HOGGAN ENGINEERING & TESTING LTD.

REFERENCE COLLECTION
PROTECTION BRANCH

PRELIMINARY REPORT
ROCK EXPLORATION
KIEWIT QUARRY
KING POINT, YUKON

Commercial & confidential for

Prepared for:

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1.0 INTRODUCTION

Hoggan Engineering and Testing Ltd has been retained by Peter Kiewit Sons Co. Ltd. to log a series of NQ boreholes in a potential quarry site in the Yukon North slope. Laboratory tests were perform to evaluate the engineering properties of the material for use as common rock fill (minus 6"), rip-rap (1-8 000#) and armor stone (minimum 4 tons) for the construction of Arctic islands.

This preliminary report presents the results which are available to date on the project and includes:

- logs of the boreholes (11 holes)
- photographic records of some of the cores as received in Edmonton (8 holes)
- laboratory test results completed to date on available cores (6 holes)
- evaluation of quality and quantity of material available

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2.0 DESCRIPTION OF SITE

The proposed Kiewit Quarry in the Yukon Territories, is located in a section of the Moose channel sandstone formations which rise up to form a 400-foot high hill in the otherwise flat tundra which slopes gently northward from the ridge to the Beaufort Sea.

The site is located about 125 air miles west of Inuvik and about 12 miles inland and due south of Kings's Point.

The quarry is to be developed in the lower part of the Moose channel sandstone formation of Tertiary age, and published geological reports by Young and Norris indicate that this formation contains beds of relatively massif sandstone in layer several hundred feet thick. The sandstone beds have been folded into a broad shallow and closed syncline, which strikes in the general north-south direction, with the northern end of the syncline dipping towards the south at an average dip of about 15^{o}. At the extreme southern end of the syncline the beds are reported to dip gently towards the north.

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From high level aerial photographs(figure 1, scale 1"=5000') the site is visible on the east side of the Quarry creek and appears as a series of southeast trending sandstone ridges (white bands) which outcrop over a 6 miles of Quarry Creek. The beds extend usually 2 miles east of the creek where they are cut by a series of east trending faults and they can no longer be traced on the photographs. The potential development site is located on the most northerly part of the outcrop area where the formations, dipping usually 15^{o} towards the south, rise 200-300 feet above the level of the local till plain.

On low level photographs (see Borehole Location Plan scale 1"=1000') the sandstone ridges appears as light colored bands which have a plan width varying from about 300 to 1200 feet, which represents thicknesses varying between 50 and 200 feet.

In general four (4) major bands can be identified starting with the most northerly band as follows:

BAND	PLAN WIDTH	ESTIMATED THICKNESS	LENGTH
Northerly 1	1200'	200'	9000'
Middle 2	250'	50'	6500'
Middle 3	300'	40'	6000'
Southerly 4	600'	100'	4000'

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Towards the south and in the middle and southern part of the syncline the light colored bands are narrower because the beds are probably not as thick. The formations are much more faulted than in the northern site and as a consequence are difficult to trace. One exception is the large white band which is about 4500 feet long and about 500 feet in plan width which represents a bed about 100 feet thick. This should be drilled in future boring programs, planned to investigate the potential for rock in the southern end of the syncline.

In the proposed quarry site, the wider northern band is cut by a deep valley about 100 feet wide and 40 feet deep and this probably represents a major fault, although only a slight displacement in the beds is visible on the photographs. Further to the east along the band and about 1000 feet from this fault a series of at least four fracture planes or additional faults cut the formation in a NE-SW direction. Beyond this zone, the formation can be easily traced on the photos and the thick bed appears to be continous over a distance of another 5000 feet. Although the thickness of the bed is not certain over this great distance, since there are at least three areas where the

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formation is either lacking or is masked beneath a dark toned surface waste material, it is believed from the information in Borehole 5, that the formation may extend southward, under a thin layer of overburden, to the thin white line which separated the overlying dark band. Under this condition, the formation would maintain its 200-foot thickness and the southern limit of the main bed would be more consistent with the information obtained in boreholes 8 and 10.

The formations dip to the south at angles which are usually in the 13 to 17 degree range but in some cases range up to 20 to 25 degrees in zones which are probably related to faulting or possibly inclined sedimentation planes.

The light colored sandstone beds are separated by dark colored bands of about equal thickness in most cases which are either composed of soft weathered sandstone, conglomerates, shales, siltstones and mud stones.

Because of the considerable depth of frost jacking in the area outcrops of intact undisturbed rock are not widespread and are confined primarily to the cuts in the river banks and occasionally to the steeper slopes on higher ground which are associated with faulting.

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In the latter case the rock has been severely affected by frost action and the appearance of rock in the larger exposures suggests that the blocks must be detached from the main formation and that they have rotated somewhat down slope and, hence in some cases, may not provide reliable strike and dip information.

Most talus slopes (3:1 - 5:1) are composed of hard tough angular slabs of sandstone which are usually up to 1 or 2 feet across and a few inches thick. Most of these pieces are very sound and show very little evidence of weathering, the edges are angular and not rounded. In moving further up slope, the inclination usually decreases and the fragment are smaller in size, visibly weathered and rounded, and are composed primarily of a rusty reddish brown sandstone which is considerably softer than the hard pieces encountered in the steeper slopes.

The harder sandstone formations as viewed in some of the few near vertical sections can be seen splitting into thin slabs up to 2 or 3 feet long and usually less than 3 or 4 inches thick, a reflection

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no doubt of the stratification. In the more massif thicker zones, the rock breaks with a distinct curved or conchoidal fracture plane, and the fragments were usually 6 to 8 inches thick, with a length or width ratio of 4 to 5 times the thickness. These fractures are therefore not related to the stratification of the beds but are probably a result of mechanical forces brought about by freezing and thawing and this confirms the tough resistant nature of the rock.

Vertical fracturing of the formation, where observed, is very variable, and in most instances is usually spaced at 5 to 8 inch intervals due primarily to the severe frost action. In the more resistant beds, blocks usually two or three times the thickness of the pieces have been observed. It is considered that this may be representative of typical condition that can be expected in the massive sandstone layers in the quarry, but it is very difficult to predict what can be expected in the deep permanently frozen section of the formations when extrapoling from surface exposures which have been subjected to such severe freezing and thawing conditions since the

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recent glacial period. Only borings drilled down the dip of the sandstone formations could determine the spacing of the jointing in the beds.

Drainage of the site is mainly by deep cut gullies which drain westward into Quarry Creek except in the northern and eastern limits of the mountain where the overlying glacial till cover has a characteristic dendritic drainage pattern which flows eastward.

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3.0 DRILLING RESULTS

Eleven widely spaced borings were drilled on the property, ten (10) of which were located in the northern section, with only one (1) hole being done on the southern part. The location of holes 2 to 11 are shown on the attached copy of the low level photographs. Most of the holes were located on the southern edges of the light bands which correspond to the top of the formations and provided more reliable information on the thickness of the beds and the quality of the rock. In view of the time limitations, inclined borings could not be done and apart from northern part of the quarry most other potential rock sources in the immediate vicinity of of the quarry, were drilled with only one (1) borehole.

The borings confirmed to a large degree what was developed from the photographs concerning the stratification, and cross-sections prepared from the field results confirmed that the major sandstone member in the western part of the site is about 200 feet thick and dips down towards the south at an inclination of about 15 degrees.

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Borehole 9 was put down on the low terrace just above Quarry Creek and indicates that the bedrock dips down towards the creek under about 70 feet of overburden. In this boring 34 feet of soft sandstone and shale was penetrated before encountering the top of the solid sandstone formation which was drilled for an additional 53 feet.

Borehole 5 was put down on the extreme east end of the sandstone bed, and encountered good sandstone at a depth of only 75 feet. This indicates that the underlying main sandstone bed visible on the photograph is somewhat thicker than can be deduced from the photo and suggests that the main bed may extend 200-300 feet further south and in line with the thin discontinuous white spots which are visible in the middle of the black band on the photo. Other borings would be required to confirm this possibility particularily in the vicinity of borehole 4.

Borehole 6, put down on the most westerly end of the band, confirmed that the sandstone bed is of comparable thickness as in boreholes 3, 8 and 10.

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4.0 TEMPERATURE RECORDINGS

One thermister string was installed in Borehole 1 for the purpose of measuring ground temperature in the quarry and the following results were obtained.

TEMPERATURE C^{o}

Depth - Ft	27 Aug/83	28 Aug/83	31 Aug/83	6 Sept/83	9 Sept/83	20 Sept/83
7	1	0	0	0	0	-1
10	20	14	5	1	-3.8	-1
27	0	0	0	-3.5	-5	-5
35	8	5	0	1	0	-5

These readings suggest that a large proportion of the drilling water was lost in fracture zones at the 10 and 35 foot levels, and that it took up to three (3) weeks for these zones to refreeze after the borehole was completed. The -5^{o} reading is considered to be representative of the minimum ground temperatures that can be expected over the full depth of the quarry zone.

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5.0 ROCK DESCRIPTIONS

5.1 Weathered Zone

Most boreholes penetrated a variable thickness of broken and fractured rock at the ground surface, and this layer was contaminated to varying degrees with finer material derived from the disintegration of softer rocks. In general, the weathered zone is about 10 to 15 feet thick except in borehole No. 6, where this layer is 43 feet thick. When considering salvaging product from this zone, it is possible that between 20 and 40% of the material could be recovered, particularily in the bottom half of the layer where most of the fines may have accumulated.

5.2 Sandstone Formations

The sandstone formations are brown and grey colored, usually fine grained and in the unaltered zones are classified as medium hard. The brown colored sandstone sections usually produce shorter cores than the grey sections.

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The borehole logs prepared indicate soft zones, fractured and thinly bedded sections, and the lengths of pieces of core recovered in the formations in the 2-4" size, 4-8", 8 to 16" and plus 16 inch size. In addition, the calculated percentage of plus 24" and 36" long cores are given together with the length of the longest recovered, so that an evaluation of the size distribution and an estimate of the maximum size of blocks that should be recoverable from the formations can be made.

Drilling in the surficial weathered zone of bedrock returned only a small percentage of cores and these were usually no more than 2 to 4 inches long and reflect the thickness of the large flat frost heaved slabs of rock which are visible on the ground surface. Below this altered frost heaved zone, the borehole encountered the principal sandstone formation which was drilled to a maximum depth of about 217 feet in borehole 8.

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The good sandstone layers, consist of uniformly bedded relatively hard and sound brown to grey colored fine grained rock, and show no signs of stratification with the exception of the occasional thin conglomerate seams which is usually less than one half inch thick. The actual Moose channel formations,however, consist of a series of beds which vary in thickness from a few inches up to a maximum of perhaps 5 to 10 feet at the very most and the core length in the boxes reflect the thickness of these beds. Numerous fracture and fault zones, and some thinly bedded sections were also identified in the cores and these contained a lot of soft fault material, which was separated from the good sections and considered as waste.

In the poorer formations the sandstone develops a distinct stratification and is thinly bedded, with the worst conditions being encountered where very thin bedded seams of coal are present and the cores can be broken by hand along the seams. In these sections of the formations, and also interbedded with the good

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sandstone beds, are layers of rusty brown soft sandstone or sand which is present in layers usually up to 4 feet thick.

Towards the base of the Moose channel formation,a series of softer and weaker greyish salt and pepper colored coarser grained sandstone was encountered and this was considered as waste and was included in the unsuitable Tent Island formation.

The following table summarizes the results of the above evaluation.

Borehole	Overburden Thickness (ft)	Length Drilled in Sandstone Formation (ft)	Length of Waste (ft)	% Waste	% + 24"	% + 36"
3	11	131	32.0	24.5	32	12
4	14	150	24.5	17.0	24	9
5	75	158	43.0	27.0	43	26
6	43	117	20.0	17.0	32	17
8	14	203	23.0	11.0	29	16
9	100 (till)	53	2.5	5.0	50	37
10	12	166	28.5	17.0	48	37
11	11	92	10.0	11.0	44	33

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6.0 PRELIMINARY TESTING PROGRAM AND TEST RESULTS

The quality of the sandstone formation was evaluated by submitting sections of the cores to the standard tests used for concrete aggregates. Samples were selected at various depths in the holes so thay any variation in the quality of the rock from the different beds in the formation could be determined.

