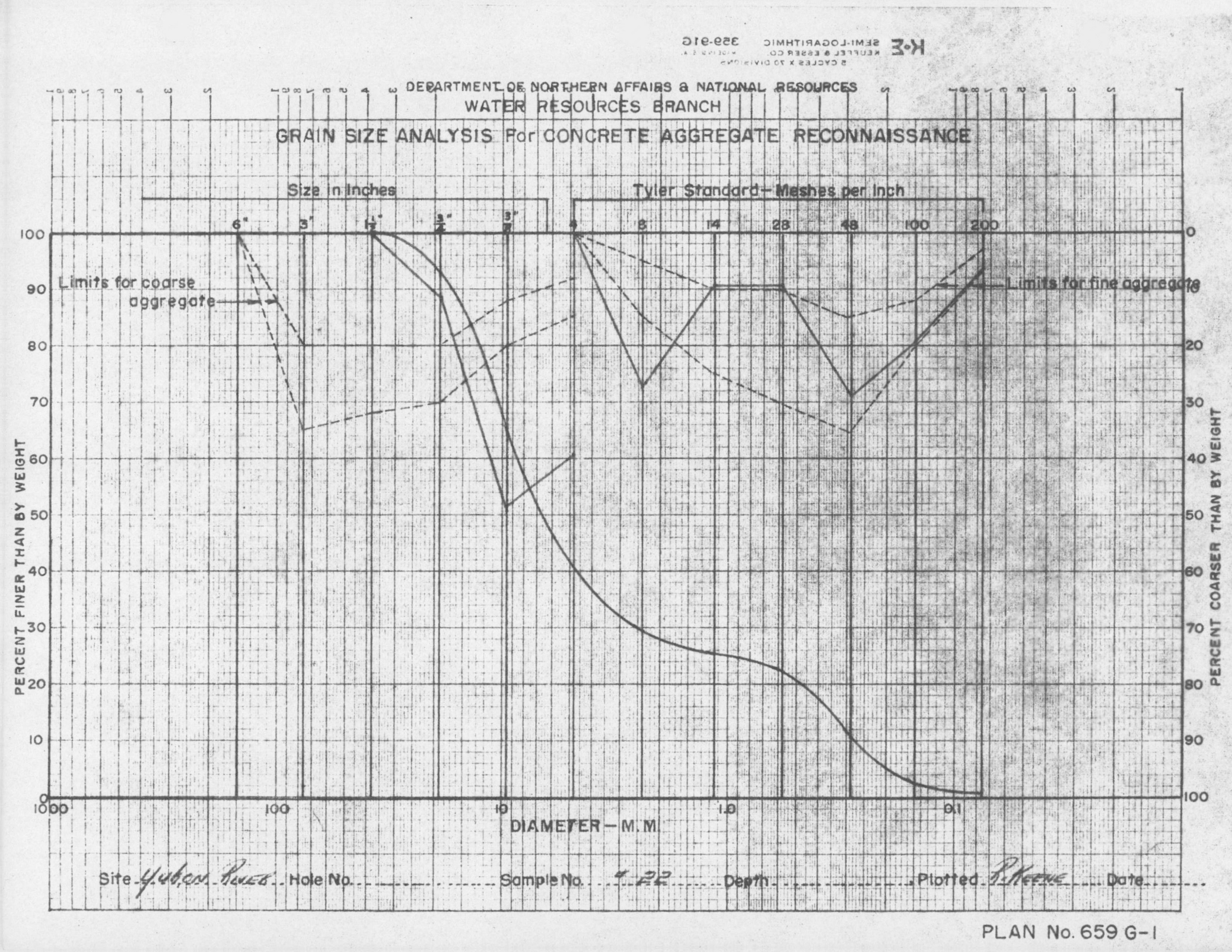
(a) Limits of fine and coarse aggregate based upon a 6-inch, maximum size.

(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. One sample (No. 23) was analysed as potential impervious material; the remainder as potential aggregate.

