No. 22

CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA
TOPICAL REPORT NO. 22

YUKON RIVER DRAINAGE BASIN
DAM SITE INVESTIGATION

SITE NO. 15

UPPER DAWSON DAM SITE

(MAP AND PRELIMINARY REPORT)

BY

E. B. OWEN

OTTAWA
1960

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Illustrations

Upper Dawson Dam Site

General Description

Upper Dawson dam site is located on Yukon River about a mile upstream from the town of Dawson. The area included on the accompanying geological map extends north along the right side of Yukon River to a point about 300 feet upstream from the mouth of Klondike River. An alternate site, designated Lower Dawson, is situated about 10 miles downstream from the Upper site. The Lower Dawson site is described in Topical Report No. 23, site No. 16. The elevation of the water surface at Upper Dawson site is about 25 feet higher than at the Lower site.

At the site the River is flowing in a northerly direction between two steep, rock bluffs which form the abutments of the proposed power dam. A low, partly-wooded island, upon which seismic lines' Nos. 1, 2 and 3 are located, divides the River into two channels. The main flow of the River occurs in the channel between the island and the right bank. The velocity of the current is swift varying between 6 and 7 miles per hour.

The rock bluffs forming the abutments are not parallel and consequently the distance between them varies considerably within the area mapped. The shortest distance is about 2,700 feet. This extends from near the sharp bend in the mining road on the right abutment to a point on the left abutment about 200 feet downstream from the north tip of the island.

The bluff forming the right abutment ascends from the River's edge to a height of 280 feet. Above the bluff a fairly level terrace covered with coarse gravel extends eastward for one-half mile. The elevation of the terrace is about 1,325 feet above sea level. The gravel

is well exposed in a former placer operation located a short distance east of the bluff. The bluff forming the left abutment rises steeply from the edge of the River to an elevation greater than 2,200 feet. Bedrock is exposed on about 30 per cent of the abutment slope; the remainder is covered with a thin layer of talus.

Information from the seismic lines indicates the elevation of bedrock surface beneath the River varies from 982 to 1,012 feet above sea level with the lowest part about half way between the abutments. These figures are believed to be fairly accurate although bedrock surface may be lower beneath the east channel of Yukon River between the island and the right abutment.

There is neither topographic or 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 course prior to the last glaciation, consequently a relatively deep channel eroded into bedrock could exist beneath the present River. Upper Dawson dam site is believed to be outside the limit of the last glaciation[1].

Except for suitable impervious material there is no lack of construction materials in the area adjacent to the site. Frozen ground was not encountered in test pits put down to depths of 9 feet on the island nor was it encountered on the abutment slopes (August 31, 1960). It is believed, however, to exist beneath the entire area mapped.

Unconsolidated Deposits

Three types of unconsolidated materials have been identified in the area about Upper Dawson dam site. These are as follows:

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

1. Recent Alluvium (silt, sand, gravel): this material varies from a fine-grained, silty sand to a sandy gravel with boulders up to 12 inches in diameter. It is a recent deposit formed by the present River. Around the perimeter of the island the material is usually a soft, silty sand containing a few, small pebbles whereas along the bottom of the abutment slopes and near the mouth of Klondike River it consists of sandy gravel with numerous rounded and subangular boulders. In some places along the River banks angular boulders derived from adjacent talus are present.

2. Recent Alluvium (silty sand): this material consists of a fine-grained, compact, silty sand which covers much of the wooded part of the island as well as that part of the area mapped which lies southeast of the abandoned mining road. On the island the thickness of the deposit varies from 6 to 7 feet.

3. Talus: Talus is spalled material derived from bedrock exposed along bluffs. At Upper Dawson site considerable talus occurs on both abutment slopes. It consists of fragments of diabase bedrock up to 2 feet in diameter along with minor quantities of residual soil derived from the more schistose phases of the same rock. An excellent section of the material can be seen in a recent cut on the downstream end of the right abutment slope directly above the sharp bend in the mining road. The cut was formed by waste water from a sluicing operation on the terrace above the slope. Here about 3 feet of talus and residual soil overlies badly weathered bedrock surface.

Bedrock

General Description

Bedrock is exposed on both abutment slopes. It consists of an altered, medium- to coarse-grained, greyish-green diabase which in

places is highly schistose. It has been described by McConnell[1] as the Moosehide diabase. The schist is a soft, light-coloured, sericitic rock which weathers easily. It occurs in places as lenticular zones varying in width from 6 inches to 10 feet and ranging up to 25 feet in length and as narrow bands of soft, highly weathered rock 6 to 12 inches wide and up to 100 feet long. The contacts between the schist and the more massive rock are usually distinct. Both rocks are traversed by numerous, small, irregular quartz veins.

Bedrock Structures

There is one prominent plane of schistosity traversing bedrock exposed at Upper Dawson dam site. The plane strikes from 60 degrees east of north to due east and dips from 27 to 45 degrees southeast. Local distortion may cause some deviation in the above figures but they are believed to be fairly accurate for the site area. The plane of schistosity intersects the proposed centre line of the dam at angles ranging from 56 to 86 degrees and dips toward the right abutment. The attitude of the schistosity is unfavourable from the engineering viewpoint. In places where it is almost parallel to the River it could readily transmit reservoir water through the foundations and abutments. Also, excavation problems in the right abutment area will be increased as a result of the southeast dip.