The following tests were performed on the cores:

- unit weight and absorption
- compressive strength
- tensile strength by "Point load Tester"
- crushing tests to determine percentage of fines to be produce during crushing
- loose unit weight of crushed material to evaluate bulking factors
- Los Angeles abrasion tests to evaluate resistance to breakdown
- sulphate soundness tests to evaluate resistance to weathering
- freeze-thaw to determine resistance to freeze thaw cycles.

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The following brief table summarizes the majority of test results obtained to date from the laboratory tests:

Borehole	Unit Weight (pcf)	Specific Gravity	Absorption (%)	Unconfined Compressive Strength (psi)	Los Angeles Abrasion Loss (%)
3	150-152	2.4-2.5	2.4-3.0	10 000-19 000	33-37
4	149-151	2.4-2.5	2.8-3.7	9 000-16 000	40-42
5	145-150	2.2-2.4	3.0-3.6	5 000-12 000	36-43
6	150-155	2.4-2.5	-	10 000-13 000	39-42
7	140-150	2.2-2.4	3.5-6.0	7 000-11 000	
8	15-153	2.4-2.5	2.8-3.2	10 000-14 000	
10	150-153	2.4-2.5	2.6-3.1	10 000-14 000	

The test results are all shown on the table of laboratory tests which accompany each borehole.

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6.1 Discussion of Test Results

Tests on the sandstone cores gave specific gravity values ranging between 2.4 and 2.5, with unit weights between 148-153 pcf. These values are considered typical of well cemented tough sandstone. Absorption values reflect the varying porosity of the sandstone formations and most values were higher than the maximum 2.5 considered for adequate quality rock. However, freeze-thaw tests carried out on typical sections of core from boreholes 3 and 4 indicate that after 12 cycles there is no sign of any breakdown or splitting. In addition, freeze-thaw tests reported by NRC in 1966 on Aklavik sandstones and shales indicated that there was an increase of about 20-25% in all sizes of a well graded minus 2 inch sample of rocks used in their tests after 400 cycles of freeze-thaw. This suggests that the sandstones are quite resistant to freeze-thaw cycles (see attached Figure 3).

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The significance of the higher absorption values obtained in some of the softer sections of the formations will be evaluated once the sulphate and freeze-thaw tests have been completed on these cores.

Crushing of the cores to minus 1 inch in a jaw crusher produced a considerable number of flat platy pieces and a grain size distribution as shown on the figures which accompany the borehole logs. Loose unit weight determination carried out in a relatively small container gave values usually in the 80 pcf range but these are considered low in view of the shape of particles and the size of the container used for the test. Values of 100-110 pcf is considered more realistic for minus 6 inch material, and this would indicate that an average bulking factor of about 35-40% would be a reasonable estimate for the solid sandstone formations.

Unconfined compression tests ranged usually between 10,000 to 14,000 psi typical of resistant or strong formations, with values decreasing according to the degree of weathering, alteration, and

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the strength of the moderately strong beds. Tests with the point load tester indicate that on samples of the uniform brown or grey sandstone the strength perpendicular to the core axis is about the same as that measured axially, and this confirms that in the unstratified homogeneous sandstone beds the rock is dense, well cemented and sound.

In cores exhibiting some form of stratification, the tensile strength was reduced and as the stratification became more pronounced, the cores could actually be split without developing any load on the testing unit. Los Angeles abrasive tests indicate losses of between 33 to 43% and all values were in the same range regardless of the color or length of cores selected. It is interesting to note that the abrasion loss on a sample of the short broken pieces of core from borehole 3 was in the same range as the other tests carried out on long pieces of core. However, a significant increase in the abrasion loss was noted for the softer and weaker grey salt and pepper colored coarse grained sandstone, and a value of 67 was obtained.

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Although the test values on the cores are at the maximum limit (40) considered acceptable for adequate quality rock, the test results are considered to be higher than normal, since the crushed samples contained numerous flat particles which were easily broken in the test. This increased the losses in the tests, and hence is a reflection of the particle shape, and not a physical weakness of the rock itself. If similar tests were performed on equidimensional fragments, the results would be expected to be lower and more representative of the minus 6 inch crusher run rock which is to be produced at the quarry.

Experience with rip-rap indicates that rocks even with losses between 45 and 75%, have satisfactory service records and, from observations of talus slopes in the field, together with the encouraging laboratory test results from the freeze-thaw and sulphate tests, it is considered that the homogeneous uniform sandstones of the Moose channel formation will be adequate for use in construction of the islands.

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7.0 QUANTITY ESTIMATES

Calculation of proven preliminary and potential volumes of in-place rock have been made using topographic information supplied by Les Consultants SOGEAM Inc. and the results of site survey work carried out by P. Kiewit field personnel. The following assumptions were made in calculating volumes :

- the results of widely spaced borehole reasonably represent the rock conditions along the strike of the formation,
- the sandstone beds dip at an average 15^{o} towards the south, and that the formation continues beneath the overburden to at least creek level,
- faulting has not interrupted the beds nor decreased the quality of the rock as represented in the boreholes,
- quality of rock has not diminished significantly from that tested in laboratory,
- quantity of talus and weathered and fractured rock, covering the formation, and the thickness of unsuitable rock within the beds, has not increased from that observed in borings completed to date.

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The following table summarises the in-place volumes of rock which can be recovered when excavating to a depth of about 300 feet in the formations, together with an estimated of the quantity of talus which must be removed to expose the top of the main sandstone member.

ESTIMATE OF IN-PLACE ROCK QUANTITY (million, cubic yards)

KIEWIT QUARRY Kings Point	Section A-A (900')	Section B-B (600')	Section C-C (900')	Section D-D (2300')	Section E-E (3500')	Section E'-E' (2500')	Total
Talus	1.5	0.33	0.47	0.85	0.91	0.44	4.50
POTENTIAL ROCK							
Level 100'	0.8	1.75	3.07	2.77	-	1.54	
Level 200'	1.65	1.88	2.00	2.77	-	1.72	
Bottom of pit	0.37	1.60	-	1.94	-	0.69	
	2.82	5.23	5.07	7.48	-	3.95	24.55
ADDITIONAL POTENTIAL ROCK							
Level 100'	0.37	-	-	2.77	5.90	1.54	
Level 200'	0.70	-	-	3.83	9.91	1.72	
Bottom of pit	0.67	-	1.65	1.94	6.74	0.69	
	1.74	-	1.65	8.54	22.55	3.95	38.43
Total Rock	4.56	5.23	6.72	16.02	22.55	7.90	62.90

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To arrive at the volume of recoverable in-place rock these figures must be reduced by between 15 and 25% to account for material contained within the formation which is considered as waste.

To arrive at the volume of rock which will be stockpiled, it is necessary to increase the volume of in-place rock by between 30 and 40% to compensate for bulking, and then to further reduce this by about 20% which should represent the percentage of reject minus 1 inch material which will be lost during blasting, handling and crushing.

7.1 SIZE OF ROCK

The quality and probable in-service performance of a given rock source can be evaluated from geologic evidence correlated to laboratory tests and service records, but the prediction of the percentage of various sizes and weights that can be recovered from the in situ rock is difficult because of the many factors involved which cannot be evaluated easily from a series of boreholes. In this case, the task is even more complicated

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since there are few outcrops which can be inspected to determine the degree of jointing and fracturing present in the formations, and the variation in both horizontal and vertical directions of the quality of the rock cannot be observed.

In addition, whatever outcrops could be found had, in all but a few cases,been severely fractured and split after many thousands of cycles of freezing and thawing. However, those large blocks which remained on site were usually rectangular in shape with the length and width usually 50% greater than their 4 and 5 foot thickness. It is from this information, together with the length of some of the longest cores recovered, that an attempt has been made to predict the probable size and weight of rip-rap which can be salvaged from the quarry providing the most advanced blasting techniques are employed to minimize shattering of the rock.

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It is considered that in the boreholes producing long cores, no more than half of the beds will remain intact after blasting and that the following sizes may be recovered provided at least equidimensional blocks can be produced:

ESTIMATE OF PROBABLE SIZE AND WEIGHT OF RIP-RAP

Borehole	+ 24"	- 24"	+ 36"	+ 48"	Estimate size & Weight + 36"(4000 #)	+ 48"(9000 #)
3	32	58	12	0		
4	24	76	9	0		
5	43	57	26	12	5%	1%
6	32	68	17	3		
8	29	71	16	10		
9	50	50	37	31		
10	47	52	37	25	15%	4%
11	44	56	33	8		

Considerable variation in the above estimated rip-rap sizes should be expected particularily in the lower sections of the formations where the logs of all the holes indicate that rock is definitely of inferior quality to the top section. The majority of large rip-rap and armor stone will most probably be found in the top of the beds, i.e. on the south side of the formations in areas which have not been affected by faulting and jointing.

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8.0 CONCLUSIONS

From the results of the widely spaced borehole, the following conclusions and recommendations have been known:

1. A 200-foot thick sandstone bed dipping 15^{o} to the south and located on the most northerly section of the quarry contains the largest quantity of hard sandstone rock in the area.

2. Two (2) other thinner sandstone beds (50') interlayered with waste rock overlie the main sandstone member on the eastern half of the quarry and these can be recovered although considerable waste will be involved in exposing the beds.

3. On the southern part of the quarry site adjacent to Eagle Point, another 100-foot thick sandstone bed may contain up to 8,000,000 cubic yards.

4. Initial laboratory tests indicates that the sandstone rock is of acceptable quality for the construction of rock islands.

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5. At least 20,000,000 yards of sandstone can be recovered at the site without involving large stripping quantities, and an additional 35,000,000 cu yards may be recoverable but stripping quantities will be considerable.

6. On the basis of core length recovered, it is estimated that between 75% and 85% of the rock will be minus 24 inches and 15-25% will be between 24 inches with about 5-10% greater than 36 inches in the more resistant and thicker beds located usually at the top of the main sandstone formation.

7. Laboratory tests indicate bulking in the sound unfractured section will probably be in the 35 to 40% range.

8. Losses of material during blasting, handling and crushing to minus 6 inches material are estimated between 20 and 30%.

Hoggan Engineering & Testing(1980) Ltd.

Noël L. Journeaux, P.Eng.