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
22	On centre line; 500 feet east of hub No. 3; 30 inches below ground surface	Fine-grained, sandy gravel; pebbles up to 2 inches, average $\frac{3}{4}$ inch	none	10-12+feet	1,500 feet wide, 3,000 feet long	On island; water table at 5 feet
24	On terrace; 4 miles east of Yukon River; 2,000 feet north and 400 feet above Rosebute Creek	Sandy gravel; cobbles up to 8 inches; considerable weathering	18 inches of silt	50+feet	large	Material mapped as Tertiary and Modern Deposits

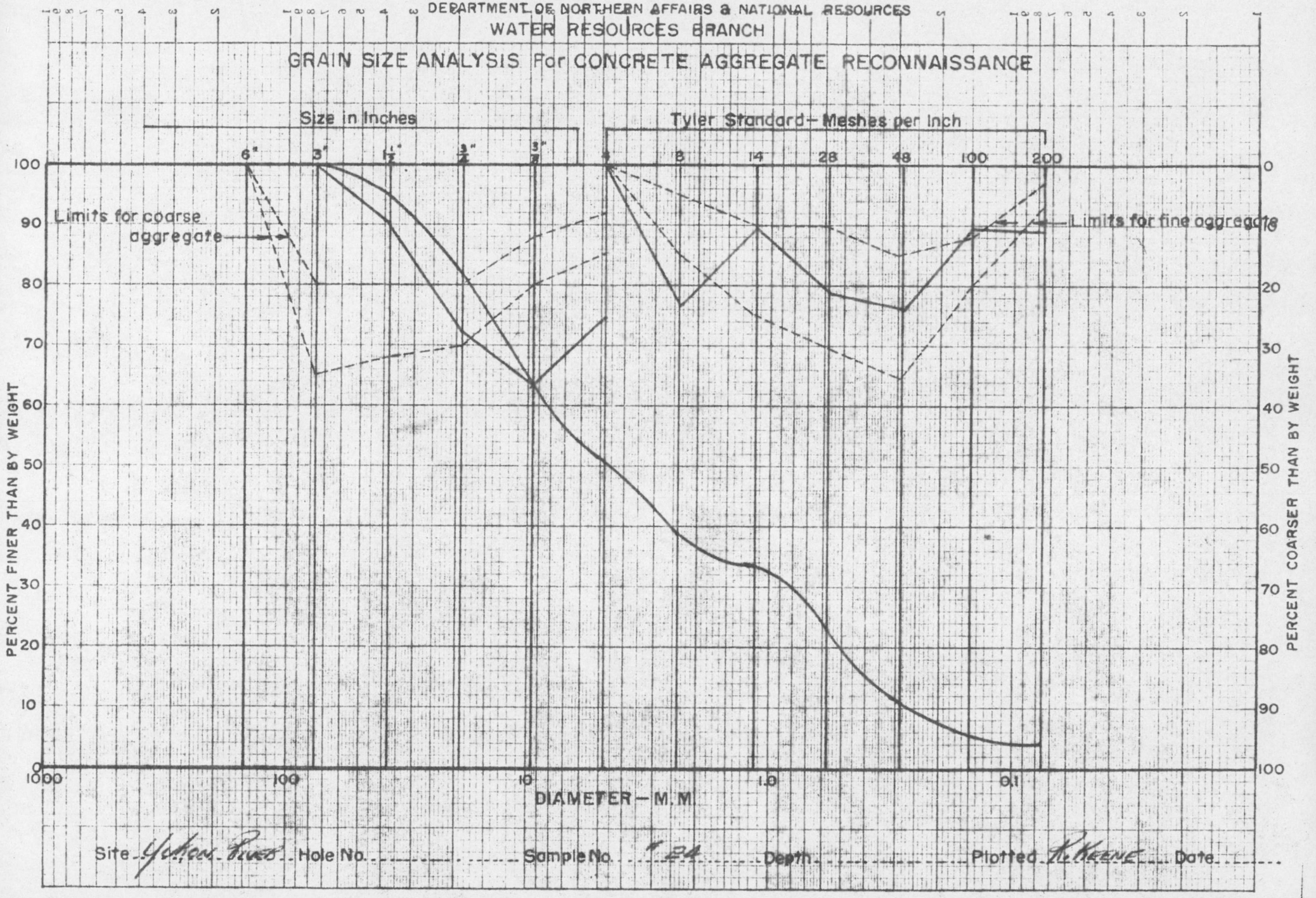


PLAN No. 659 G-1

DEPARTMENT OF NORTHERN AFFAIRS & NATIONAL RESOURCES

WATER RESOURCES BRANCH

GRAIN SIZE ANALYSIS For CONCRETE AGGREGATE RECONNAISSANCE



Site Yukon River Hole No. Sample No. 24 Depth Plotted R. KEENE Date