Bedrock exposed in the abutment slopes is extensively jointed. The most prominent joint set strikes between north and 25 degrees east of north and has an average easterly dip of about 78 degrees. A second

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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. 22.

set strikes 68 to 75 degrees east of north and has an almost vertical dip. The more prominent set intersects the proposed centre line at a relatively small angle and dips downstream, whereas the other set, which is approximately parallel to the schistosity, intersects the centre line approximately at right angles and dips steeply toward the right abutment.

Faulting is evident in both abutment slopes. A relatively large fault zone, located in the bluff near the upstream end of the right abutment area, consists of 2 to 3 inches of soft, brown, clayey gouge with 3 to 4 feet of shattered bedrock on either side. The fault zone strikes at about 60 degrees east of north and is vertical. Bedrock is sufficiently broken along the fault that a small valley, some 10 feet in width, has formed in the face of the bluff. A smaller, parallel fault is located about 8 feet upstream. The movement on the two faults is vertical with the northwest side moving up. Another vertical fault striking 40 degrees east of south is located about 50 feet upstream from the first.

Several small faults occur in the downstream part of the left abutment area. These have been located on the accompanying geological map.

It is believed all faults observed in the site area are potential aquifers. Frequently bedrock associated with them has a thin, brown coating of iron carbonate probably deposited by circulating ground water. Grouting will be necessary to prevent leakage of reservoir water.

Quality of Bedrock

The diabase occurring at Upper Dawson site is an intrusive rock which normally is massive in structure and possesses adequate

bearing and shearing strength for any engineering requirement. The specific gravity of the fresh rock is high (2.95). At the site, however, the diabase has been highly altered and weathered and it is doubtful if it has retained many of its original properties. The presence of numerous, schistose zones in bedrock render it unsound for engineering purposes. Test borings should be put down to determine the quality of bedrock constituting the two abutments and the potential foundations of the powerhouse and spillway structures beneath the River.

Engineering Considerations

Depth of Overburden

Overburden on both abutment slopes consists of a thin layer of talus and residual soil. The greater part of the material is talus and consequently it has been mapped as such. It is everywhere believed to be less than 10 feet in thickness. Overburden exposed in a cut on the right abutment slope formed by waste water descending from a nearby sluicing operation has an average thickness of about 3 feet.

The results from the 3 seismic lines located on the island are believed to be indicative of the thickness of overburden beneath the River. The results show overburden beneath the island increases in thickness from 19 to 44 feet in an easterly direction across the River. It is believed the quantity of overburden beneath the right channel of the River may be considerably greater, i.e. about 75 feet, due to the possible presence of a buried stream channel eroded into the surface of underlying bedrock.

Abutments and Foundations

It is believed bedrock at Upper Dawson dam site should be thoroughly investigated before any decision is reached regarding its suitability as abutment or foundation material. Weathering has penetrated bedrock on the abutment slopes to depths greater than 3 feet. Consequently considerable loose, weathered material will have to be removed before solid, fresh rock against which concrete can be placed will be exposed. Grouting will be necessary to seal the numerous joint and fault planes along which reservoir water can move through the abutments and foundations. It is believed a diversion tunnel could be constructed in either abutment. A lining will probably be necessary whenever faulted or schistose rock is encountered. The southeast dip of the schistosity into the right abutment increases the danger of overhang during excavation in this area.

Construction Materials

Aggregate

Large quantities of aggregate will doubtless be required during construction of the proposed dam structures. Several of the gravel deposits described in the report on the Lower Dawson site (topical report No. 23, site No. 16) could be considered potential sources of aggregate for the Upper Dawson site.

The gravel deposit nearest the site is located on the terrace immediately east of the right abutment. Here considerable gravel is exposed in an abandoned placer operation access to which may be gained by an abandoned mining road which ascends the north part of the abutment. The material is a sandy gravel containing a small quantity of silt.

It closely resembles the material in sample No. 43. The larger rock fragments range from pebbles to boulders up to 12 inches in diameter. They consist chiefly of quartz and grey quartzite with minor quantities of granitic rocks and soft, greenish schist. There are numerous small, black chert pebbles up to 1 inch in diameter. The quantity of gravel exposed in the stripped area is about 120,000 cubic yards. Much more probably exists, however, east of the exposure. The total quantity of gravel available on the terrace could only be determined by a program of test pitting.

Grain size analyses curves for representative samples from 4 potential sources of natural aggregate, are included at the end of this report. Two of the samples (Nos. 42 and 43) were taken from gravel deposits which occur extensively throughout the placer workings in the Dawson area. One of these, sample No. 42, is from the gold-bearing material called the "White Channel Gravel".

Impervious Material

It is assumed only limited quantities of impervious material would be required at Upper Dawson site. The fine-grained, silty sand which overlies part of the island as well as the level ground on which the mining road is located is a potential source of impervious material. However, the deposit is thin and the quantity available is small. As described in the report on the Lower Dawson site a similar material, usually more yellow in colour, occurs in many localities along Yukon River. It has been encountered on terraces as high as 500 feet above the River overlying material similar to the Klondike gravels near Dawson. The thickness of the deposit is usually 2 to 3 feet but in some localities it may occur in sufficiently thicker quantities to

warrant investigation for construction purposes. One such deposit is located at the mouth of OK Creek on the left bank of Yukon River about 3 miles upstream from Upper Dawson site. Here a deposit of dense, yellowish-brown, clayey silt rests on the surface of a gravel terrace which extends to a height of about 25 feet above the River. The terrace is about one-half mile in length. The average thickness of the silt is 5 feet. It overlies some 20 feet of coarse gravel. A program of test pitting would be required to determine the quantity of silt available. The deposit is accessible by a road which extends south along the west side of Yukon River from West Dawson. A representative sample (No. 45) of the silt was taken and forwarded to the Soils Laboratory of the Water Resources Branch in Vancouver for grain size analysis. The resultant curve is included at the end of this report.

