No. 5

CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

TOPICAL REPORT NO. 23

YUKON RIVER DRAINAGE BASIN

DAM SITE INVESTIGATION

SITE NO. 16

LOWER DAWSON DAM SITE

(MAP AND PRELIMINARY REPORT)

BY

E. B. OWEN

OTTAWA

1960

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Contents

Illustrations

Lower Dawson Dam Site

General Description

Lower Dawson dam site is located on Yukon River about 9 miles downstream from the town of Dawson. An alternate site, designated Upper Dawson, is situated about 10 miles upstream from the Lower site, immediately above the mouth of Klondike River. The Upper Dawson site is described in Topical Report No. 22, site No. 15. The elevation of the water surface at Upper Dawson site is about 25 feet higher than at Lower Dawson site.

At Lower Dawson site Yukon River is flowing in a northwest direction along the northeast side of a valley some 2,400 feet in width. Along the right (northeast) side of the River a steep, rock bluff rises to a height greater than 1,500 feet above the River. The right abutment of the proposed dam would be located in this bluff.

On the left side a gently sloping terrace extends southwest for a distance of about 900 feet to the toe of a fairly steep bluff which forms the left abutment of the power house. Bedrock is not exposed on the left side except for one small outcrop located at the edge of the water. Overburden consists of silty sand overlying sandy gravel on the terrace and residual soil on the abutment slope. The talus on the right abutment consists chiefly of relatively small fragments of weathered schist.

Information from 2 seismic lines located southwest of the River indicates the elevation of bedrock surface decreases toward the River. On the left abutment the elevation of bedrock surface varies between 1,149 and 1,153 feet above sea level (seismic line No. 2) and close to the River it varies from 971 to 982 feet (seismic line No. 1). There is neither

topographic nor geologic evidence to suggest the existence of a former course of Yukon River in the area. It is believed the River was flowing in its present channel prior to the last glaciation, consequently, a relatively deep channel eroded into bedrock could exist beneath the present River. Lower Dawson dam site is believed to be outside the limit of the last glaciation[1].

There is a lack of overburden suitable for construction purposes in the site area. Frozen ground was encountered in several places southwest of the River but was not observed on the right side. It is believed to exist beneath the entire area mapped.

Unconsolidated Deposits

Five types of unconsolidated deposits have been identified in the area about Lower Dawson dam site. These are as follows:

1. Recent Alluvium: This material varies from a soft, silty sand to a coarse-grained gravel containing boulders up to 12 inches in diameter. It is a relatively unimportant deposit occurring along both sides of the River below elevation 1,036.

2. Alluvium (silty sand): This is a compact, silty sand which covers much of the area southwest of the River. It was usually frozen when encountered and consequently little information was obtained concerning its thickness or the quality of the underlying material. However, in test pits put down in the bottoms of the shot holes along seismic line No. 2, thicknesses as great as 7 feet were found to overlie sandy gravel.

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

3. Alluvium (sandy gravel): This material is exposed in two small areas southwest of the River. It is a loose, sandy gravel with cobbles up to 6 inches in diameter. Most cobbles are rounded to semi-rounded and consist of quartz, quartz porphyry and quartzite with a few small, weathered, schist fragments. Gravel was encountered beneath unfrozen silty sand in a few test pits dug on the terrace southwest of the River. It is suggested test borings be put down in this area to investigate the extent and permeability of the material.

4. Talus: Talus is spalled material derived from bedrock exposed along bluffs. At Lower Dawson site it occurs only on the right abutment slope as a shallow deposit consisting of small fragments of weathered micaceous schist with a few small boulders of quartz.

5. Residual Soil: The residual soils, which have been derived by weathering from the underlying bedrock, occur extensively on ground surface in the southwest part of the map-area. Considerable quantities are also mixed with the fine talus on the right abutment slope. The material consists of silt and fine sand in which are scattered numerous angular, weathered fragments of schist up to 2 inches in diameter. In areas where ground surface is level the residual soil is believed to have been derived directly from the underlying bedrock. On the left abutment slope, however, the residual soil has accumulated in the lower part due to an imperceptible downslope movement or creep.

Bedrock

General Description

Except for one small outcrop on the left edge of the River, bedrock at Lower Dawson site is exposed only on the right abutment slope. It consists chiefly of a soft, grey, highly weathered, sericite schist with lesser

amounts of greenish, chlorite schist. A few beds of grey quartzite, too small to be shown on the accompanying geological map, are interbedded with the schist. Small, irregular veins of white quartz intruding both schist and quartzite are common. In places the rock is discoloured brown due to a thin coating of iron oxides. It is believed bedrock exposed at Lower Dawson site consists of altered, sedimentary rocks described by McConnell[1] as the Nasina series.

Bedrock Structures

There are two planes of schistosity traversing bedrock in the area about the proposed dam site. The most prominent plane strikes approximately 30 degrees east of north and dips 20 degrees southeast. This plane intersects the centre line at 20 degrees and dips upstream. The other plane is nearly at right angles to the first. It strikes about 25 degrees east of south and dips 75 degrees northeast. This plane intersects the centre line at about 25 degrees and also dips upstream. The schistosity is parallel to the interbedded quartzite. Local deformations, due to minor folding, are indicated on the accompanying geological map by strikes at variance with the general trend of the strata.

Minor jointing is common and has doubtless aided the processes of weathering. The most prominent joint set intersects the proposed centre line at about 25 degrees and dips steeply upstream. A second set, which is vertical, intersects the centre line at about 45 degrees. There is no visible evidence of major faulting at Lower Dawson site. However, geological investigations, conducted in 1960 by Klondike Lode Gold Mines Limited, indicate a fault may underlie the valleys of Eldorado and Bonanza Creeks. It is

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[1] McConnell, R.G.: "Report on the Klondike Gold Fields, Geol. Surv., Canada, Annual Rept., Vol. 15, 1901, pt. B, p. 12.

possible any large fault existing beneath these valleys may extend downstream along Yukon River to the site area.

Quality of Bedrock

The schist, which constitutes most of the rock exposed at the site, 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 be thoroughly investigated regarding its shear strength and durability before a decision is reached as to its competency. The presence of considerable jointing suggests weathering may have deeply penetrated the rock.

Engineering Considerations

Depth of Overburden

Overburden on the right abutment slope consists of a mixture of talus and residual soil. The greater part of the material is talus; consequently, it has been mapped as such. The thickness of overburden is believed to be less than 10 feet throughout the entire abutment area. The results of seismic lines Nos. 1 and 2 indicate the thickness of overburden beneath the terrace southwest of the River increases from 12 and 16 feet at the toe of the bluff forming the left abutment to 33 and 39 feet along the left side of the River. These figures are believed to be reasonably accurate.

The presence of frozen ground in the left abutment limited the depths of the test pits in this area to about 18 inches. The thickness of overburden here is probably not greater than 5 feet.

The thickness of overburden beneath Yukon River at the site is unknown.

Abutments and Foundations

The schist, which constitutes the greater part of bedrock exposed at Lower Dawson site, is a soft, easily weathered rock. The presence of numerous joints suggests the schist may be deeply weathered and consequently it is believed considerable rock will have to be removed before fresh, solid material, against which concrete or dyke material can be placed, will be obtained. Test borings should be put down to investigate the quality of the rock and also the extent of the weathering. The upstream dip of the two principal planes of schistosity is favourable for construction of a dam. It is possible a large, vertical fault, striking parallel to the River, exists in bedrock between the abutments. The presence of such a fault could best be investigated by drilling bore holes at an angle of about 60 degrees in a direction parallel to the proposed centre line.