NLJ/fp
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ROCK STRENGTH CLASSIFICATION

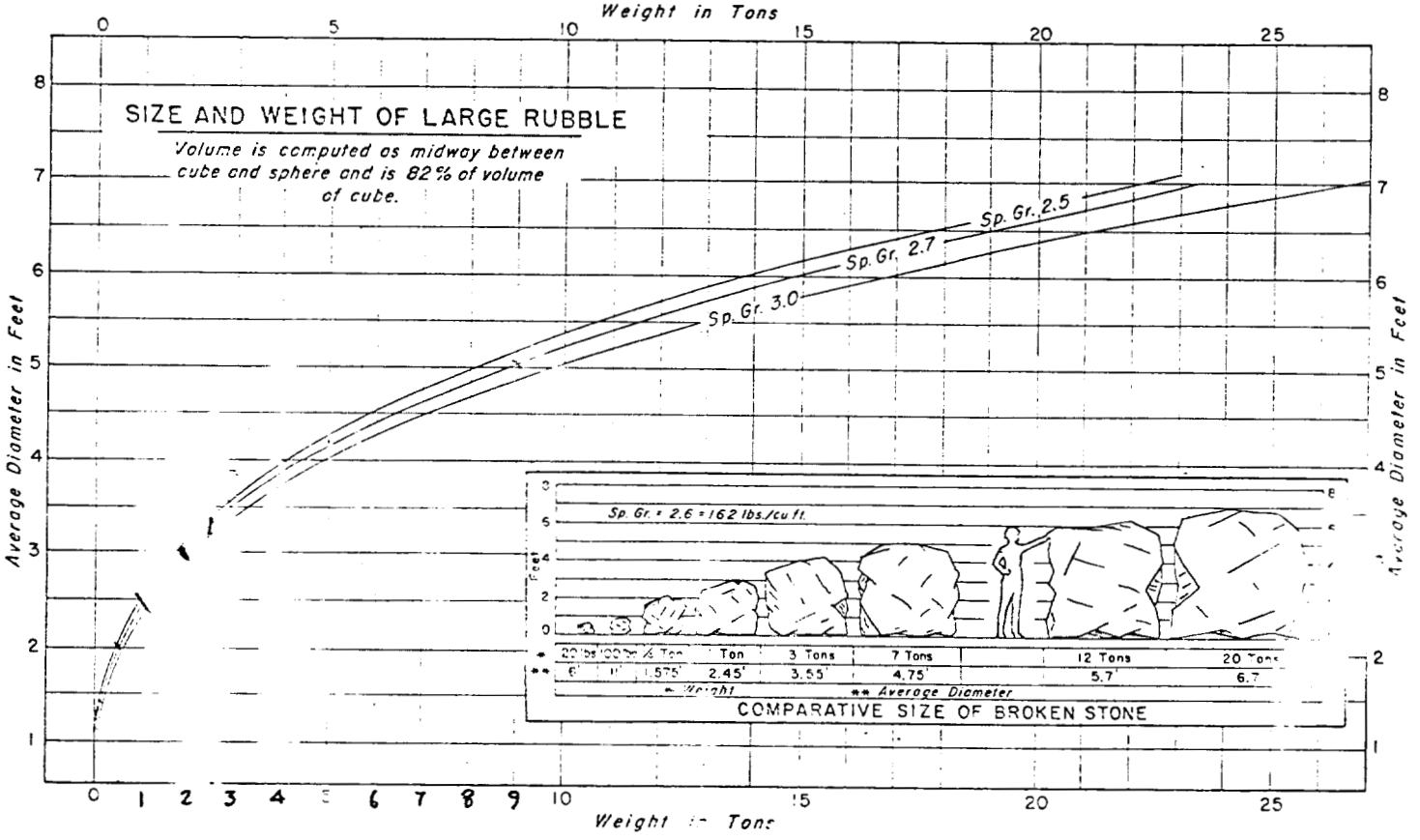
ENGINEERING GROUP OF GEOLOGICAL SOCIETY
'LOGGING OF ROCK CORES FOR ENGINEERING PURPOSES'

TERM	Uniaxial Compressive Strength MN/m²	lbs/in²	kg/cm²
Very weak	< 1.25	< 182.5	< 12.8
Weak	1.25 to 5	182.5 to 730	12.8 to 51
Moderately weak	5 to 12.5	730 to 1825	51 to 128
Moderately strong	12.5 to 50	1825 to 7300	128 to 510
Strong	50 to 100	7300 to 14600	510 to 1020
Very strong	100 to 200	14600 to 29200	1020 to 2040
Extremely strong	> 200	> 29200	> 2040

ROCK MASS CLASSIFICATION

ENGINEERING GROUP OF GEOLOGICAL SOCIETY
'LOGGING OF ROCK CORES FOR ENGINEERING PURPOSES'

DESCRIPTION	DISCONTINUITY SPACING M
Very thickly bedded	2.0
Thickly bedded	0.600 to 2.000
Medium bedded	0.200 to 0.600
Thinly bedded	0.060 to 0.200
Very thinly bedded	0.020 to 0.060
Laminated	0.006 to 0.020
Thinly laminated	0.006


Weight in Tons
SIZE AND WEIGHT OF LARGE RUBBLE
Volume is computed as midway between cube and sphere and is 82% of volume of cube.
Sp. Gr. 2.5
Sp. Gr. 2.7
Sp. Gr. 3.0
Average Diameter in Feet
Sp. Gr. = 2.6 = 162 lbs./cu ft.
Ton
3 Tons
7 Tons
12 Tons
2.45'
3.55'
4.75'
5.7'
** Average Diameter
COMPARATIVE SIZE OF BROKEN STONE

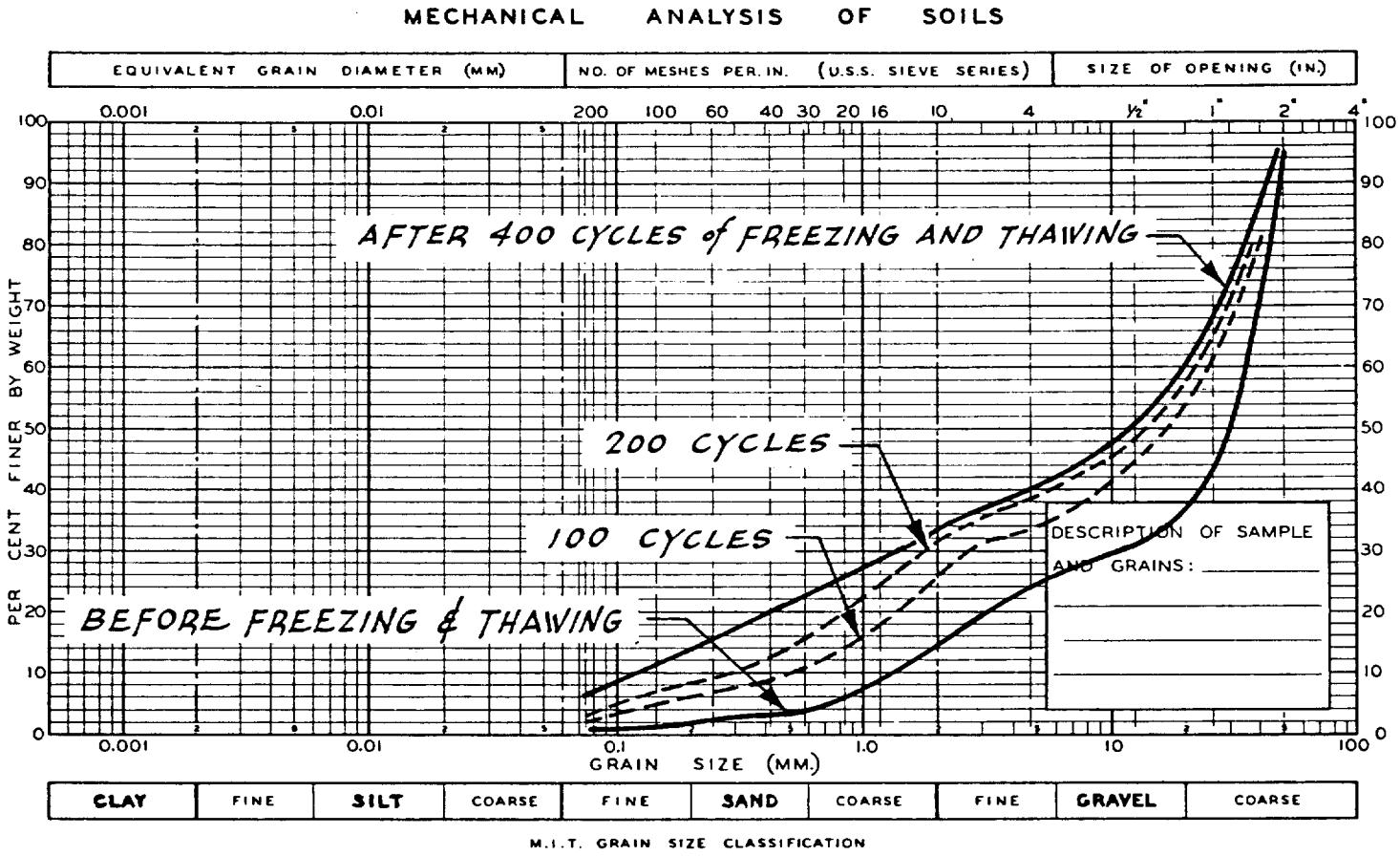


Figure 7. Disintegration of rock sample from willow fan gully near Aklavik, Northwest Territories, Canada, by freeze-thaw cycling in laboratory (Test no. 1)

HOGGAN

OFFICE BOREHOLE RECORD

APPENDIX
BOREHOLE No: 1
REPORT NO.:

CLIENT: P. Lee Kiewit Sons Company Ltd.
DATE OF BORING: August 25-26, 8[illegible]
SITE AND/OR PROJECT: Quarry Investigation, Yukon
DATE OF WL READING: August 27, 8[illegible]

DEPTH, ft	ELEVATION DEPTH AND WATER LEVEL	STRATIGRAPHY	SOIL DESCRIPTION (1)	CONDITION	TYPE	NUMBER	RECOVERY %	RQD, >4 in %	GRAIN SIZE, HYDROMETER, UNIT WEIGHT, CONSOLIDATION	LABORATORY AND FIELD TEST RESULTS: (x) FIELD VANE, (o) LABORATORY VANE, (Cu), (w) WATER CONTENT, W, (w_p, w_L) ATTERBERG LIMIT	GRAPHIC SCALE % 100 100 100 100
0			Ground level								2-4 in / 4-8 in / 8-16 in / >16 in / MAX CORE in
	1.5'		Overburden: Broken Sandstone slabs with fines in bottom half								
			Sandstone: brown, soft, fine to medium grained, thin fractured 1"-4", vertically fractured		NQ	1	100	0			17 / 0 / 0 / 0
					NQ	2	29	10			0 / 10 / 0 / 0
			10-12: Rusty brown sandstone and sand		NQ	3	100	0			0 / 0 / 0 / 0
					NQ	4	15	0			0 / 0 / 0 / 0
			25-27: Rusty brown fractured Sandstone and sand		NQ	5	75	0			8 / 0 / 0 / 0
			Ice lenses 0.5" at 26'		NQ	6	100	0			21 / 0 / 0 / 0
	Lip 23'		: Lost of water @ 28'		NQ	7	75	12			8 / 12 / 0 / 0
	20'		36-37: Vertical fracture in solid sandstone.		NQ	8	100	10			19 / 10 / 0 / 0
					NQ	9	100	0			0 / 0 / 0 / 0
			38-43: Vertical fracture in solid sandstone.		NQ	10	82	16			0 / 0 / 16 / 0
	30'		43-46: Rusty brown fractured sandstone and sand		NQ	11	96	0			0 / 0 / 0 / 0
			46-50: Vertical fracture in soft sandstone		NQ	12	58	0			33 / 0 / 0 / 0
	16'		50-53: Brown fractured sandstone and sand		NQ	13	90	0			9 / 0 / 0 / 0
					NQ	14	90	27			10 / 27 / 0 / 0
	14'		58-60: Vertical fracture in		NQ	15	100	0			17 / 0 / 0 / 0
			61-62: Sandstone		NQ	16	100	33			10 / 18 / 15 / 0
			65-66: Shale; grey, soft very fractured.		NQ	17	100	17			0 / 17 / 0 / 0
	20'				NQ	18	100	30			4 / 30 / 0 / 0
			72-75: Shale; grey, soft very fractured.		NQ	19	93	10			20 / 10 / 0 / 0
					NQ	20	100	47			0 / 7 / 40 / 0
			84-86: Shale; grey, soft very fractured.		NQ	21	100	59			7 / 12 / 17 / 30
	17'				NQ	22	100	-			- / - / - / -

DATUM

VERIFIED BY

UNDRAINED SHEAR STRENGTH, kg/cm²

HOGGAN

OFFICE BOREHOLE RECORD

APPENDIX
BOREHOLE NO. 1
REPORT NO.