Pervious Material

The sandy gravel deposits described under the "aggregate" heading should provide suitable material for filters or drains. The gravel would have to be washed, screened and reblended to obtain the coarse, granular material required.

Riprap and Rock Fill

The durability and specific gravity of unaltered diabase is relatively high. However, much of the rock exposed at the site is highly altered and has not retained many of its original properties. It is suggested tests be made on the diabase before any decision is reached regarding its suitability as riprap. The presence of numerous

joints and soft, schistose zones in the diabase indicate it may be difficult to obtain large rock fragments by blasting. The rock occurring in the downstream part of the right abutment will probably yield the most satisfactory material.

Ground Water

There is little information regarding the ground-water table in the area about the proposed dam site. Seepages of ground water do not occur in either abutment. Accurate information regarding the ground-water table can only be obtained by installing several ground-water observation holes. The presence of frozen ground throughout the area would add considerably to the cost of such a program.

Frozen Ground

Frozen ground was not encountered in any of the shallow test pits put down in the map-area. It is believed, however, to exist beneath the entire site.

Further Investigations - Conclusions

It should be remembered the present geological investigation of the proposed Upper Dawson dam site is a preliminary one designed to furnish the engineers with as much information as possible before any money is spent on expensive engineering investigations both in the field and in the laboratory.

As a result of this geological survey the following conclusions have been made:

1. Bedrock exposed in the abutment slopes consists of diabase

which has been intensively altered and sheared. Large quantities of soft, schistose material are present. Bedrock surface is badly weathered especially where it is covered with overburden. As all the major dam structures will be founded on bedrock detailed information concerning its character is required. Test borings should be put down into both abutments and along two or more parallel lines across the River to determine the depth of weathering and the quality and permeability of the rock. Ground-water observation holes should be established.

2. Large quantities of aggregate will doubtless be required for the dam structures. The most accessible deposits of potential aggregate are the gravels occurring along Klondike River and its tributaries near Dawson. These should be investigated regarding their suitability as construction material.

Comparison between Upper and Lower Dawson dam sites

The results of the investigation indicate that, geologically, the site at Upper Dawson is more favourable for construction of a dam than the Lower.

1. Quality of Bedrock

Bedrock at the Upper site is more competent and structurally sound and should provide satisfactory abutment and foundation material for a dam. It is suggested, however, the physical properties of the diabase occurring at the Upper site be thoroughly investigated before a decision is reached regarding its competency. The schist, which constitutes most of the rock occurring at the Lower site, is not believed to be satisfactory as foundation or abutment material.

2. Bedrock Structures

With the exception of the foliation, which is more pronounced at the Lower site, bedrock structures at the two sites are much the same.

Jointing is common and several large faults are visible on the abutment slopes at both sites.

3. Depth of Overburden:

The thickness of overburden at the two sites is approximately the same. Bedrock forming the abutments is covered with a thin layer of talus and residual soil. Everywhere it is believed to be 10 feet or less in thickness.

4. Aggregate:

Sufficient quantities of natural aggregate are available for each site. They are, however, more easily accessible from the Upper site.

5. Frozen Ground:

Frozen ground is believed to underlie both sites.

Chemical Analyses of Yukon and Klondike River Water

During the investigation samples were taken of Yukon River water at the site and of Klondike River water at a point about one-half mile upstream from its mouth. The samples were analysed 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 on the following page. The reported value of the turbidity should be considered only as indicative. Flash floods may cause a rapid increase in the sediment land. A proper sediment study, therefore, requires regular sampling; often in the case of flash flooding, at hourly intervals.

Chemical Analyses of Yukon and Klondike River Water
(parts per million)

Location	Date	River Discharge	pH	SiO_2	Ca	Mg	Na	K	Fe	CO_3	HCO_3	SO_4	Cl	F	Turbidity	Total Hardness as $CaCO_3$
Yukon River at Upper Dawson Site	Aug.16 1960	Medium High	7.8	6.4	30.6	8.4	2.5	2.4	40.0	0.0	104.0	28.1	0.8	0.03	1,100	111.0
Yukon River at Upper Dawson Site	Sept. 5, 1960	Low	7.8	6.7	28.3	7.5	2.4	1.1	0.59	0.0	97.3	25.2	0.8	0.0	5	101.0
Yukon River at Lower Dawson Site	Aug.16, 1960	Medium High	7.8	6.9	36.8	9.2	2.3	2.3	32.0	0.0	124.0	28.6	0.6	0.01	1,000	130.0
Klondike River ; 1/2 mile above its mouth	Aug.16, 1960	Medium High	7.6	6.1	25.0	7.8	1.5	0.5	0.79	0.0	75.7	32.1	0.5	0.11	12	94.6
Klondike River; 1/2 mile above its mouth	Sept. 5, 1960	Low	7.7	6.6	27.9	8.1	1.6	0.4	0.54	0.0	84.1	36.1	0.5	0.0	14	103.0

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.

Sample No. 45 was analysed as potential impervious material; the remainder as potential aggregate.