Construction Materials

Aggregate

It is assumed large quantities of aggregate will be required for the proposed spillway, powerhouse and gravity dam. The extent of the sandy gravel occurring beneath the silty sand on the terrace southwest of the River is unknown. Test pits should be put down in this area to investigate the quantity and quality of gravel available.

Grain size analyses curves for representative samples from 6 potential sources of natural aggregate are included at the end of this report. Large quantities of gravel exist in several terraces along both sides of Yukon River downstream from the site. The chief disadvantage of these deposits is that they are inaccessible except by River.

Gravel deposits, which are more accessible, occur upstream from the site along both Yukon and Klondike Rivers in the vicinity of the town of Dawson. An unused road, once utilized for hauling timber, exists between Dawson and a point about two and one half miles east of the site. This road could be easily extended to the right abutment area. Northeast of Fort Reliance the road traverses a broad, level terrace the elevation of which is about 485 feet higher than Yukon River. Overburden on the terrace consists of a thin layer of silt overlying sandy gravel. The quantity of gravel available is considerable. About 9 feet of the material is exposed along the top of the steep bluff below the terrace but its thickness is probably much greater near the centre of the terrace. The gravel is more weathered and contains a higher percentage of chert pebbles than that on the lower Terraces downstream from the site.

Large quantities of gravel are exposed in many of the former placer operations along Klondike River, Bonanza Creek and other creeks southeast of Dawson. These deposits are readily accessible from Dawson. They are described in the report on Upper Dawson site (Topical Report No. 22, site No. 15).

Impervious Material

It is assumed only limited quantities of impervious material would be required at Lower Dawson site. The fine-grained, silty sand which overlies much of the terrace southwest of the River at the site is a potential source of impervious material. It is believed, however, this deposit is thin and does not exist in useful quantities.

A similar silt covers much of ground surface on the terraces along Yukon River both upstream and downstream from the site. The thickness is variable and in some places there may be sufficient quantities available

that it could be used for construction purposes. Such a deposit occurs along the left bank of Yukon River about 6 miles downstream from Fifteen Mile River. Here a 20-foot bluff of fine-grained, silty sand extends along Yukon River for a distance of 1,000 feet.

Pervious Material

Any pervious material required at the Lower Dawson site for filters or drains 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.

Riprap and Rock Fill

Bedrock exposed at Lower Dawson site is a soft, highly weathered schist which will probably not provide suitable riprap or rock fill. Durability tests should be conducted on fresh, representative samples of this rock. Bedrock occurring in the right abutment at the Upper Dawson site would probably yield more satisfactory material.

Ground Water

There is little information regarding ground-water conditions in the area about the proposed dam site. Seepages of ground water were not observed on the steep, right abutment slope. Water was not encountered in any of the numerous test pits put down to depths up to 5 feet in the southwest part of the area mapped. Accurate information regarding the ground-water table can best be obtained by installing ground-water, observation holes. The presence of frozen ground at the site would considerably increase the cost of such a program.

Frozen Ground

Frozen ground was encountered in most test pits put down southwest of the River; both on the terrace and on the left abutment slope. It usually occurred beneath an insulating layer of moss or decayed vegetation and varied in depth from 12 to 30 inches beneath ground surface (August 12, 1960). There is no visible evidence of frozen ground in the right abutment area. It is believed, however, to exist beneath the entire site area.

Further Investigations

It should be remembered the present geological investigation of the proposed Lower Dawson 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 the following test borings along the proposed centre line are suggested as part of the program:

Hole Number	Location
1	Gravity dam; left abutment; 800 feet southeast of left side of River
2	Powerhouse structure; 400 feet southeast of left side of River
3	Powerhouse structure; left side of River
4	Powerhouse structure; 400 feet northwest of left side of River

Hole Number	Location
5	Powerhouse structure; 800 feet northwest of left side of River
6	Spillway structure; 420 feet southeast of right side of River
7	Gravity dam; right abutment; right side of River
8	Gravity dam; right abutment; 100 feet northwest of right side of River

It is recommended all test borings be put down to elevation 920 and if bedrock is not encountered at that depth the borings be continued downward until 15 feet of rock has been penetrated. Soil samples should be taken at 5-foot intervals or where a change in material occurs. Permeability tests should be conducted and the elevation of the ground-water table and frost table noted. Borings should be vertical unless during the drilling program there is an indication of vertical fractures which could be caused by faulting or open jointing; in which case angle holes should be drilled.

Comparison between Upper Dawson and Lower Dawson Dam Sites

Lower Dawson site is an alternative to Upper Dawson site. A comparison between the two sites is included in the report on Upper Dawson site (Topical Report No. 22, Site No. 15).

Chemical Analyses of Yukon and Klondike River Waters

Chemical analyses of the water from the Yukon and Klondike Rivers are included in the report on Upper Dawson 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. Each grain size sheet for potential aggregate shows the following information:

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

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

(c) Curves showing the 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.

Two samples (Nos. 38 and 40) were analysed as potential, impervious material; the remainder as potential aggregate.

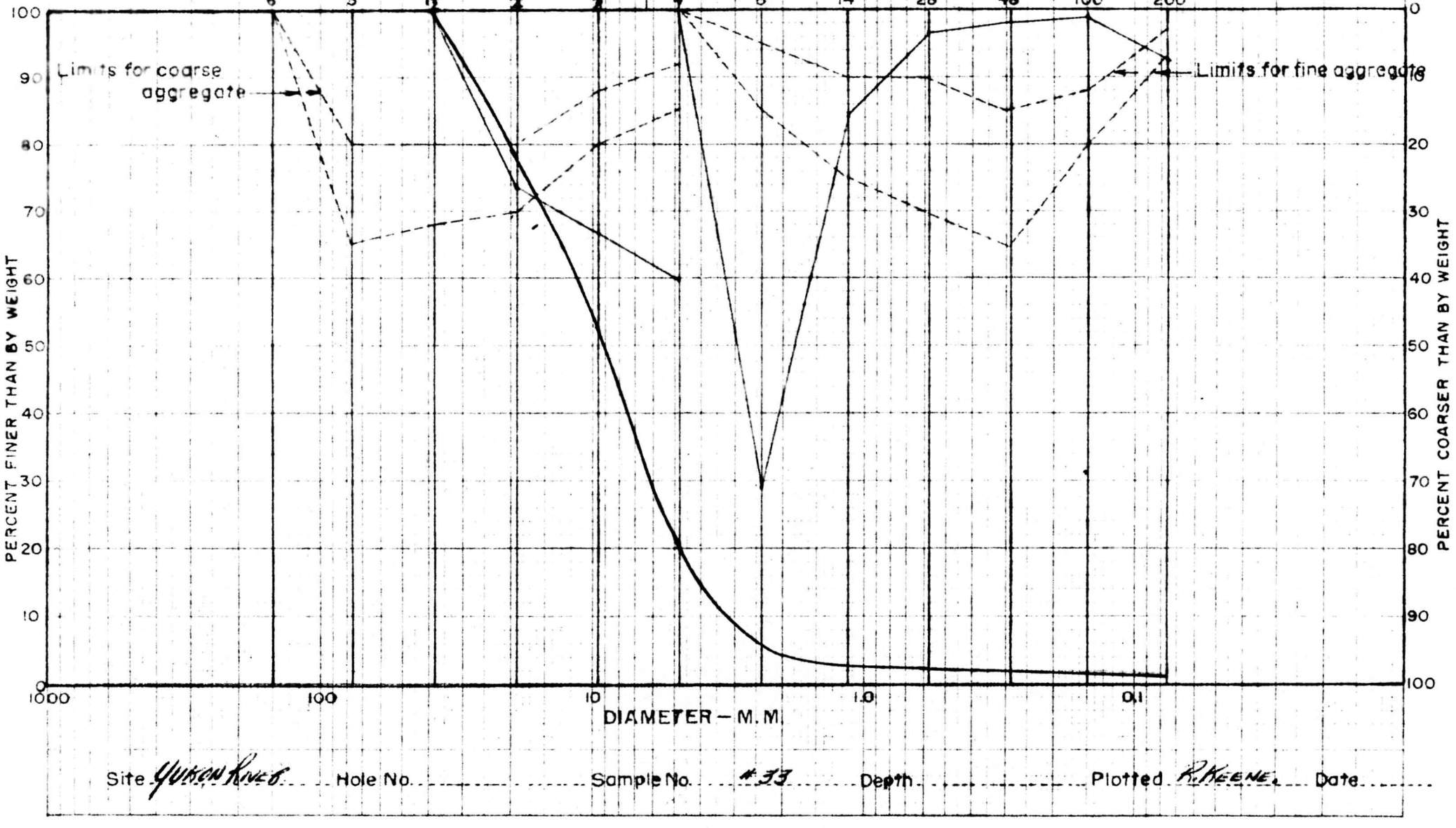
Description of Potential Aggregate for the following Grain Size Analyses Curves