CLIENT: Peter Kiewit Sons Company Ltd.
SITE AND/OR PROJECT: Quarry Investigation, Yukon

DATE OF BORING: 25-26 August '83
DATE OF WL READING: 27 August '83

DEPTH, ft	ELEVATION DEPTH AND WATER LEVEL	STRATIGRAPHY	SOIL DESCRIPTION (1)	CONDITION	TYPE	NUMBER	RECOVERY %	RQD, >4 in %	GRAIN SIZE HYDROMETER UNIT WEIGHT CONSOLIDATION
	Bip		Continuation of Borehole #1						
90			Shale: grey, soft fractured. RQD: Very poor		N	23	100	–	
100			92-102: Sandstone-shale thinly bedded and very broken with thin seams of coal between 97' and 99'		N	24	100	–	
	12				NQ	25	100	–	
110					NQ	26	100	–	
	15		102-130: Thinly bedded broken shale and grey sandstone.		NQ	27	96	–	
120					NQ	28	90	–	
					NQ	29	100	–	
					NQ	30	100	–	
			130-213': Shale very fractured broken with some thinly bedded zones Sandstone layer very broken 161 - 162 168 - 169 171 - 172 180 - 181		NQ	31	100	–	
140					NQ	32	100	–	
					NQ	33	98	–	
150					NQ	34	83	–	
					NQ	35	70	–	
160					NQ	36	100	–	
					NQ	37	90	–	
170					NQ	38	100	–	
					NQ	39	98	–	
180									

LABORATORY AND FIELD TEST RESULTS
- △ IN SITU FIELD VANE, S_u
- ▽ LABORATORY VANE, C_u
- ○ WATER CONTENT, W, %
- ⊢⊣ ATTERBERG LIMIT W_P W_L

GRAPHIC SCALE %

DATUM:
VERIFIED BY:
UNDRAINED SHEAR STRENGTH kPa

HOGGAN

OFFICE BOREHOLE RECORD

APPENDIX I

BOREHOLE No. 1

REPORT NO.

CLIENT: Peter Kiewit Sons Company Ltd.

SITE AND/OR PROJECT: Quarry Investigation, Yukon

DATE OF BORING: 25-26 August/83

DATE OF WL READING: 27 August /83

DEPTH, ft	ELEVATION DEPTH AND WATER LEVEL	STRATIGRAPHY	SOIL DESCRIPTION (1)	CONDITION	TYPE	NUMBER	RECOVERY %	RQD, >4 in %	GRAIN SIZE HYDROMETER UNIT WEIGHT CONSOLIDATION G S γ C	LABORATORY AND FIELD TEST RESULTS: Δ IN SITU FIELD VANE, S; ▲ LABORATORY VANE, C; ○ WATER CONTENT, W %; ⊢ WP WL ATTERBERG LIMIT; GRAPHIC SCALE %
	Dip		Continuation of Borehole #1							
180					NQ	40	85	–		
					NQ	41	80	–		
190					NQ	42	100	–		
					NQ	43	95	–		
200	20°				NQ	44	90	–		
					NQ	45	100	–		
210					NQ	46	90	–		
					NQ	47	93	–		
220	24°		218-223: Broken thinly bedded grey sandstone		NQ	48	98	–		
					NQ	49	100	–		
230			223-253: Shale badly broken with thin bed of fine sandstone, conglomerate soft between 249'-251'		NQ	50	100	–		
					NQ	51	100	–		
240					NQ	52	90	–		
					NQ	53	83	–		
250	15°		253-318: Broken sandstone with thin bed of shale		NQ	54	83	–		
			255-258: Vertical fracture		NQ	55	100	–		
260					NQ	56	100	–		
	10°									
			267. Conglomerate bed 1"		NQ	57	83	–		
270										

DATUM:

VERIFIED BY:

UNDRAINED SHEAR STRENGTH kPa

HOGGAN

OFFICE BOREHOLE RECORD

APPENDIX 1

BOREHOLE No. 1

REPORT NO

CLIENT: Peter Kiewit Sons Company Ltd.

SITE AND/OR PROJECT: Quarry Investigation, Yukon

DATE OF BORING: 25-26 August/83

DATE OF WL READING: 27 August/83

DEPTH ft	ELEVATION DEPTH AND WATER LEVEL	STRATIGRAPHY	SOIL DESCRIPTION (1)	CONDITION	TYPE	NUMBER	RECOVERY %	ROD, > 4 in %	GRAIN SIZE HYDROMETER UNIT WEIGHT CONSOLIDATION	LABORATORY AND FIELD TEST RESULTS
	Dip		Continuation of Borehole #1							GRAPHIC SCALE
270	5°				NQ	58	100	–		
					NQ	59	92	–		
			278-280: Conglomerate beds		NQ	60	80	–		
280					NQ	61	100	–		
			285-297: Bed of soft sandstone		NQ	62	100	–		
290					NQ	63	78	–		
300	5°				NQ	64	100	–		
					NQ	65	92	–		
310			310-312: Bed of grey sandstone		NQ	66	100	–		
					NQ	67	100	–		
320			End of Borehole @ 318 ft.							

DATUM

VERIFIED BY:

UNDRAINED SHEAR STRENGTH kPa

Borehole No. 2 18 ft. - 138 ft.

HOGGAN

OFFICE BOREHOLE RECORD

APPENDIX
BOREHOLE No: 2
REPORT NO.:

CLIENT: Peter Kiewit Sons Company Ltd.
DATE OF BORING: 28-29 August/83
SITE AND/OR PROJECT: Quarry Investigation, Yukon
DATE OF WL READING:

DEPTH, ft	ELEVATION DEPTH AND WATER LEVEL	STRATIGRAPHY	SOIL DESCRIPTION (2)	CONDITION	TYPE	NUMBER	RECOVERY %	RQD, >4 in %	GRAIN SIZE HYDROMETER UNIT WEIGHT CONSOLIDATION
0			Ground Level						
			Overburden of silt sand and gravel conglomerate pieces						
10			Sandstone & conglomerate medium hard to hard with some fractured zones, chert pebbles in top 10 feet, very hard						
	Dip		18-19: Thin fractures sandstone Less 2"		NQ	1	0	0	
20			21-22: Vertical fracture in solid medium grained sandstone (15°-20°)		NQ	2	100	67	
					NQ	3	93	84	
30	12°				NQ	4	93	81	
	14°		33-34: Rusty grey soft sandstone folded, dip 80°, coal		NQ	5	100	81	
40			38-43: Conglomerate		NQ	6	100	87	
	17°				NQ	7	95	89	
			48-50: Vertical fracture in solid fine grained sandstone (2")		NQ	8	93	89	
50					NQ	9	98	88	
60			Fractured coarse grained conglomerate sandstone, coal		NQ	10	100	53	
			62-63: Thin seams of coal		NQ	11	100	40	
			66-67: Shale seam						
70			68-69: Brown and soft gravel in conglomerate		NQ	12	100	22	
			76-77: Soft sandstone with seam of coal		NQ	13	100	58	
80					NQ	14	100	33	
	14°				NQ	15	100	46	
90					NQ	16	100	10	

LABORATORY AND FIELD TEST RESULTS
△ IN SITU FIELD VANE, S_v
□ LABORATORY VANE, S_v
○ WATER CONTENT, W_n
⊢ ATTERBERG LIMIT
W_P W_L

GRAPHIC SCALE %

2-4 in	4-8 in	8-16 in	≥16 in	MAX CORE in
0	0	0	0	
0	36	31	0	
7	0	0	84	16
13	9	45	27	16
14	35	19	27	
11	51	0	0	
5	28	26	35	22
0	0	14	75	33
9	8	28	52	42
18	25	28	0	
25	40	0	0	
17	8	15	0	
18	43	15	0	
43	33	0	0	
15	0	15	31	
20	10	0	0	

UNDRAINED SHEAR STRENGTH, psf

HOGGAN

OFFICE BOREHOLE RECORD

APPENDIX

BOREHOLE No: 2

REPORT NO:

CLIENT: Peter Kiewit Sons Company Ltd.

DATE OF BORING: 28-29 August, 83

SITE AND/OR PROJECT: Quarry Investigation, Yukon

DATE OF WL READING:

DEPTH ft	ELEVATION DEPTH AND WATER LEVEL	STRATIGRAPHY	SOIL DESCRIPTION (2)	CONDITION	TYPE	NUMBER	RECOVERY %	RQD, >4 in %	GRAIN SIZE HYDROMETER UNIT WEIGHT CONSOLIDATION G S >C
			Continuation of Borehole #2						
90					NQ	16	100	10	
			96-101: Very soft, fine grained sandstone, folded, dip 80°-90°, coal		NQ	17	100	62	
100			100: Mudstone seam (3")		NQ	18	100	45	
			103.7-104: Thin 1"-2" sandstone cores						
	12'		104-107: Vertical fracture in medium grained soft sandstone (0-5°)		NQ	19	100	31	
110			112.5-113.5: Vertical fracture		NQ	20	100	89	
			113.5-114.2: Thin 2"-3" sandstone cores						
			115-119: Fractured conglomerate and sandstone, 1"-4" cores, coal seams		NQ	21	100	36	
120					NQ	22	98	62	
			123-124: Vertical fracture in medium grained conglomerate		NQ	23	100	88	
			124-125: Very fractured soft shale						
130					NQ	24	100	100	
					NQ	25	100	100	
140			End of Borehole @ 138 ft. Drill rods froze in hole at 138 ft. and lost						
150									
160									
170									
180									

LABORATORY AND FIELD TEST RESULTS

- IN SITU FIELD VANE, S_v
- LABORATORY VANE, C_u
- WATER CONTENT, W_c %
- ATTERBERG LIMIT, W_P W_L

GRAPHIC SCALE %

	2-4 in	4-8 in	8-16 in	≥16 in
	20	10	0	0
	21	25	37	0
	21	45	0	0
	3	31	0	0
	6	28	33	28
	13	18	18	0
	18	29	33	0
	4	23	65	0
	0	7	36	57
				100

DATUM:

VERIFIED BY:

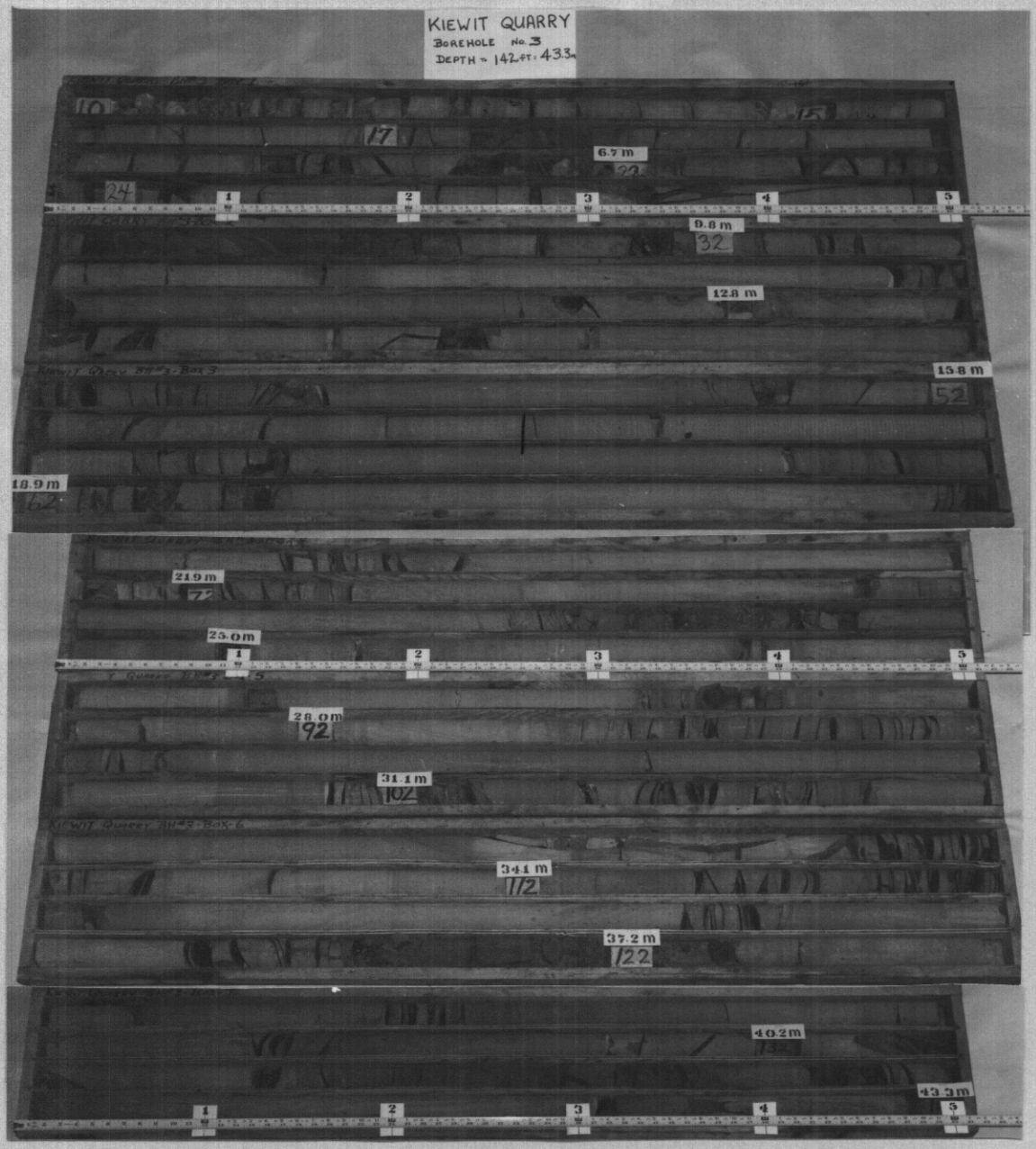
UNDRAINED SHEAR STRENGTH kPa

CLIENT: PETER KIEWIT SONS CO. LTD.
PROJECT: YUKON QUARRY

BOREHOLE 2

Depth (ft)	Description	Bulk Relative Density (lb/ft3)	Bulk Relative Specific Gravity	Absorption (%)	Uniaxial Point Load Compressive Tests Diametral (psi)	Axial (psi)	Unconfined Compressive Strength (psi)	Freeze Thaw	Los Angeles Abrasion (% wear)	Sulphate Soundess (% loss)
24'	Solid conglomerate	167.1	2.681	0.44						
25'-25'4"	Solid conglomerate & sandstone	165.8	2.660				14800			
26'6"-27'	Solid grey fine to med. grained sandstone, salt & pepper	166.5	2.668				13700*			
27'5"	Solid grey fine to med. grained sandstone				17400	13600				
28'5"-28'9"	Solid conglomerate & sandstone	163.8	2.627				12400			
29'3"-30'		157.8	2.53					F/T		
30'-30'4"	Fine to medium grey sandstone & conglomerate	148.5	2.382				4900			
30'8"	Soft medium grained sandstone				6400					
31'1"-31'7"	Soft medium grained sandstone salt & pepper	149.2	2.391				6600*			
35'	Medium soft, medium grained sandstone	156.1	2.504	1.87						
35'5"-35'9"	Fine grained grey solid sandstone	162.7	2.609				13500			
37'0"	Grey sandstone & conglomerate									
37'5"-37'11"	Grey sandstone & conglomerate	156.0	2.499				5100*			
38'8"-39'2"		156.1	2.503					F/T		
40'10"-41'7"		151.3	2.427					F/T		
41'10"	Solid conglomerate, coarser grained cemented limestone				3500	2800				
42'-42'6"	Solid conglomerate, coarser grained cemented limestone	152.3	2.440							
43'	Medium soft conglomerate	152.5	2.446	2.19						
44'-44'4"	Fine grained grey solid sandstone	152.4	2.444				8600			
45'-45'6"	Sandstone, salt & pepper	152.5	2.446				6200*			
45'9"	Sandstone				9200	6600				
52'-52'4"	Conglomerate & sandstone	148.6	2.383				7500			
52'4"-52'8"	Conglomerate & sandstone	148.1	2.375				7300			
53'9"-54'3"	Sandstone & conglomerate, medium to coarse grained	150.5	2.412				4000*			
53'10"-54'7"	Sandstone & conglomerate, medium to coarse grained	148.3	2.379							
54'9"	Sandstone & conglomerate medium to coarse grained				6300	3700				
56'-56'4"	Conglomerate & sandstone	147.8	2.371				5500			
57'	Medium soft sandstone, fine-medium grained	148.1	2.375	3.50						
69'8"-70'2"	Sandstone & conglomerate medium to coarse grained	153.0	2.452			4000				
70'4"	Sandstone & conglomerate medium to coarse grained				2800					
75'-75'6"	Sandstone & conglomerate medium to coarse grained	152.6	2.443		3900		2900*			
75'7"	Sandstone & conglomerate, medium to coarse grained	151.7	2.431				4400*			
81'5"-81'9"	Conglomerate & sandstone	149.1	2.392				5100			
84'5"	Medium grained sandstone				5700					
84'11"-85'8"		155.9	2.501							
94'	Sandstone & conglomerate	156.9	2.517	1.97						
97'1"-97'5" •	Fine & medium grained sandstone - grey	154.6	2.477							
97'8"	Fine & medium grained sandstone									
99'6"-100'		141.9	2.276					F/T		
105'-105'4"	Solid medium sandstone	152.3	2.442				8000			
109'-109'6"	Fine grained sandstone (stratified) salt & pepper	152.4	2.442				8600*			
109'9"	Fine grained sandstone (stratified				7600					
112'	Sandstone & coal	163.1	2.615	0.60						
119'-119'4"	Sandstone & solid conglomerate	155.7	2.497				8000			
119'10"-120'9"		156.7	2.514							
120'9"-121'2"	Sandstone & conglomerate, medium to coarse grained	162.0	2.596				5500*			
120'6"	Sandstone & conglomerate, medium to coarse grained				17100					
120'9"	Sandstone & conglomerate, medium to coarse grained				7800					
127'2"	Sandstone & conglomerate				7800					
127'3"-127'9"	Sandstone & conglomerate	155.4	2.491				4700*			
128'5"-128'9"	Sandstone & conglomerate	156.9	2.516				9800			
133'9"-134'10"		137.2	2.200					F/T		
135'-135'6"	Sandstone & conglomerate	156.8	2.513				6000*			
135'8"	Sandstone				6900					
137'	Medium grained sandstone	152.6	2.447	2.80						
137'-137'4"	Sandstone & solid conglomerate	153.3	2.458				7100			

Note: • Oven dry sample.



Borehole No. 3 10 ft. - 142 ft.

HOGGAN

OFFICE BOREHOLE RECORD

APPENDIX

BOREHOLE No: 3

REPORT NO:

CLIENT: Peter Kiewit Sons Company Ltd.

SITE AND/OR PROJECT: Quarry Investigation, Yukon

DATE OF BORING: 5-6 Sept./83

DATE OF WL READING: 13 Sept./83

DEPTH, ft	ELEVATION DEPTH AND WATER LEVEL	STRATIGRAPHY	SOIL DESCRIPTION (3)	CONDITION	TYPE	NUMBER	RECOVERY %	RQD, >4 in %	GRAIN SIZE HYDROMETER UNIT WEIGHT CONSOLIDATION
0			Ground Level						
			Talus of broken sandstone slabs with some fine's in lower part						
	Dip								
10	11		Sandstone Formation:						
	17°		Brown to grey medium hard,		NQ	1	62	13	
	16°		fine grained.						
			17-18: Rusty brown sand		NQ	2	100	88	
20			20-22: Thin fractured sandstone 45° - 60° Fractures		NQ	3	100	47	
			23-24: Fractured sandstone with oxydation on fracture face		NQ	4	83	33	
			26-28: Vertical fracture in solid sandstone		NQ	5	88	25	
30			28-31: Rusty brown sand, folded, Dip 50°						
			32-33: Fractured sandstone						
			38-40: Fractured sandstone		NQ	6	97	78	
40									
			47-48: Thin 3" sandstone		NQ	7	100	68	
50									
	23°		58-59: Thin 2" sandstone cores		NQ	8	97	86	
60			62-64: Thin 1-3" sandstone cores						
			67.5: Conglomerate bed (0.5")		NQ	9	98	71	
			68-69: Thin 1-3" sandstone cores						
70			71-73: Thin 1-3" sandstone cores						
					NQ	10	98	66	
80			79-81: Rusty brown sand, coal						
	15		82.5: Conglomerate bed (0.5")						
	12°		88.5: Conglomerate bed		NQ	11	98	90	
90			89-90: Thin sandstone seams (very soft)						

LABORATORY AND FIELD TEST RESULTS

△ IN SITU FIELD VANE, S_u

□ LABORATORY VANE, C_u

○ WATER CONTENT, W, %

I ATTERBERG LIMIT W_P W_L

GRAPHIC SCALE %

	2-4 in	4-8 in	8-16 in	>16 in	MAX CORE in
	100	100	100	100	
	20	13	0	0	
	10	84	0	0	
	19	33	14	0	
	17	0	33	0	
	8	14	11	0	
					37
	13	9	15	54	28
					25
	23	8	20	40	24
					20
	2	26	14	46	31
					41
	5	10	0	61	33
					34
	4	0	0	66	29
					26
	2	6	8	76	24
					16

DATUM

VERIFIED BY:

UNDRAINED SHEAR STRENGTH kPa

HOGGAN

OFFICE BOREHOLE RECORD

APPENDIX

BOREHOLE No. 3

REPORT NO.

CLIENT: Peter Kiewit Sons Company Ltd.

SITE AND/OR PROJECT: Quarry Investigation, Yukon

DATE OF BORING: 5-6 Sept/83

DATE OF WL READING: 13 Sept/83

DEPTH ft	ELEVATION DEPTH AND WATER LEVEL	STRATIGRAPHY	SOIL DESCRIPTION (3)	CONDITION	TYPE	NUMBER	RECOVERY %	RQD, >4 in %	GRAIN SIZE HYDROMETER UNIT WEIGHT CONSOLIDATION G S γ C	LABORATORY AND FIELD TEST RESULTS
			Continuation of Borehole #2							Δ IN SITU FIELD VANE, S_u □ LABORATORY VANE, C_u ○ WATER CONTENT W, % ⊣ WP WL ATTERBERG LIMIT
90			94-96: Thin sandstone ¼"-2"		NQ	12	100	70		GRAPHIC SCALE % 100 100 100 100
	18'									2 6 8 76 31
100										8 0 0 70 21 16
	13'		102-105: Thin sandstone ¼"-4" with a conglomerate bot 1" at 103'							
			107-109: Vertical fracture		NQ	13	100	53		9 11 12 30 36
110			109-110: Seam 0-1"							
			113-115: Thin sandstone ½"-1" seams							
					NQ	14	99	54		7 5 0 49 36 16
120			119-120: Seamy sandstone 120-122: Rusty yellow brown sand							
	16'									
					NQ	15	99	78		8 0 0 78 16 26 18
130										
			134-137: Rusty brown sand, thin sandstone on top & bottom		NQ	16	98	63		6 12 22 29 36 17
140										
			End of Borehole @ 142 ft.							