Description of Potential Aggregate for the following Grain Size Curves

Sample Number	Location	Field Description of Material	Field Description of Overburden	Thickness of Deposit	Areal Extent (Estimated)	Remarks
41	Cut on north side of Dawson-Boundary road; 41 miles west of Dawson; 6 feet below ground surface	Sandy gravel; minor silt; dense; considerable brown weathering throughout material; numerous rounded pebbles up to 3 inches in diameter; a few boulders up to 12 inches; pebbles are predominately quartz and black chert	2-3 feet of brown silty sand	6+ feet	A small, thin deposit	The considerable brown weathering and the presence of numerous chert pebbles indicates this material will not provide satisfactory aggregate. It is, however, suitable as road material
42	Jackson Gulch; 2 miles east of Dawson; sample taken 15 feet below contact with sample No. 43	Coarse-grained gravel locally called "White Channel Gravel"; material is gold-bearing and consists of 50 per cent quartz, with considerable soft, green, Klondike schist, no chert	Sample No. 43	Extremely Variable	Unlimited	Excellent source of aggregate providing schist can be removed; easily accessible

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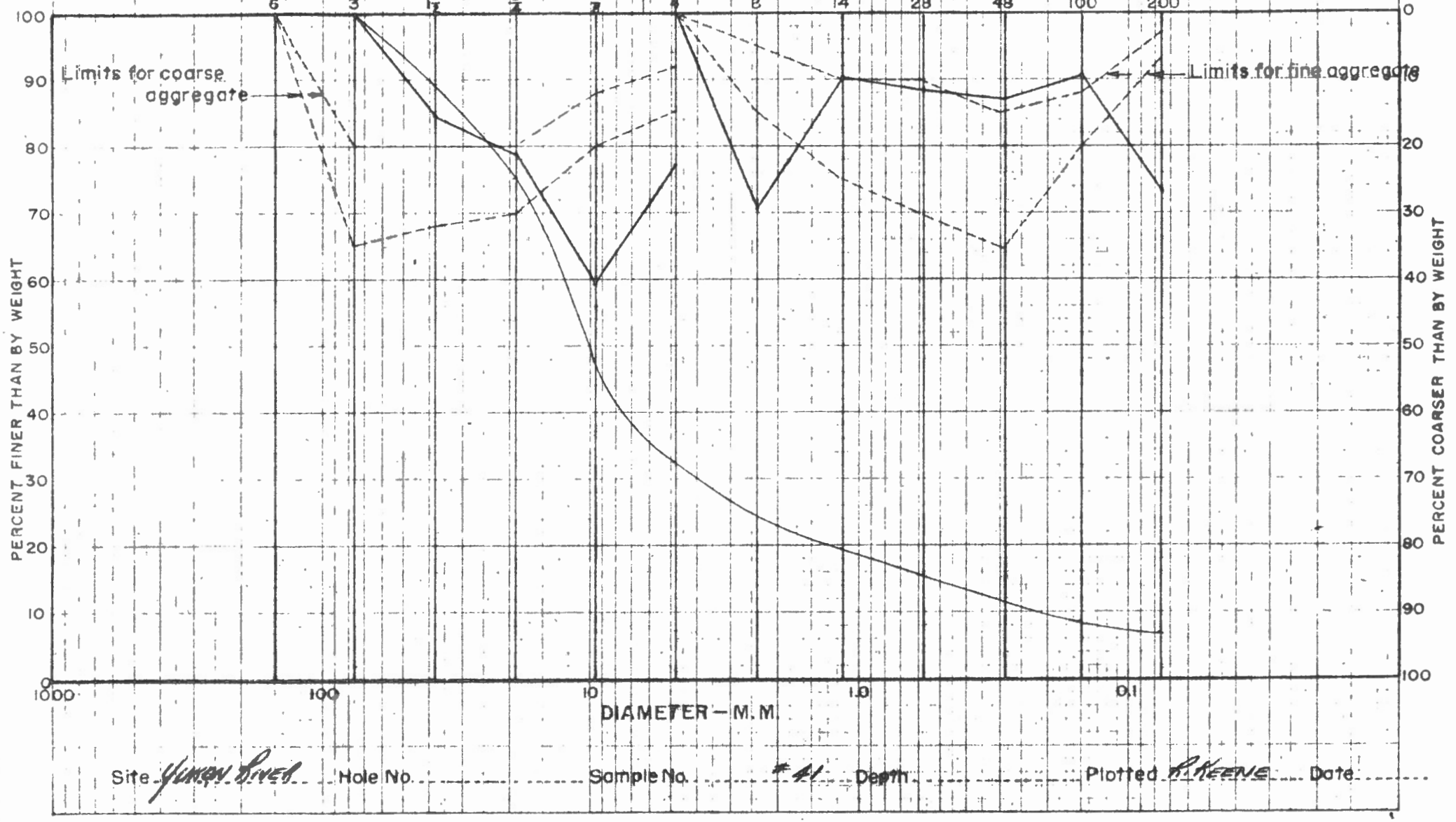
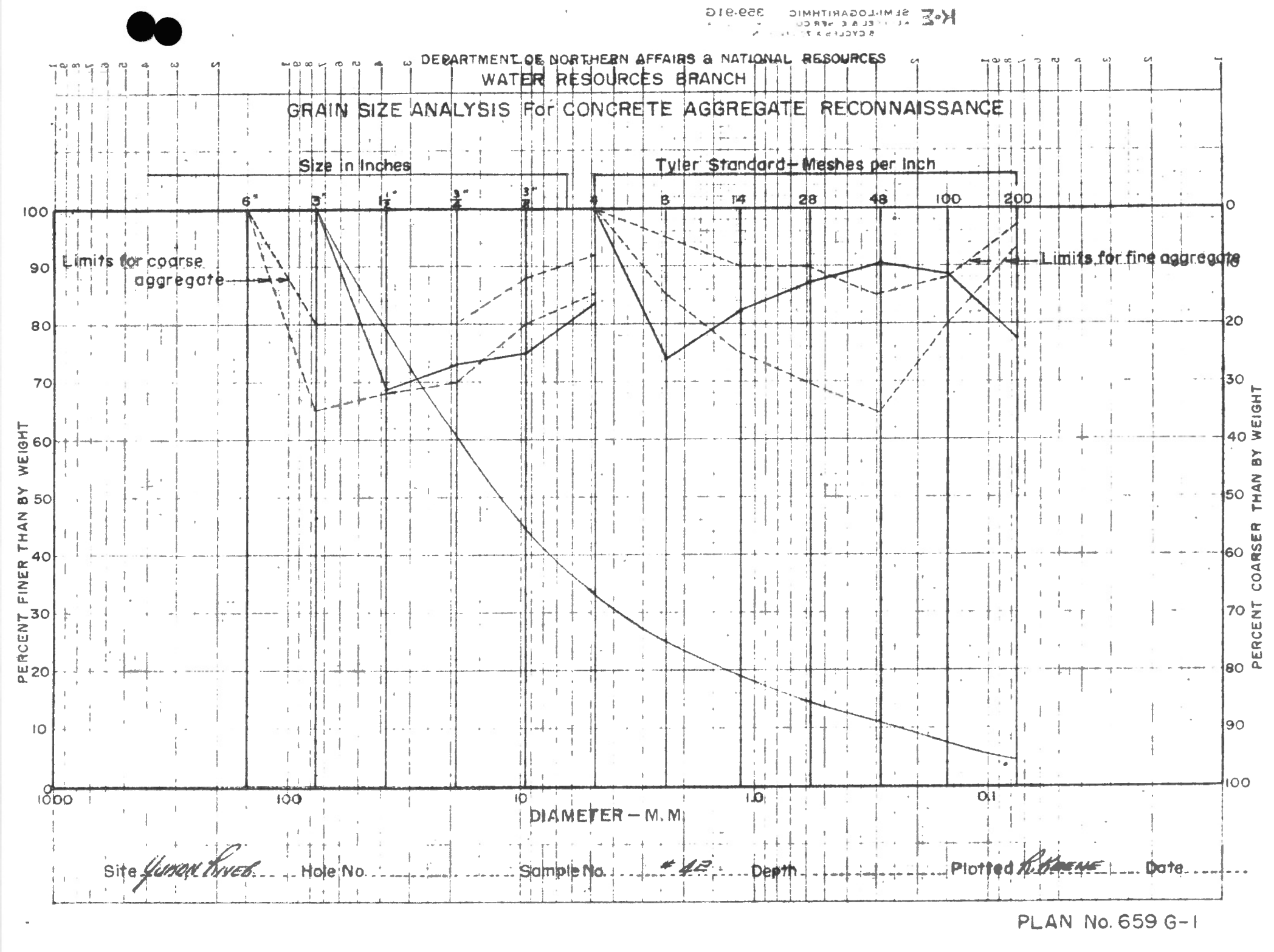
WATER RESOURCES BRANCH