Sample Number	Location	Field Description of Material	Field Description of Overburden	Thickness of Deposit	Areal Extent (Estimated)	Remarks
33	On terrace; left side of Yukon River; 13 miles downstream from site; opposite mouth of Fifteen mile River; 3 feet below ground surface	Medium-grained gravel; numerous rounded pebbles of quartz and quartzite from 1/8 to 3 inches in diameter; a few partially weathered granitic boulders 12 inches in diameter.	None	60 feet	100 feet wide, 2 miles long	Accessible by River only
34	North side of Quebec Creek; 3,700 feet west of Yukon River; 35 feet below terrace which is about 475 feet above Yukon River; 3 feet below ground surface	Well graded, sandy gravel; rounded cobbles of quartzite, quartz and some schist up to 6 inches in diameter; silt content small	2 to 3 feet of silt	50 feet	250 feet wide, 1,200 feet long	Excellent prospect; easily accessible up Quebec Creek valley

DEPARTMENT OF NORTHERN AFFAIRS & NATIONAL RESOURCES

WATER RESOURCES BRANCH

GRAIN SIZE ANALYSIS For CONCRETE AGGREGATE RECONNAISSANCE



Site Yukon River Hole No. Sample No. #33 Depth Plotted R. KEENE Date

PLAN No. 659 G-1

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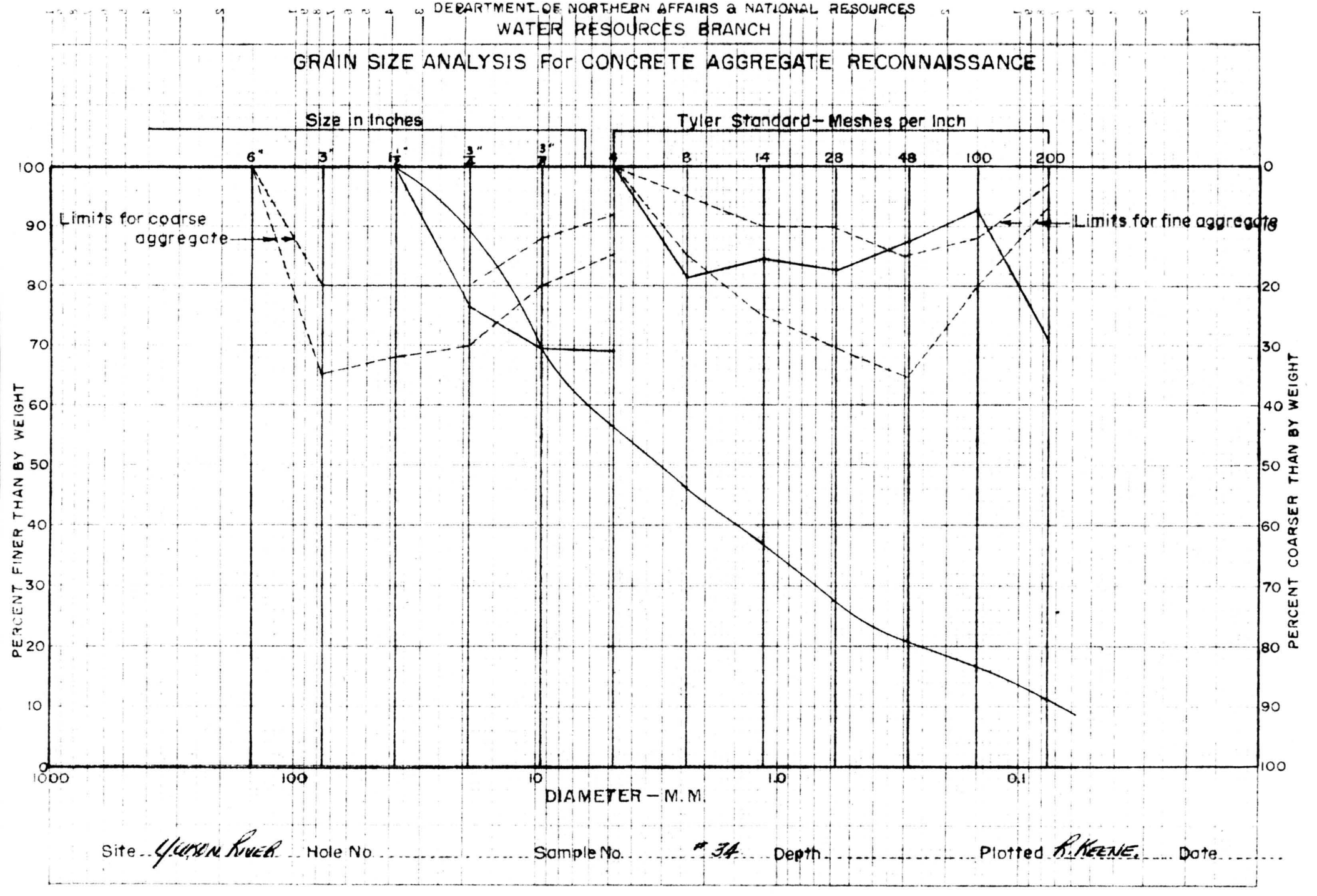
GRAIN SIZE ANALYSIS For CONCRETE AGGREGATE RECONNAISSANCE