2-4 in	4-8 in	8-16 in	>16 in	MAX CORE in

Note: -02 plus 24" long cores
-12 plus 36" long cores

DATUM: VERIFIED BY:

UNDRAINED SHEAR STRENGTH kPa

CLIENT: PETER KIEWIT SONS CO. LTD.
PROJECT: YUKON QUARRY

Depth (ft)	Description	Bulk Relative Density (lb/ft3)	Bulk Relative Specific Gravity	Absorption (%)	Uniaxial Point Load Compressive Tests Diametral (psi)	Uniaxial Point Load Compressive Tests Axial (psi)	Unconfined Compressive Strength (psi)	Freeze Thaw	Los Angeles Abrasion (% wear)	Sulphate Soundess (% loss)
13'	Fine grained solid sandstone	162.4	2.604	2.76						
16'	Fine grained sandstone				16000					
16'7"-17'	Fine grained sandstone	150.1	2.406				10000*			
19'4"-20'1"		149.0	2.387					F/T		
20'	Fine grained sandstone, solid	151.2	2.425	2.92						
23'3"-23'11"		149.5	2.396					F/T		
24'-24'4"	Fine grained light brown solid sandstone	151.5	2.430				11400			
24'9"-25'3"	Fine grained sandstone (with closed ferric joint)	151.5	2.427				10900*			
25'7"	Fine grained sandstone				19000					
30'	soft weakly cemented sandstone with haematite				0					
33'-33'10"		153.6	2.462					F/T		
35'	Fine grained grey sandstone				16500					
35'4"-35'10"	Fine grained grey sandstone	151.7	2.431		18800		16400*			
37'-37'4"	Fine grained sandstone	149.8	2.403				10500			
41'	Fine grained sandstone with conglomerate	151.2	2.426	2.56						
42.5'	Fine grained sandstone, solid	151.9	2.436	2.44						
43'-43'4"		151.1	2.423				12500			
43'0"-43'10"		151.6	2.430					F/T		
47'-54'							12800*			
47'3"	Fine grained grey brown sandstone				12800					
47'6"-48'0"	Fine grained grey brown sandstone	153.3	2.457				17500*			
48'	Rusty bonded grey brown fine grained sandstone (jointed rusty seams)				4700					
53'6"	Fine grained grey sandstone				18000					
53'11"54'5"	Fine grained grey sandstone	150.4	2.411				17300*			
54'8"-55'3"		150.9	2.418					F/T		
55'	Grey fine grained sandstone, solid	150.5	2.414	2.39						
56'-56'4"	Fine grained sandstone	151.2	2.425				13300			
61'		150.4	2.413	2.69						
61'-61'6"		153.5	2.459					F/T		
65'11"-66'5"	Grey brown sandstone with rusty bending	150.7	2.416		14600		16400*			
66'6"	Grey brown sandstone with rusty bending				14500					
69'-69'4"	Grey fine grained sandstone	150.2	2.410				10700			
71'	Fine grained sandstone, solid	150.2	2.408	2.69						
75'	Grey fine grained sandstone				17800					
75'1"-75'7"	Grey fine grained sandstone	151.8	2.433		17500		14400*			
77'-77'4"	Grey fine grained sandstone	151.7	2.433				12200			
78'6"	Rusty bended sandstone, horizontally bedded (cleares along rusty planes)				5300					
79'	Friable rusty brown sandstone, rusty				0					
80'	Fine grained sandstone, solid	149.3	2.394	2.71						
82'-82'6"	Grey fine grained sandstone	150.4	2.410		21300		17100*			
82'-86'							10400			
82'8"		152.9	2.450					F/T		
83'-83'4"	Grey fine grained sandstone	151.5	2.430				13300			
86'-86'6"	Grey fine grained sandstone	151.6	2.429		19100		19100*			
86'8"					19200					
91'	Grey fine grained, solid	149.0	2.390	2.90						

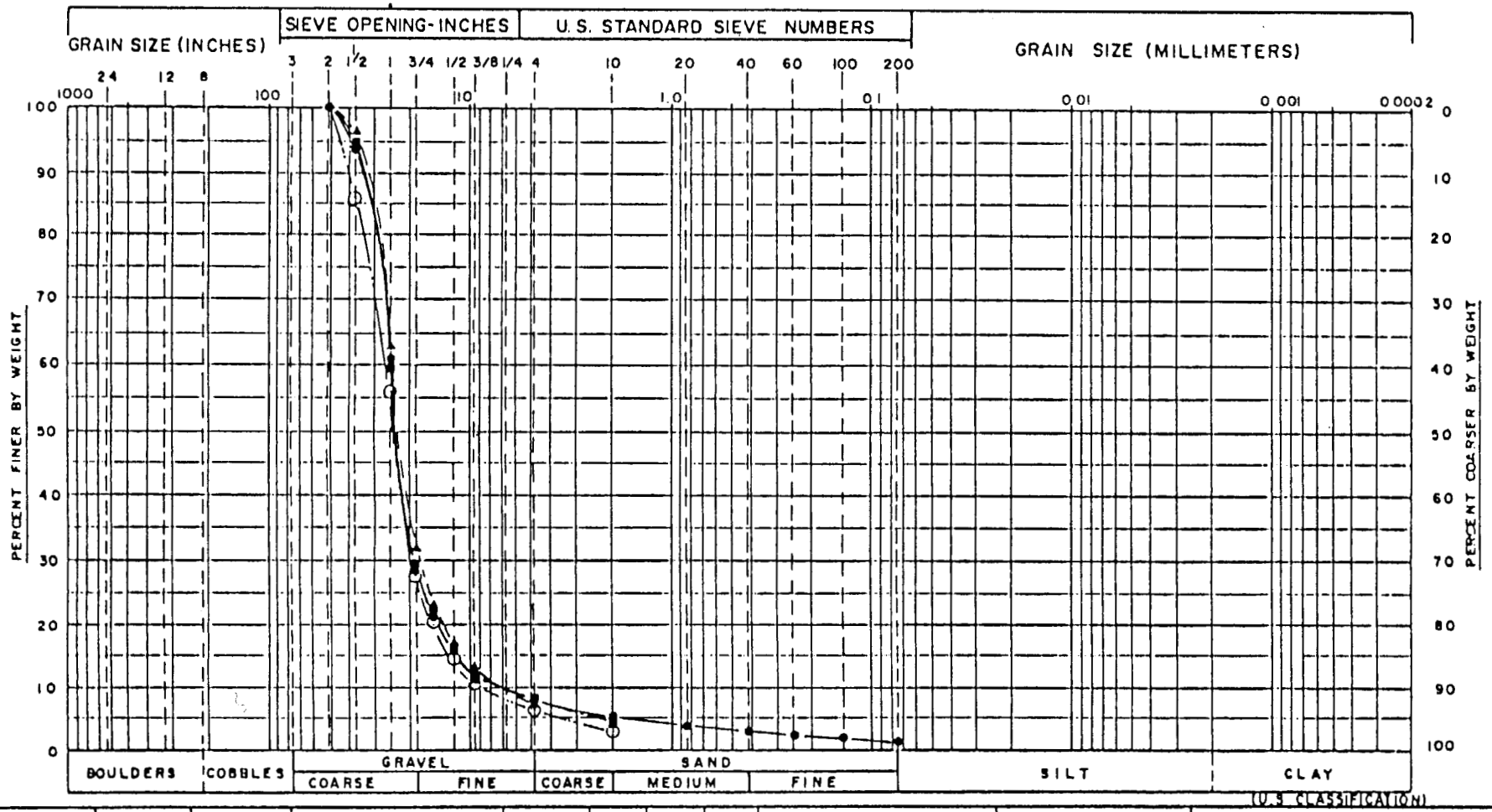
Note: * Oven dry sample.

CLIENT: PETER KIEWIT SONS CO. LTD.
PROJECT: YUKON QUARRY

Depth (ft)	Description	Bulk Relative Density (lb/ft3)	Bulk Relative Specific Gravity	Absorption (%)	Uniaxial Point Load Compressive Tests Diameter (psi)	Axial (psi)	Unconfined Compressive Strength (psi)	Freeze Thaw	Los Angeles Abrasion (% wear)	Sulphate Soundess (% loss)
92'-93'4"		150.8	2.416					F/T		
103'	Fine grained sandstone & conglomerate	151.5	2.430	2.96			7400			
104'3"	Grey brown fine grained sandstone				16300					
104'6"-105'	Grey brown fine grained sandstone	151.8	2.432				13500 14900*			
109'9"	Grey brown fine grained sandstone	152.3	2.441				16200*			
110'8"-111'10"		151.0	2.420					F/T		
113'10"	Grey brown bended sandstone; some ferric bands which are joint planes, badly jointed				11900					
118'	Grey brown fined grained sandstone				15300					
118'3"-118'9"	Grey brown fine grained sandstone				13800		11800 14000*			
121'	Rusty ochre brown sand (loosely cemented)				0					
128'-128'6"	Grey brown fine grained sandstone	151.4	2.429		15000		15100* 12400*			
128'-134'										
129'	Fine grained sandstone, solid	152.1	2.440	2.54						
129'7"-131'1"		153.8	2.464					F/T		
133'3"	Grey brown fine grained sandstone				15300					
133'6"-134'	Grey brown fine grained sandstone	152.2	2.439		13000		15100*			
135'8"	Bended rusty sandstone; loosely cemented with ferric bands to 12mm, fractured, highly ferric				1300					
141'6"	Grey brown sandstone with ferric bands small pebbles -									
	- coarse black sand				5200					
	- uniform material				10000					
Crushed sample										
0'-40'	Sandstone (crushed) (see sieve analyses S.A.#2949(a) - 2" crushed core (in lab.), 7% sand S.A.#2949(b) - crushed from 33" length of core at 33' depth, 6.1% sand)	81.4 (loose density of crushed samples)	2.389	3.27					33.4	
40'-90'	Sandstone (crushed) (see sieve analysis S.A.#2950 - 2" crushed core (in lab.), 7.5% sand)	77.5 loose density of crushed samples)	2.381	3.58					37.6	
90'-140'	Sandstone (crushed) (see sieve analysis S.A.#2951 - 2" crushed core (in lab.), 7.9% sand	78.9 (loose Density of crushed samples)	2.409 (bulk relative density)	3.33					35.4	
0'-140'	Poor quality core (miscellaneous crushed) (see sieve analysis) S.A.#2955 - 2" crushed core (in lab.), 3.7%	80.0 (loose density of crushed Sample)	2.411	3.71					36.8	

Note: • Oven dry sample.

GRAIN – SIZE DISTRIBUTION



	TEST PIT OR BORING No.	SAMPLE No.	ELEV. OR DEPTH	U.S. CLASSIFICATION	NAT. WC	LL	PL	PI	COMPACTION TEST MAX. DENSITY	COMPACTION TEST OPT. WC
●	3	2949	0-40	SANDSTONE						
▲	3		30-90	SANDSTONE						
■	3	3	90-140	SANDSTONE						
○	3	4	0-140	BAD PORTION						

REMARKS— CRUSHED CORES FROM BOREHOLE 3

PROJECT No. 3761
KIEWIT QUARRY
AREA KING POINT
DATE OCT. 13/83

FIGURE No.

Borehole No. 4 2 ft. - 222 ft.

HOGGAN

OFFICE BOREHOLE RECORD

APPENDIX

BOREHOLE No. 4

REPORT NO.:

CLIENT: Peter Kiewit Sons Company Ltd.

SITE AND/OR PROJECT: Quarry Investigation, Yukon

DATE OF BORING: 7-8 Sept, 1983

DATE OF WL READING: 13 Sept, 1983

DEPTH, FT	ELEVATION DEPTH AND WATER LEVEL	STRATIGRAPHY	SOIL DESCRIPTION (4)	CONDITION	TYPE	NUMBER	RECOVERY %	RQD, >4 in %	GRAIN SIZE, HYDROMETER, UNIT WEIGHT, CONSOLIDATION
0	Pipe		Ground Level						
10	▽		Overburden with slabs of thin sandstone		NQ	1	7	0	
					NQ	2	25	0	
20			Sandstone: Light brown to grey fine grained becoming more fine grained at depth -24° plus 24" long cores - 9° plus 36" long cores		NQ	3	95	64	
	20°		19-21: Sand seam 23-26: Fractures at 55° & 60°		NQ	4	71	64	
30	23		35-36: 75° Dipping fracture		NQ	5	92	75	
40			39: 65° Fracture 42: 60° Dipping fracture 44: 55° Fracture						
	15°		45: Sand bed						
50			50-51: 80° Dipping fracture		NQ	6	97	78	
	10°		59-60: 70° Dipping fracture		NQ	7	97	81	
60			69: Thin sand bed		NQ	8	97	92	
70	15°		72-74: Rusty brown sand contact at 23 77: Conglomerate bed		NQ	9	100	96	
80			83: 10° Dipping fracture 85-86: 73° Dipping fracture		NQ	10	100	88	
90	14°		87-89: Conglomerate seams						

SAMPLES

LABORATORY AND FIELD TEST RESULTS

- IN SITU FIELD VANE S
- LABORATORY VANE C
- WATER CONTENT W %
- ATTERBERG LIMIT W_P W_L

GRAPHIC SCALE %: 100 100 100 100

2-4 in	4-8 in	8-16 in	>16 in	max core in
0	0	0	0	
10	0	0	0	
23	64	0	0	
4	0	27	37	20 29
2	3	14	58	21 20 34
5	6	57	15	19 33
3	15	11	56	16 19 33
0	4	20	68	30 19
0	4	11	81	40 29
0	11	0	0	19 77 46

DATUM:

VERIFIED BY:

UNDRAINED SHEAR STRENGTH kPa

HOGGAN

OFFICE BOREHOLE RECORD

APPENDIX
BOREHOLE No. 4
REPORT NO

CLIENT: Peter Kiewit Sons Company Ltd.
SITE AND/OR PROJECT: Quarry Investigation, Yukon

DATE OF BORING: 7-8 Sept, 1982
DATE OF WL READING: 13 Sept, 1982

DEPTH, FT	ELEVATION DEPTH AND WATER LEVEL	STRATIGRAPHY	SOIL DESCRIPTION (4)	CONDITION	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY %	RQD, >4 in %	DRAIN SIZE HYDROMETER UNIT WEIGHT CONSOLIDATION	LABORATORY AND FIELD TEST RESULTS: IN SITU FIELD VANE; LABORATORY VANE; WATER CONTENT; ATTERBERG LIMIT WP WL; GRAPHIC SCALE % 100 100 100 100
	Dip		Continuation of Borehole #4				%	%		
90					NQ	10	100	88		0 11 0 0 77
			91-95: Fractured sandstone		NQ	11	93	64		10 0 0 60 18 17 37
	17°		104: Seal packer (6"							
110			106-114: Rusty brown soft sandstone and coal		NQ	12	82	30		6 9 11 0
120	15°		123: " Conglomerate layer		NQ	13	100	96		6 22 33 36 24 19
					NQ	14	96	71		8 0 22 44 31 28
130			130: 2" Conglomerate bed							
			134-136: Rusty brown sand and soft sandstone fractured		NQ	15	91	59		17 11 9 34 21 20
140			142-143: Soft sandstone broken							
			146: " Conglomerate bed							
			150: " Conglomerate bed		NQ	16	100	89		9 32 26 31 18 20
150	18°		155: " Conglomerate bed							
			Formation of soft grey coarse sandstone and conglomerate with some layers of shale and coal.		NQ	17	100	90		10 28 27 35 42
160			164-166: Conglomerate bed with coal seam (4")							
			166-171: Shale with some layers of sandstone		NQ	18	100			MAX CORE 10 - - - - -
170					NQ	19	100			- - - - -

DATUM | VERIFIED BY | UNDRAINED SHEAR STRENGTH psf

HOGGAN

OFFICE BOREHOLE RECORD

APPENDIX
BOREHOLE No. (4)
REPORT NO

CLIENT Peter Kiewit Sons Company Ltd. | DATE OF BORING 7-8 Sept, 1983
SITE AND/OR PROJECT Quarry Investigation, Yukon | DATE OF WL READING 13 Sept, 1983

DEPTH FT	ELEVATION DEPTH AND WATER LEVEL	STRATIGRAPHY	SOIL DESCRIPTION (4) Continuation of Borehole #4	CONDITION	TYPE	NUMBER	RECOVERY %	R.Q.D. > 4 in %	GRAIN SIZE / HYDROMETER / UNIT WEIGHT / CONSOLIDATION	LABORATORY AND FIELD TEST RESULTS
180	Dip		171-212: Coarse grey salt & pepper sandstone soft to very soft with shale zones @ 187 - 188, 190 - 191.5, 192 - 197; 1" mud seams at 206 and 212		NQ	19	100			- - - -
					NQ	20	100			- - - -
190	17				NQ	21	100			- - - -
200					NQ	22	98			- - - -
210			212-222: Shale with some layers of sandstone, thinly bedded		NQ	23	100			- - - -
220			End of Borehole @ 222 ft.							
230										

LABORATORY AND FIELD TEST RESULTS: IN SITU FIELD VANE S; LABORATORY VANE C_u; WATER CONTENT W%; ATTERBERG LIMIT W_P W_L; GRAPHIC SCALE % 100 100 100 100

DRAWN | VERIFIED BY | UNDRAINED SHEAR STRENGTH

CLIENT: PETER KIEWIT SONS CO. LTD.
PROJECT: YUKON QUARRY

Depth (ft)	Description	Bulk Relative Density (lb/ft3)	Bulk Relative Specific Gravity	Absorption (%)	Uniaxial Point Load Compressive Tests Diametral (psi)	Uniaxial Point Load Compressive Tests Axial (psi)	Unconfined Compressive Strength (psi)	Freeze Thaw	Los Angeles Abrasion (% wear)	Sulphate Soundess (% loss)
0-15'	Fine grained sandstone solid, reddish	149.8	2.403	3.16						
20'-20'6"	Grey fine grained sandstone (some coarse particles)	146.8	2.352		10600		8900*			
20'8"	Grey fine grained sandstone (some coarse particles				10300					
21'	Grey fine grained sandstone (medium hard)	147.3	2.362	3.53						
21'-21'4"	Fine grained brown solid sandstone	148.5	2.382				10000			
22'4"-23'2"		158.0	2.535					F/T		
25'-32'	Sandstone						9800			
25'4"-25'10"	Pale brown fine grained sandstone	148.3	2.377		8100		11700*			
26'0"	Pale brown fine grained sandstone				6600					
32'2"	Brown grey fine grained sandstone				11800					
32'5"-32'11"	Brown grey fine grained sandstone	149.1	2.389		11900		12800*			
33'-33'4"	Fine grained sandstone	148.9	2.388				7400			
43'	Grey sandstone, fine grained some conglomerate	150.5	2.414	2.83						
43'5"-43'9"	Grey brown solid sandstone	150.8	2.419				12000			
46'4"	Grey brown fine grained sandstone, some ferric bands				8500					
46'6"-47'	Grey brown fine grained sandstone, some ferric bands	145.2	2.326				11500*			
48'6"-50'9"		151.2	2.424					F/T		
54'6"-55'	Grey brown fine grained sandstone	149.6	2.398		15800		14600*			
55'-65'	Grey brown fine grained sandstone						10600*			
55'3"	Grey brown fine grained sandstone				15400					
56'-56'4"	Fine grained sandstone	148.6	2.384				12200			
60'	Grey fine grained sandstone	148.6	2.384	3.12						
65'-65'6"	Brown grey fine grained sandstone	151.5	2.427				16200*			
65'9"	Brown grey fine grained sandstone				15200					
67'-67'4"	Brown grey fined grained sandstone	149.1	2.391				9100			
67'11"-68'5"	Brown grey fine grained sandstone	149.7	2.399		14100		15500			
68'8"	Brown grey fine grained sandstone				13300					
68'10"-69'8"	Brown grey fine grained sandstone	151.4	2.428					F/T		
74'7"-75'1"	Brown grey fine grained sandstone	150.8	2.417		15600		17100*			
75'6"	Brown grey fine grained sandstone				13500					
77'-77'4"	Brown grey fine grained sandstone	150.1	2.408				10900			
82'	Brown grey sandstone (some rusty coarse grains cemented in sandstone matrix)				15900					
82'3"-82'9"	Brown grey sandstone	150.2	2.407		13500		13300*			
82'6"-90'							11300			
90'0"	Grey brown fine grained sandstone	147.0	2.357	3.71	15300					
90'3"-90'9"	Grey brown fined grained sandstone	150.0	2.404		13100		14900*			
98'-98'6"	Fine grained sandstone(closed joint at top of specimen)	149.6	2.399				6300			
100'9"-101'3"	Fine grained sandstone (with closed joint)	151.0	2.421				2300			
102'-102'4"	Brown grey sandstone	147.8	2.370				8000			
102'6"	Brown grey sandstone, jointed (joint planes are rusty ferric bands)				10700					
108'	Brown grey sandstone seam (between sand layers)				7800					
113'9"-114'2"	Sandstone	153.21	2.457				9200			
118'	Brown grey sandstone (immediately below fractured sandstone with rusty joint planes & above thin layer of conglomerate)				12300					

Note: * Oven dry sample.

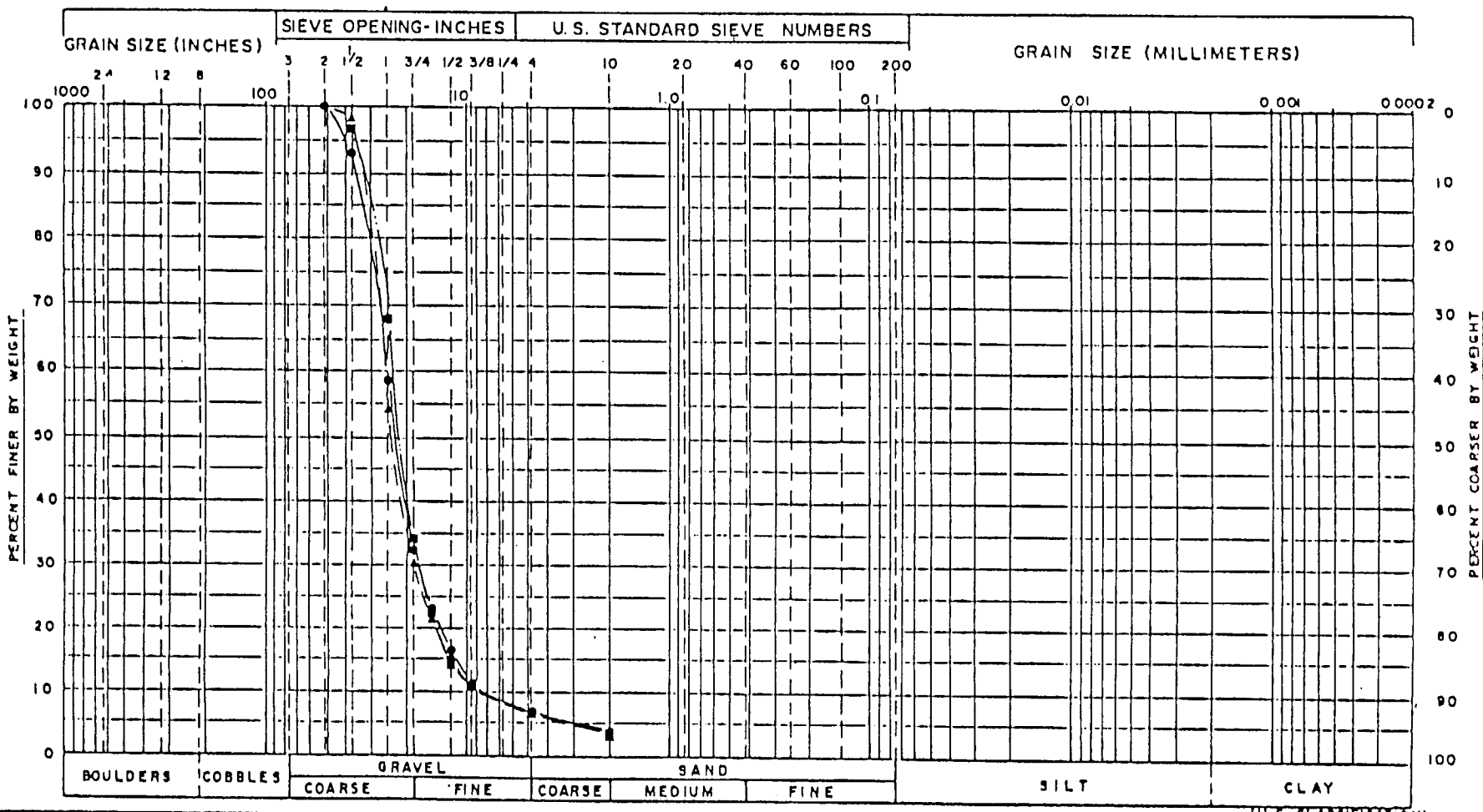
CLIENT: PETER KIEWIT SONS CO. LTD.
PROJECT: YUKON QUARRY

Depth (ft)	Description	Bulk Relative Density (lb/ft3)	Bulk Relative Specific Gravity	Absorption (%)	Uniaxial Point Load Compressive Tests Diametral (psi)	Axial (psi)	Unconfined Compressive Strength (psi)	Freeze Thaw	Los Angeles Abrasion (% wear)	Sulphate Soundess (% loss)
122'	Sandstone	148.9	2.388	3.21						
126'11"-127'5"	Sandstone	149.5	2.398				9300			
129'-129'4"	Sandstone	147.4	2.365				7600			
135'6"	Brown weakly cemented sandstone				5600					
137'4"-137'11"	Fine grained sandstone	146.5	2.350				6600			
139'-139'4"	Fine grained sandstone	147.3	2.362				8000			
146'-146'6"	Grey fine grained sandstone	148.8	2.386				11400			
146'9"	Grey fine grained sandstone				11800	10600				
147'6"	Grey fine grained sandstone				9100					
155'	Solid sandstone with conglomerate	152.0	2.438	3.14						
157'-157'6"	Fine grained sandstone, brown grey	149.5	2.398				10200			
157'6"	Brown grey fine grained sandstone				12800					
157'8"	Brown grey fine grained sandstone				15600					
159'10"	Grey brown sandstone				14600	12800				
160'-160'6"	Grey brown sandstone	152.0	2.438				13700			
160'7"	Grey brown sandstone					12800				
163'3"	Brown grey sandstone, fine matrix with coarse medium grains				15400	11400				
163'6"-164'	Brown grey sandstone, medium grained (with closed joint)	155.3	2.491				9300			
166'	Grey shale (broken	136.8	2.194	8.15						
174'-174'6"	Medium grained sandstone	152.2	2.442				6200			
174'7"	Medium grained sandstone				8100					
178'	Medium grained sandstone soft/weak	145.1	2.328	4.28						
200'	Medium grained sandstone medium soft with coal	147.5	2.366	3.61						
200'3"-200'7"	Medium grained sandstone	151.6	2.431				9000			
200'9"	Medium grained sandstone				7000					
209'	Medium to fine grained sandstone with coal	147.1	2.360	4.98						
209'4"	Medium grained sandstone				7600	5100				
210'2"-210'8"	Medium grained sandstone	146.7	2.353				5000			