GRAIN SIZE ANALYSIS For CONCRETE AGGREGATE RECONNAISSANCE



Site Yukon River Hole No. Sample No. #41 Depth Plotted P.KEENE Date

PLAN No. 659 G-1



PLAN No. 659 G-1

Description of Potential Aggregate for the following Grain Size Curves

Sample Number	Location	Field Description of Material	Field Description of Overburden	Thickness of Deposit	Areal Extent (Estimated)	Remarks
43	Jackson Gulch; 2 miles east of Dawson; sample taken 10 feet above contact with sample No. 42	Coarse-grained gravel locally called "Klondike Gravel"; pebbles consist chiefly of quartzite and black chert; very little quartz	None	Extremely variable	Unlimited	Presence of considerable black chert prevents this material from providing suitable aggregate; easily accessible
44	On steep slope; 30 feet below terrace; on left side of Yukon River; $\frac{3}{4}$ mile downstream from OK Creek; 2 feet below ground surface	Sandy gravel; numerous rounded to subrounded pebbles up to 1 inch in diameter; pebbles are chiefly quartzite and black chert; slight weathering;	None	45 feet	200 feet wide, $1\frac{3}{4}$ mile long	Material is similar to that in sample No. 43; accessible by River only

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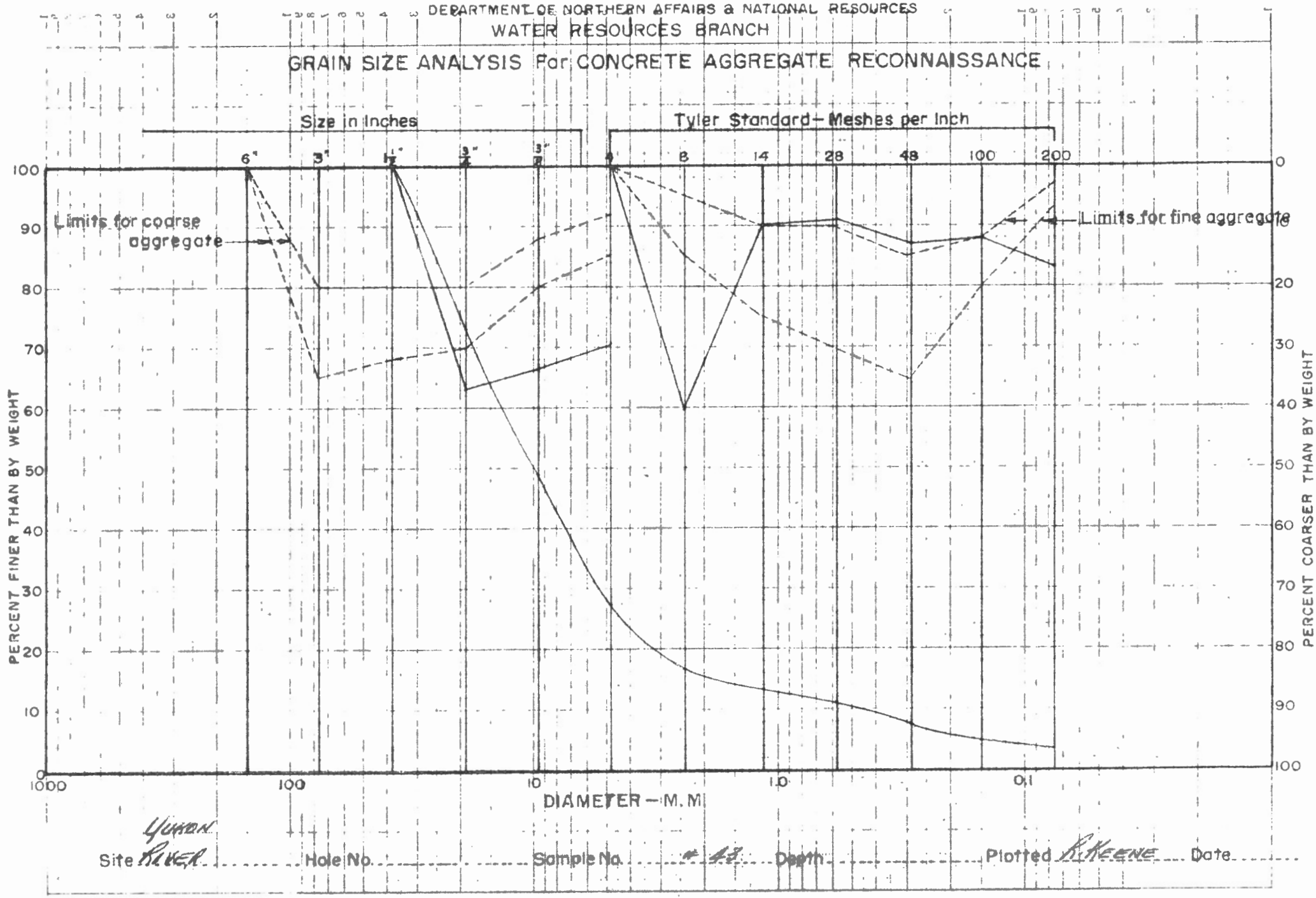
GRAIN SIZE ANALYSIS For CONCRETE AGGREGATE RECONNAISSANCE



Site Yukon River Hole No. Sample No. # 43 Depth Plotted R. Keene Date

PLAN No. 659 G-1

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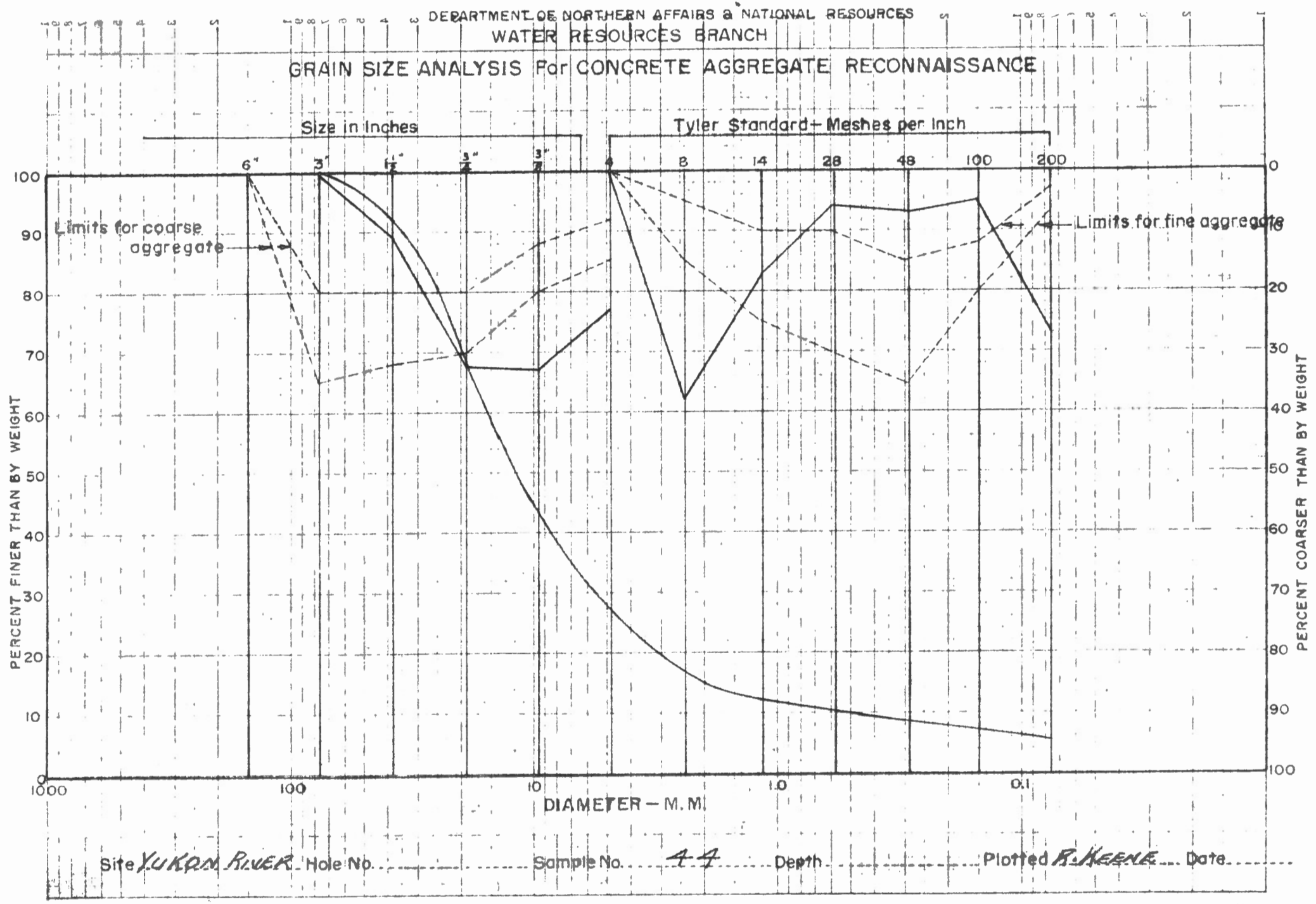
GRAIN SIZE ANALYSIS For CONCRETE AGGREGATE RECONNAISSANCE