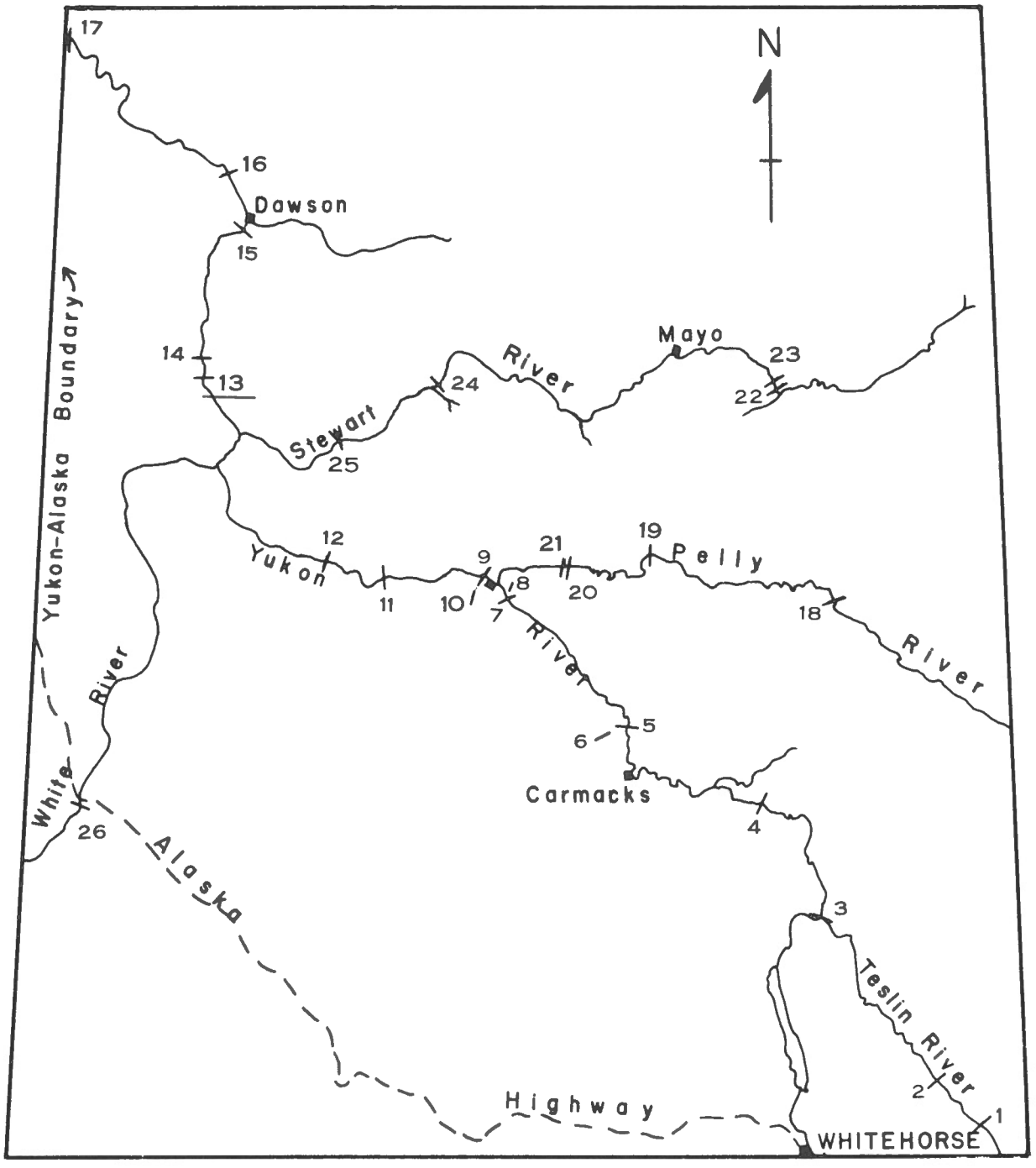
PLAN No. 659 G-1

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

Sample Number	Location	Field Description of Material	Field Description of Overburden	Thickness of Deposit	Areal Extent (Estimated)	Permeability* (cm./sec.)
23	On centre line; 250 feet east of hub No. 3; 40 inches below ground surface	Fine-grained, brown, alluvial, silty sand; some organic matter	None	1-5+ feet	1,200 feet wide, 1,500 feet long	10^{-6}

* Permeability computed in the field using a Soiltest Permeameter, Model K-620

DEPARTMENT OF NORTHERN AFFAIRS & NATIONAL RESOURCES
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 #23
Depth
Plotted R. KEENE
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		