Site Yukon River Hole No. Sample No. # 34 Depth Plotted R. Keene Date

PLAN No. 659 G-1

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
35	Bluff below terrace on right side of Yukon River; 2 miles below mouth of Chandindu River; 10 miles below site; 15 feet below terrace; 4 feet below ground surface	Sandy gravel; many rounded pebbles of granite, quartzite, basalt and some schist less than 2 inches in diameter; a few weathered granite boulders up to 12 inches in diameter.	8 to 15 feet of silty sand covers the terrace	20 feet	50 feet wide; 2 miles long	Accessible by River only
36	Bluff below terrace on left bank of Yukon River; 7 miles downstream from site; 12 feet below terrace; 2 feet below ground surface	Well stratified sand and sandy gravel; average thickness of beds is 8 inches; many rounded pebbles of quartzite, quartz and basalt less than 2 inches in diameter; a few weathered granite boulders up to 10 inches in diameter	10 feet of fine-grained sand	20 feet	50 feet wide; 1,000 feet long	Accessible by River only

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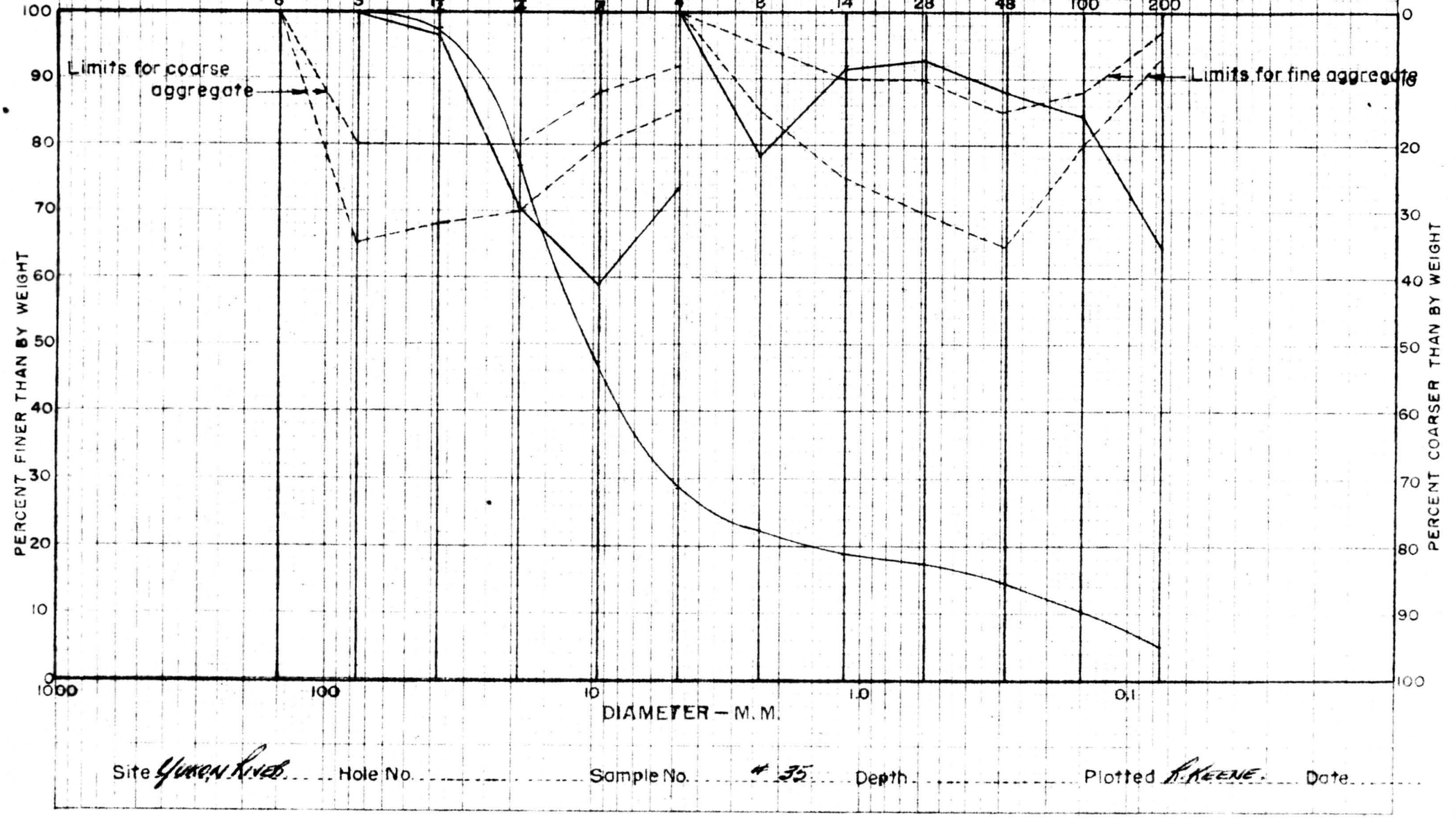
WATER RESOURCES BRANCH

GRAIN SIZE ANALYSIS For CONCRETE AGGREGATE RECONNAISSANCE



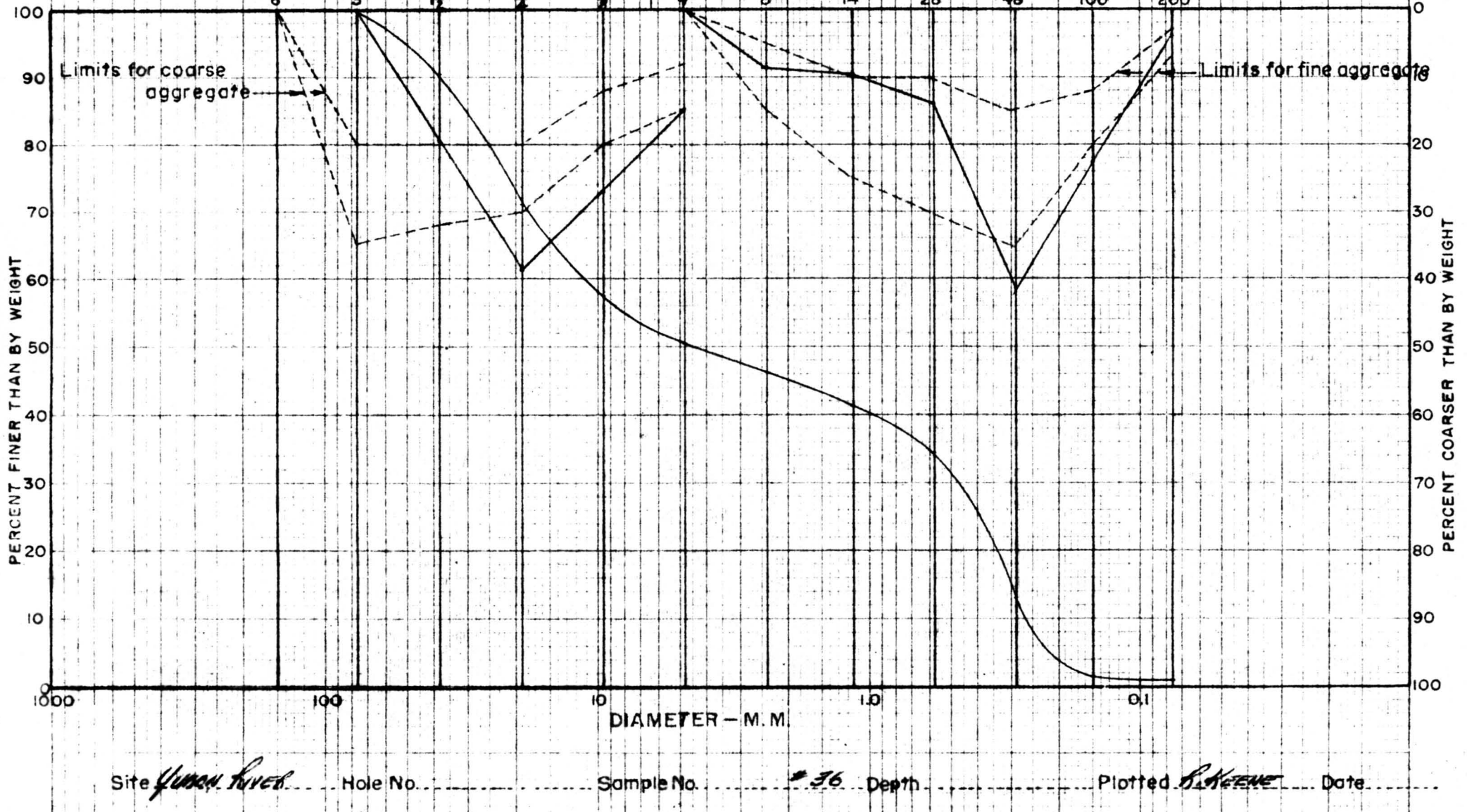
Site Yukon River Hole No. Sample No. # 35 Depth Plotted K. KEENE Date