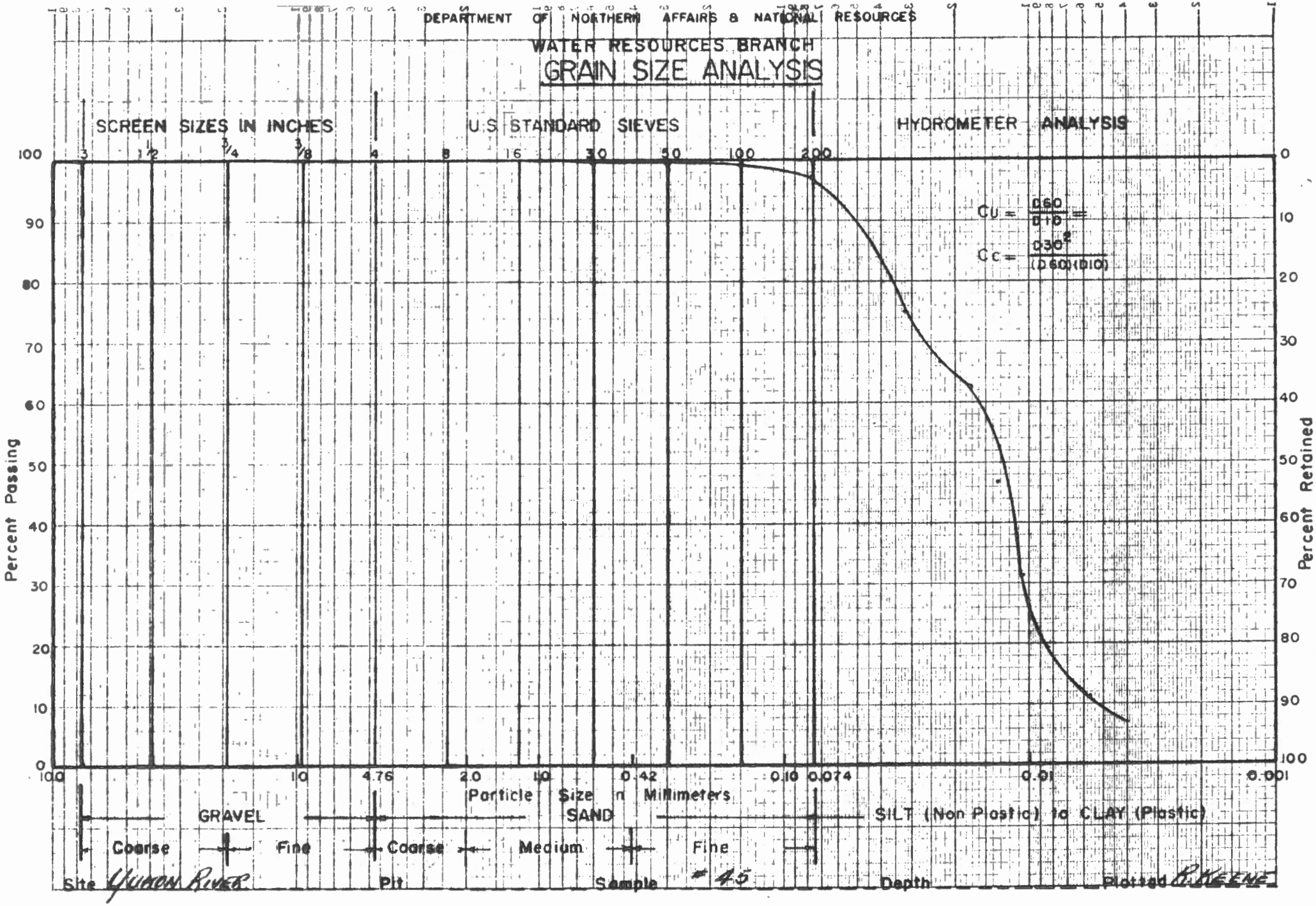


Site YUKON RIVER Hole No. ..... Sample No. 44 Depth ..... Plotted R. KEENE Date .....