PLAN No. 659 G-1

DEPARTMENT OF NORTHERN AFFAIRS & NATIONAL RESOURCES

WATER RESOURCES BRANCH

GRAIN SIZE ANALYSIS For CONCRETE AGGREGATE RECONNAISSANCE

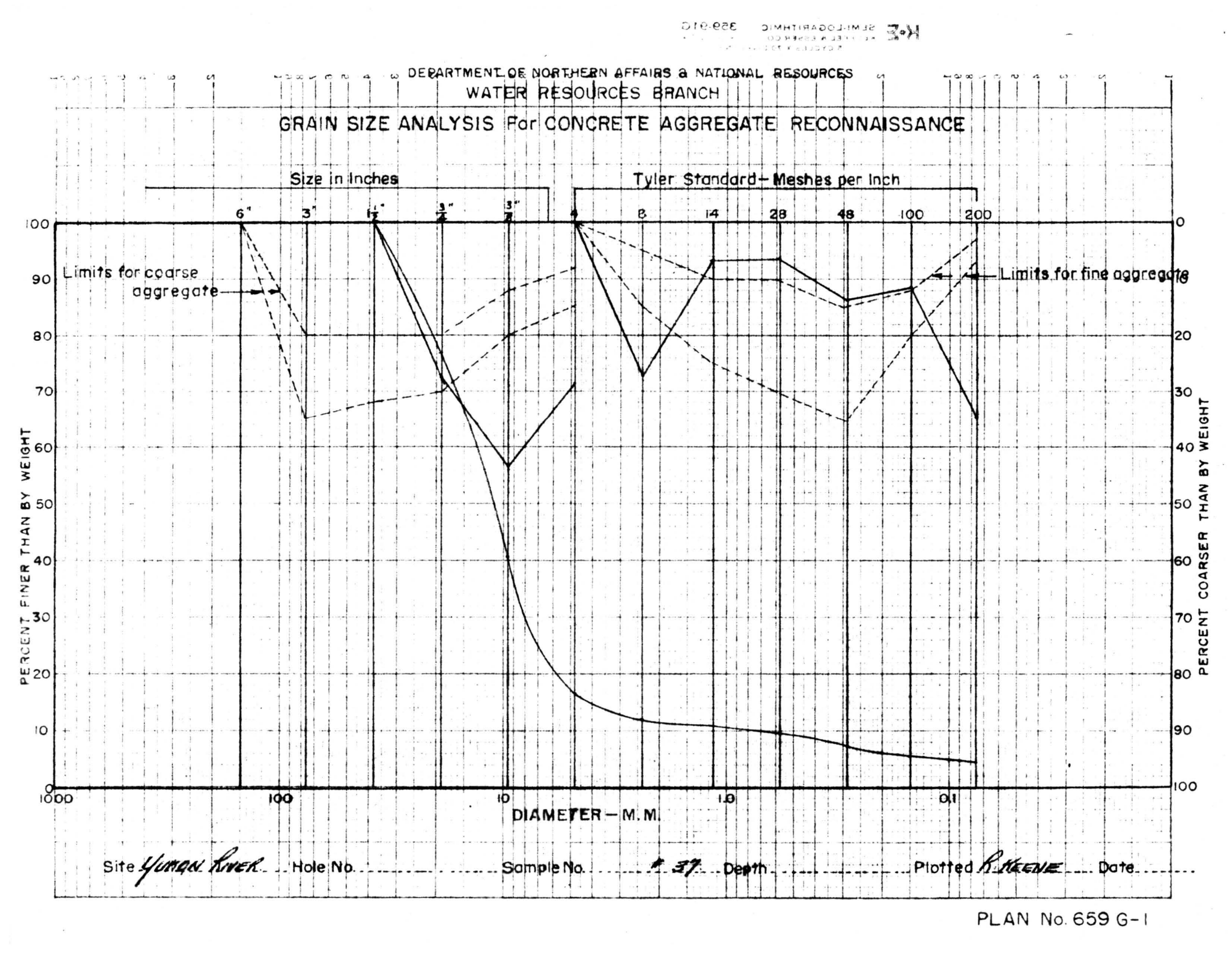


Site Yukon River Hole No. Sample No. #36 Depth Plotted G.A.K.E.M.E. Date

PLAN No. 659 G-1

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
37	Bluff below Terrace on right side of Yukon River; $2\frac{1}{2}$ miles down-stream from site; 20 feet below terrace; 3 feet below ground surface	Fine- to medium-grained gravel; some sand; many rounded pebbles of quartzite, quartz and granite less than $2\frac{1}{2}$ inches in diameter; very little weathering; no visible boulders.	12 inches of silt	60 feet	50 feet wide; 2 miles long	This may be a bedrock terrace with only a thin veneer of gravel; accessible by River only
39	Bluff below terrace on right side of Yukon River; 4 miles up-stream from site; $\frac{3}{4}$ mile below mouth of Fourth Creek; 25 feet below terrace; 3 feet below ground surface	Sandy gravel; many subrounded quartz and basalt pebbles and cobbles; a few chert pebbles; boulders are not common; very little weathering	15 feet of sandy silt	25 feet	50 feet wide; $\frac{3}{4}$ mile long	Possibly accessible from Fort Reliance


DEPARTMENT OF NORTHERN AFFAIRS & NATIONAL RESOURCES
WATER RESOURCES BRANCH
GRAIN SIZE ANALYSIS For CONCRETE AGGREGATE RECONNAISSANCE
Size in Inches
Tyler Standard – Meshes per Inch
6"
3"
1½"
¾"
⅜"
4
8
14
28
48
100
200
Limits for coarse aggregate
Limits for fine aggregate
PERCENT FINER THAN BY WEIGHT
PERCENT COARSER THAN BY WEIGHT
100
90
80
70
60
50
40
30
20
10
0
1000
100
10
1.0
0.1
DIAMETER – M.M.
Site Yukon River
Hole No.
Sample No. # 37
Depth
Plotted R. KEENE
Date
PLAN No. 659 G-1

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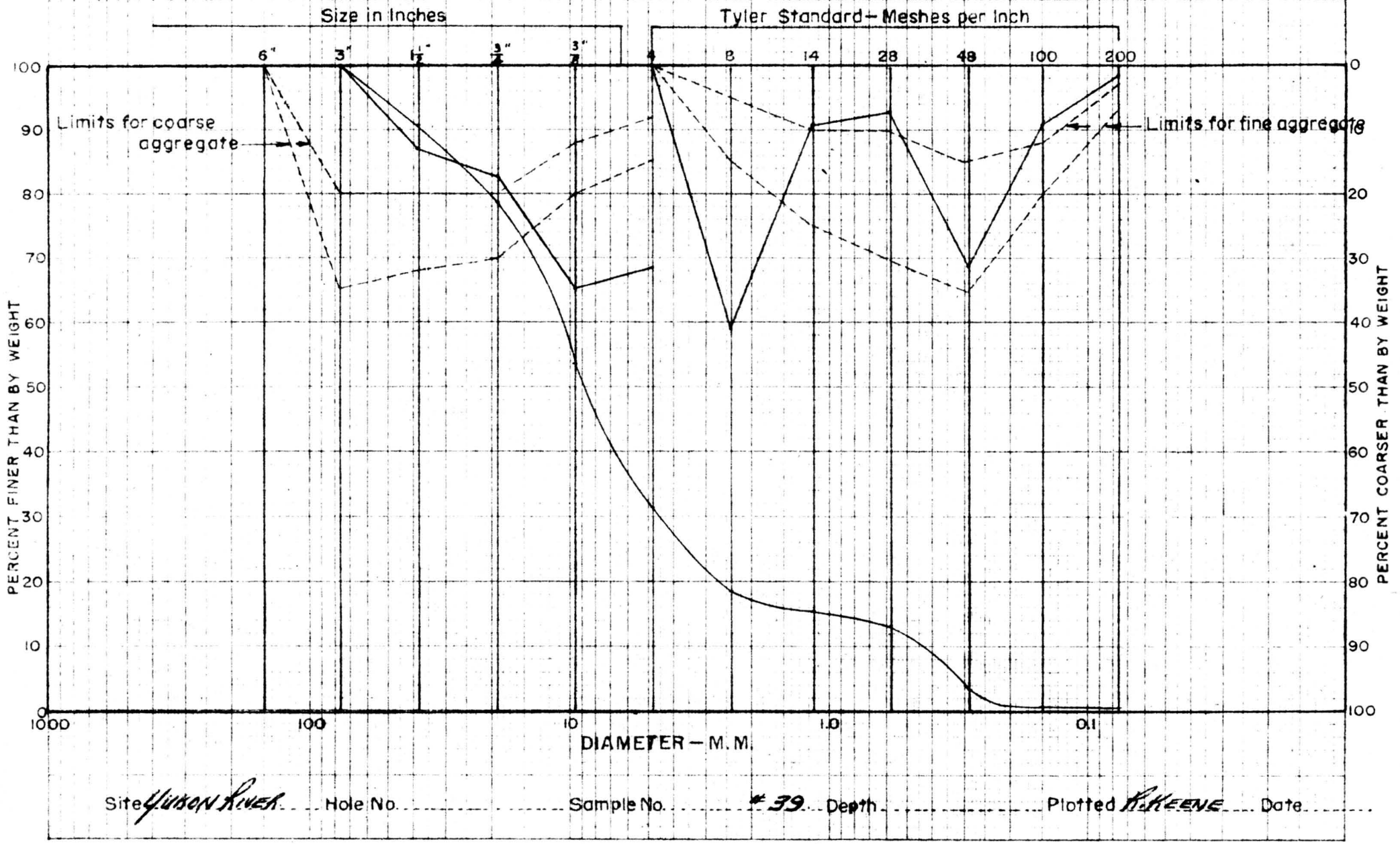
GRAIN SIZE ANALYSIS For CONCRETE AGGREGATE RECONNAISSANCE