PLAN No. 100 – 13

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
45	At mouth of OK Creek; 3 miles upstream from site; sample taken on 25-foot terrace 2 feet below ground surface	Yellowish-brown, clayey silt; fair dry strength; overlies 20 feet of sandy gravel	None	5 feet	200 feet wide; 1/2 mile long	The thickness of this silt deposit varies; a test-pitting program is required here; accessible by road from West Dawson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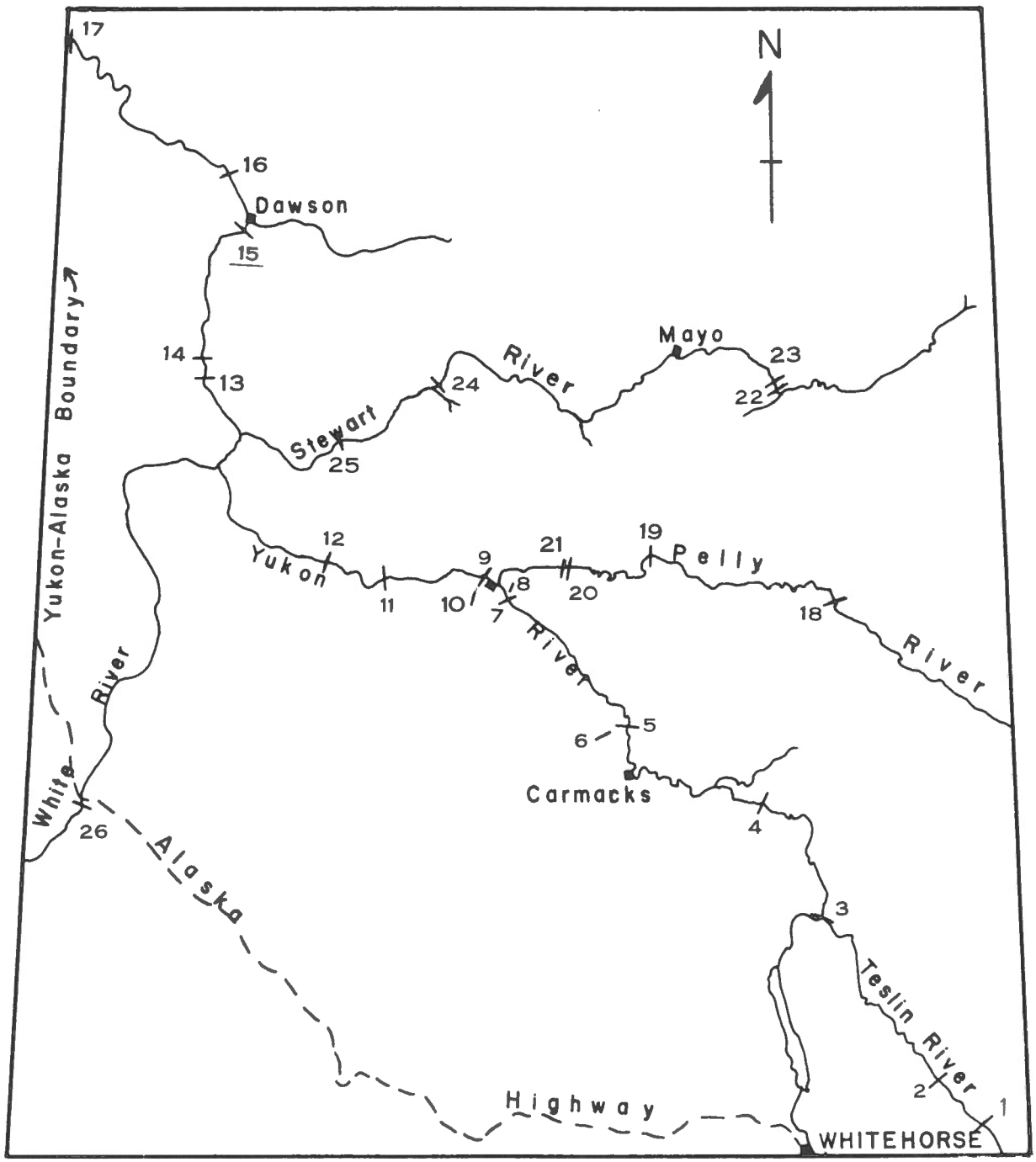
WATER RESOURCES BRANCH
GRAIN SIZE ANALYSIS
SCREEN SIZES IN INCHES
U.S. STANDARD SIEVES
HYDROMETER ANALYSIS
3
1 1/2
3/4
3/8
4
8
16
30
50
100
200
Cu = D60 / D10 =
Cc = D30² / (D60)(D10)
Percent Passing
Percent Retained
100
90
80
70
60
50
40
30
20
10
0
100
10
4.76
2.0
1.0
0.42
0.10
0.074
0.01
0.001
Particle Size in Millimeters
GRAVEL
SAND
SILT (Non Plastic) to CLAY (Plastic)
Coarse
Fine
Coarse
Medium
Fine
Site Yukon River
Pit
Sample #45
Depth
Plotted R. GREENE
PLAN

Upper Dawson dam site looking upstream from "Midnight Dome"; town of Dawson in the foreground; Klondike River on the left.



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		