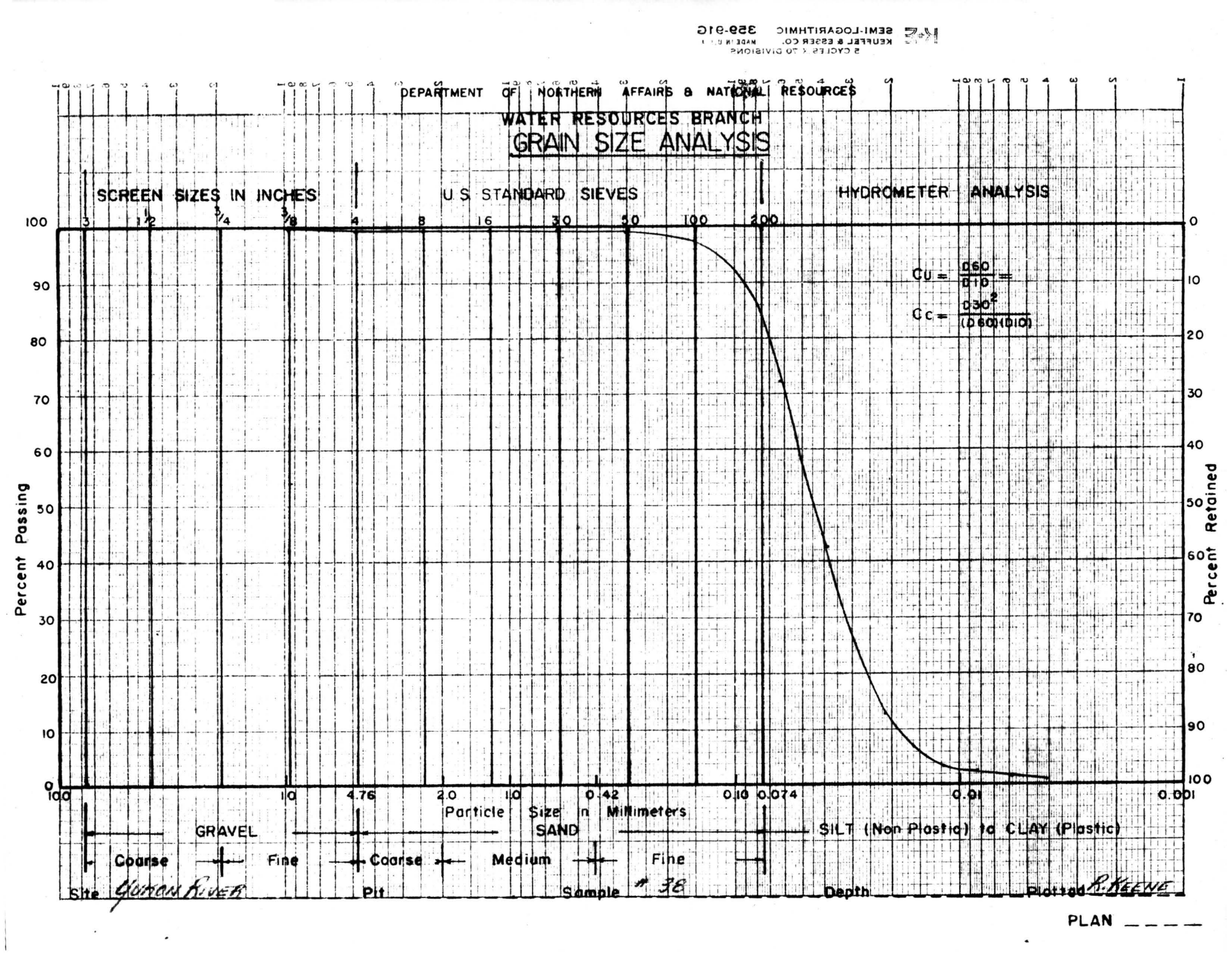


Site Gibson River Hole No. Sample No. #39 Depth Plotted R. KEENE Date

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)	Remarks
38	15 feet directly above sample No. 39	Brown, sandy silt; only slight dry strength.	None	15 feet	50 feet wide; $\frac{3}{4}$ mile long	Possibly accessible from Fort Reliance
40	Bluff below terrace on left side of Yukon River; $3\frac{1}{2}$ miles upstream from site; 15 feet below terrace; 3 feet below ground surface.	Yellow, silty sand; deposit is 10 feet in thickness and lies between 10-foot beds of medium-grained sand.	10 feet of medium-grained sand	10 feet	50 feet wide; $\frac{1}{2}$ mile long	Accessible by River only; would be difficult to excavate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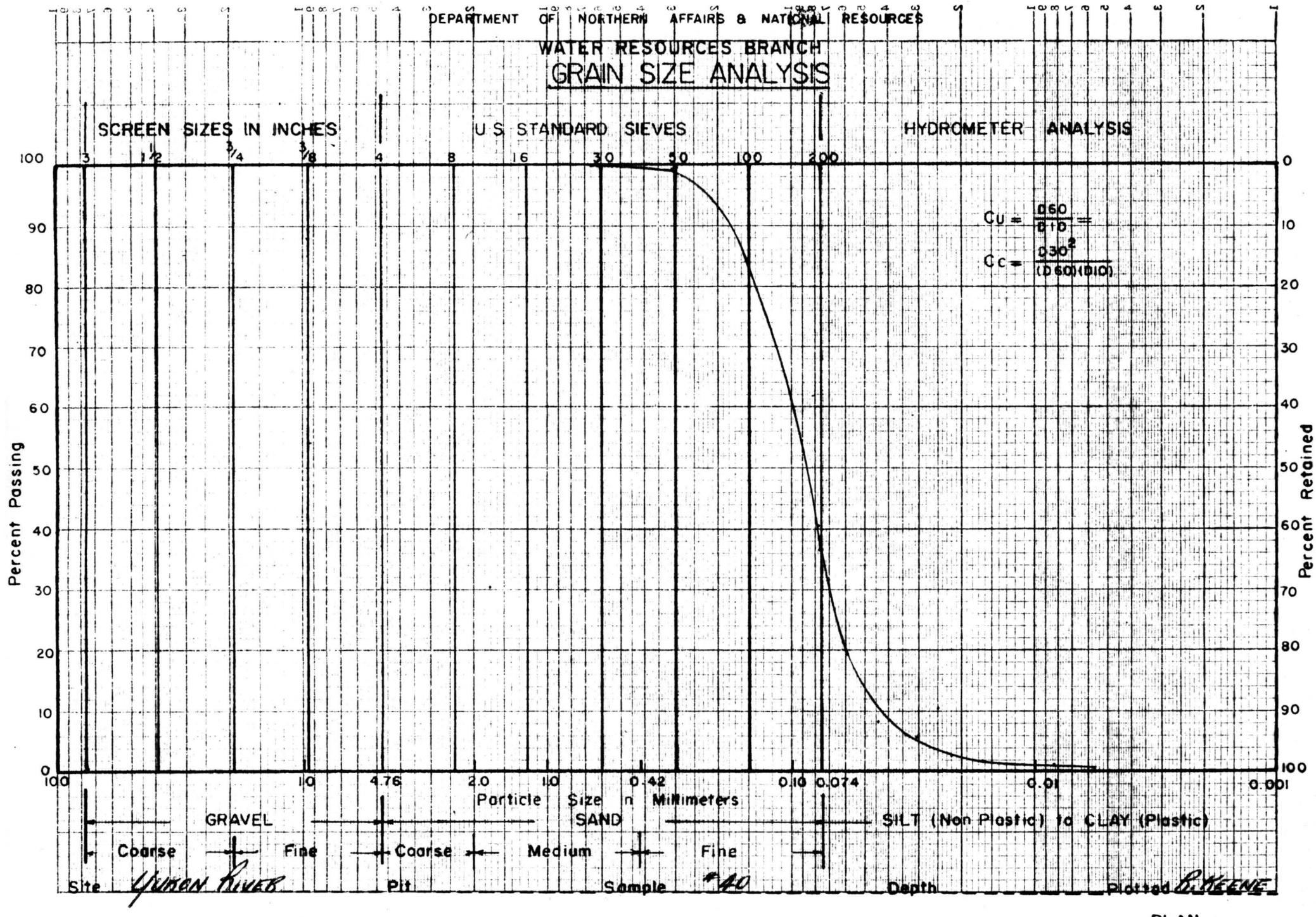
WATER RESOURCES BRANCH
GRAIN SIZE ANALYSIS
SCREEN SIZES IN INCHES
U S STANDARD SIEVES
HYDROMETER ANALYSIS
3
1 1/2
3/4
3/8
4
8
16
30
50
100
200
Cu = D60/D10 =
Cc = D30²/(D60)(D10)
Percent Passing
Percent Retained
100
90
80
70
60
50
40
30
20
10
0
100
10
4.76
2.0
1.0
0.42
0.10
0.074
0.01
0.001
Particle Size in Millimeters
GRAVEL
SAND
SILT (Non Plastic) to CLAY (Plastic)
Coarse
Fine
Coarse
Medium
Fine
Site Gloman River
Pit
Sample # 38
Depth
Plotted R. KEENE
PLAN

DEPARTMENT OF NORTHERN AFFAIRS & NATIONAL RESOURCES

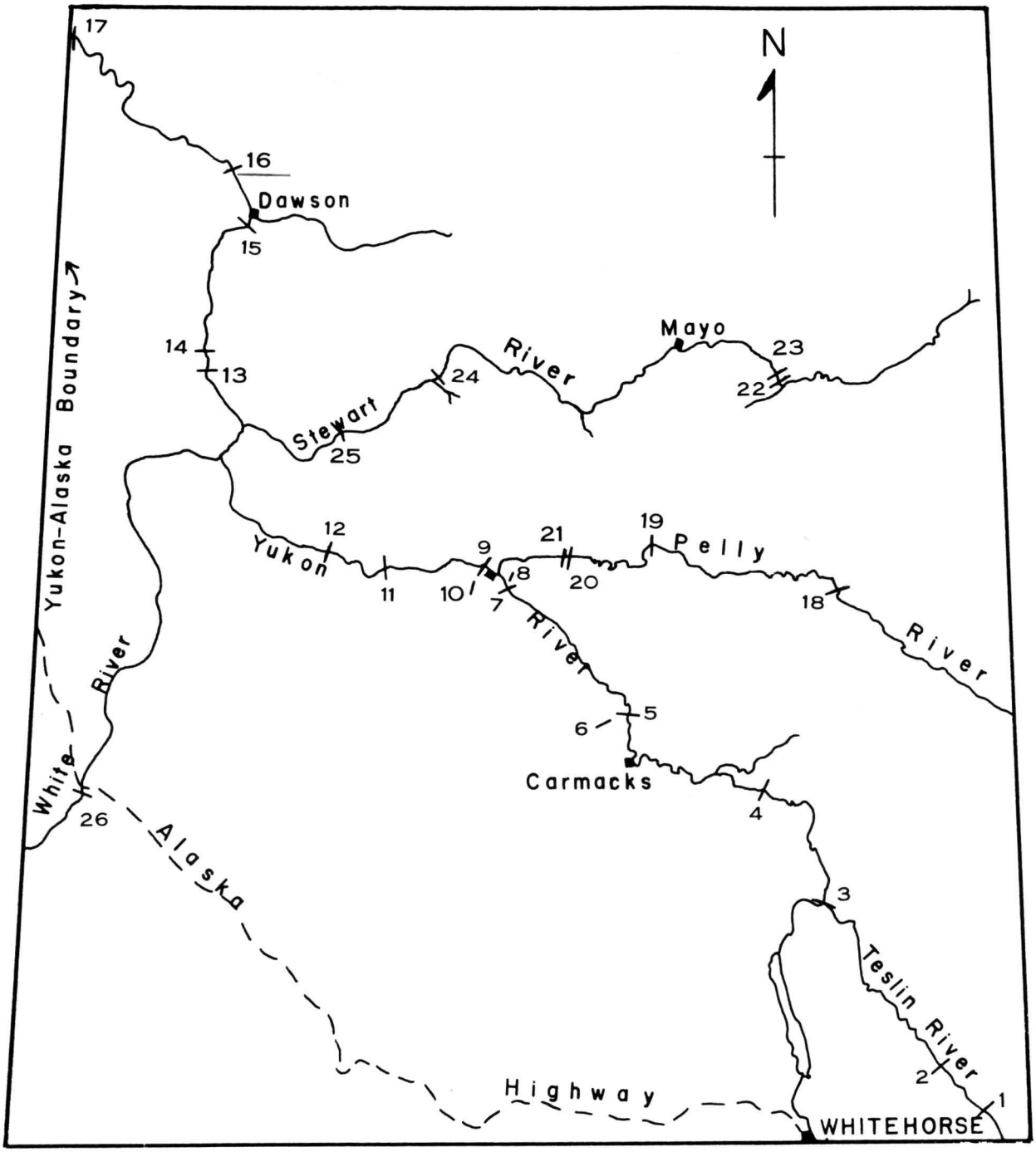
WATER RESOURCES BRANCH

GRAIN SIZE ANALYSIS



Site Yukon River Pit Sample #40 Depth Plotted S. KEENE

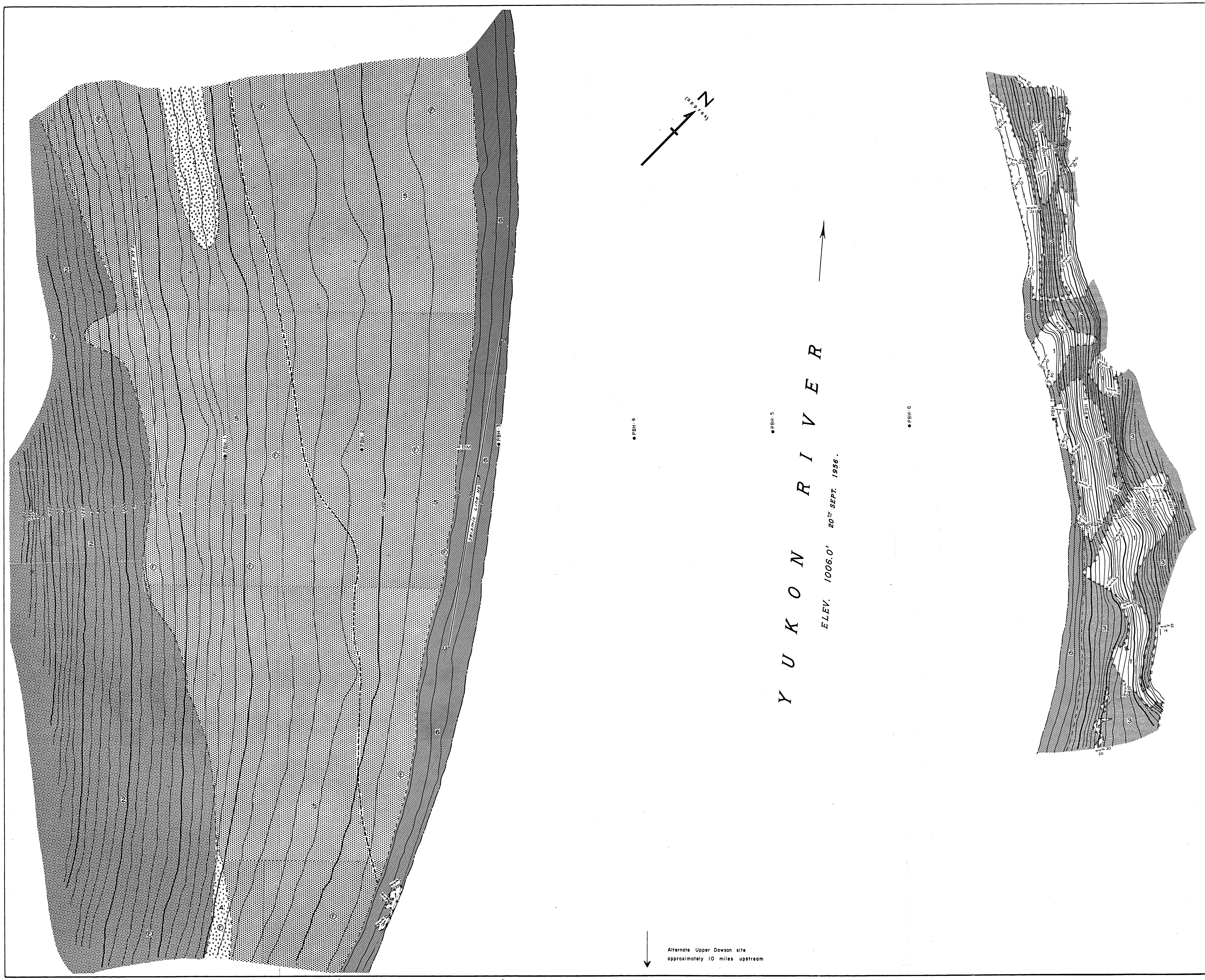
PLAN ____



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		

GEOLOGICAL SURVEY OF CANADA
DEPARTMENT OF MINES AND TECHNICAL SURVEYS



LEGEND

CENOZOIC

QUATERNARY

- 6 — ALLUVIUM: silt, sand, gravel boulders up to 12 inches
- 5 — ALLUVIUM: fine-grained, silty sand
- 4 — ALLUVIUM: sandy gravel
- 3 — TALUS
- 2 — RESIDUAL SOIL

PRECAMBRIAN AND LATER

- 1 — SCHIST

Jointing

Schistosity

Edge of outcrop

Geological boundary (approximate)

Trail

Proposed bore hole — PBH-1

Topographic Survey bench mark No. M25, 1958, unadjusted elevation is 1036·1 feet above sea level — BM

Frozen ground encountered within 30 inches of ground surface (August 12, 1960) — (F)

Magnetic declination 33° E (approximate)

100 0 100 200

SCALE IN FEET

YUKON RIVER DRAINAGE BASIN

SITE NO. 16

LOWER DAWSON DAM SITE — YUKON RIVER

TO ACCOMPANY TOPICAL REPORT NO. 23

GEOLOGY BY E.B. OWEN, 1960