Crushed Samples

0'-80'	Sandstone crushed S.A.#2956 - 7% sieve #4	78.8 (loose density of crushed sample)	2.346	3.90					40.5	
80'-113'	Sandstone crushed S.A.#2960 - 6.9% seive #4	80.6 (loose density of crushed sample)	2.364	3.99					42.1	
163'-211'	Soft sandstone (salt & pepper) S.A.#2960 - 6.9% sieve #4	80.2 (loose density of crushed sample)	2.288	5.55					67.3	

GRAIN – SIZE DISTRIBUTION



	TEST PIT OR BORING No.	SAMPLE No.	ELEV. OR DEPTH	U.S. CLASSIFICATION	NAT. WC	LL	PL	PI	COMPACTION TEST MAX. DENSITY	COMPACTION TEST OPT. WC	
●	4	2956	0-80'	SANDSTONE							
▲	4	2957	80-163'	"							
■	4	2960	163-211'	"							

REMARKS – CRUSHED CORES FROM BOREHOLE #4

PROJECT No. 3761

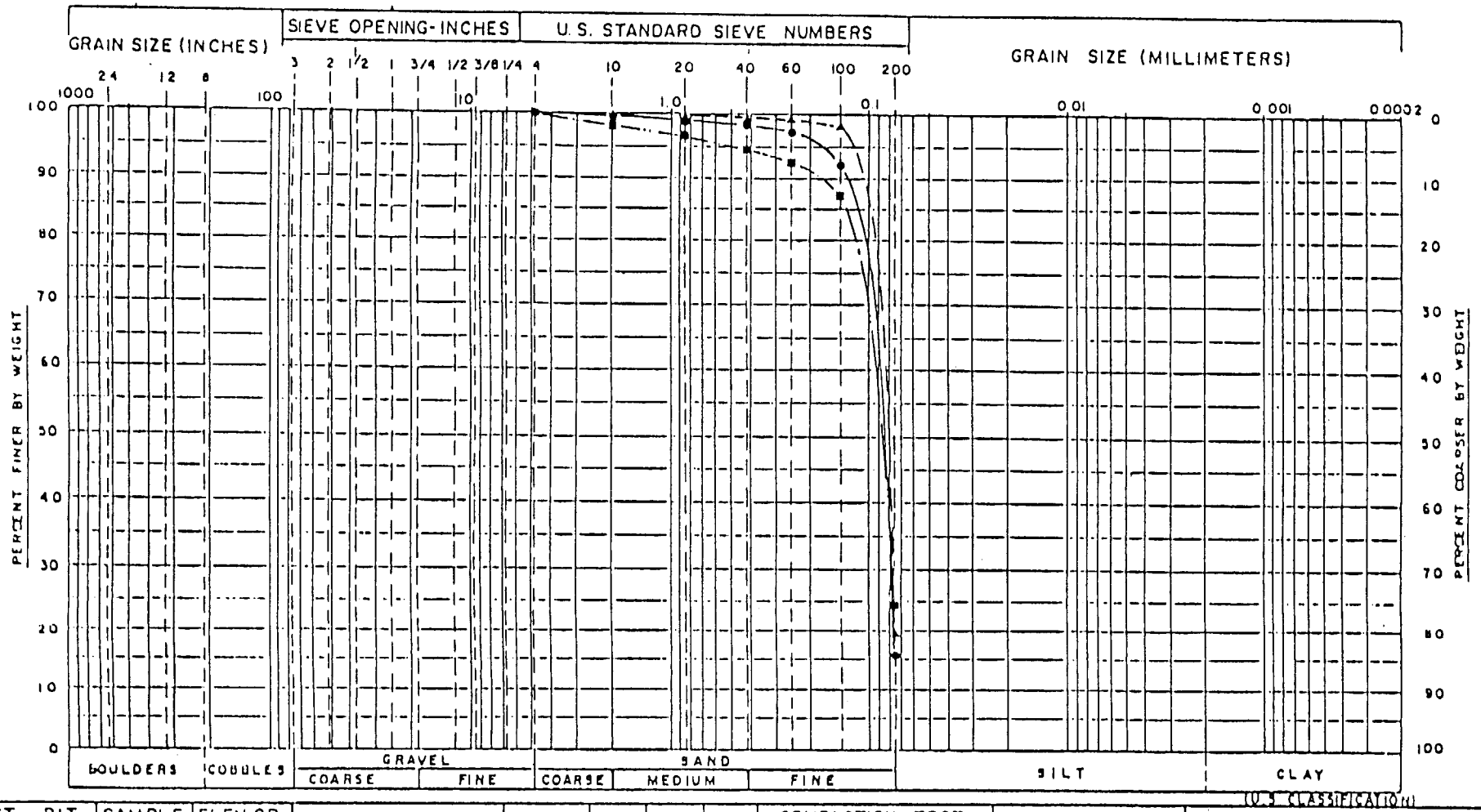
KIEWIT QUARRY

AREA KING POINT

DATE OCT. 13/83

FIGURE No. ____

GRAIN – SIZE DISTRIBUTION



	TEST PIT OR BORING No.	SAMPLE No.	ELEV OR DEPTH	U.S. CLASSIFICATION	NAT. WC	LL	PL	PI	COMPACTION TEST MAX. DENSITY	COMPACTION TEST OPT. WC	
●	4	2944	108'	SAND SEAM							
▲	4	2945	112'	" "							
■	4	2946	127'	" "							

REMARKS —

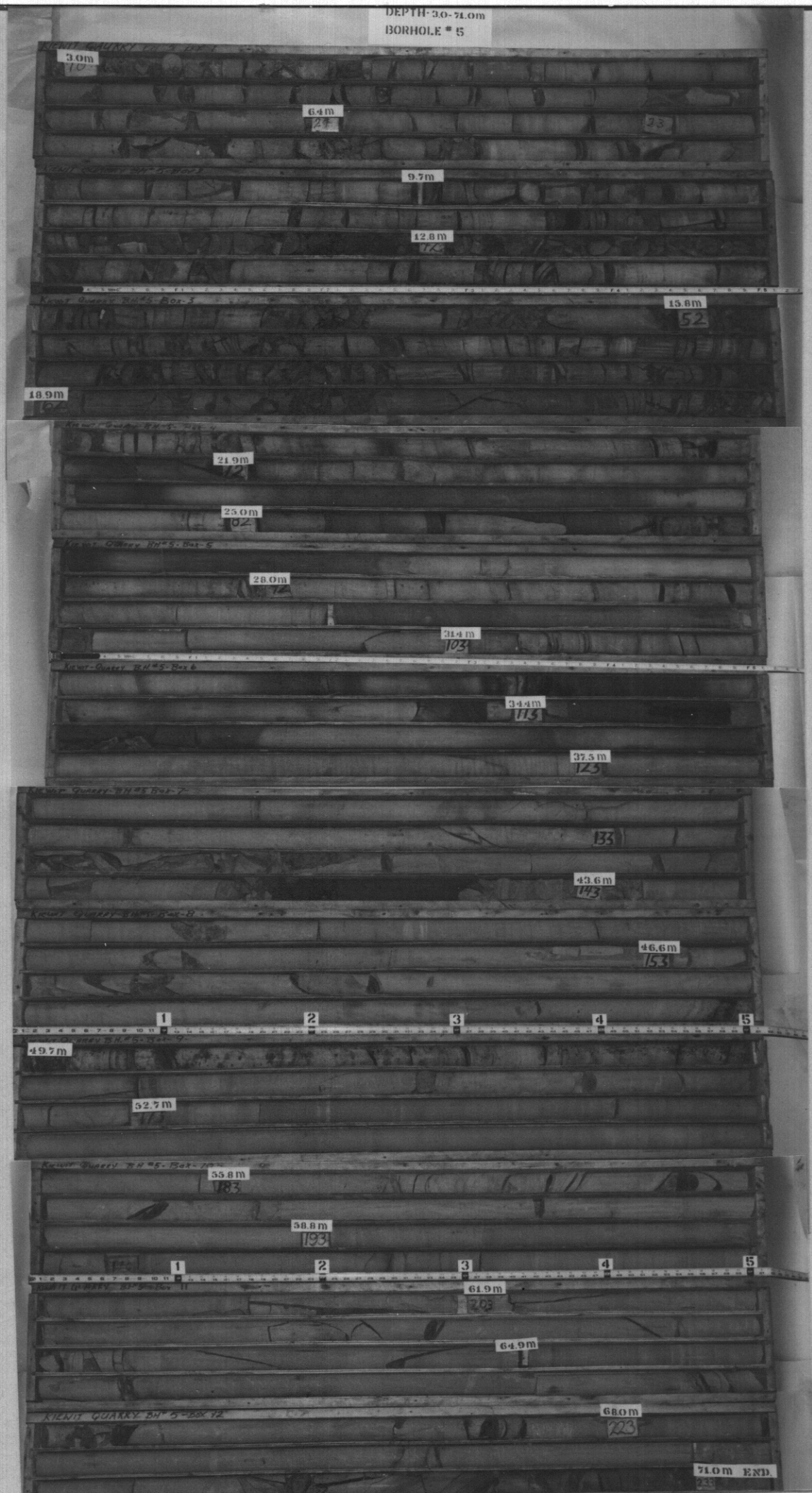
PROJECT No. 3761

KIEWIT QUARRY

AREA KING POINT

DATE OCT. 13/83

FIGURE No. ____



Borehole No. 5

10 ft. - 233 ft.

HOGGAN

OFFICE BOREHOLE RECORD

APPENDIX I

BOREHOLE No: 5

REPORT NO.:

CLIENT: Peter Kiewit Sons Company Ltd.

DATE OF BORING: 9-10 Sept, 1983

SITE AND/OR PROJECT: Quarry Investigation, Yukon

DATE OF WL READING: 13 Sept, 1983

DEPTH, FT	ELEVATION DEPTH AND WATER LEVEL	STRATIGRAPHY	SOIL DESCRIPTION (5)	CONDITION	TYPE	NUMBER	RECOVERY %	R Q D, > 4 in %	GRAIN SIZE HYDROMETER UNIT WEIGHT CONSOLIDATION
	Dip		Ground Level						
0			Overburden of soft sandstone fragment with some sand and voids						
10	24°		Sandstone: Grey sandstone Fractured into pieces less than 3" - 4"		NQ	1	70	0	
			17: Thin bed of sand		NQ	2	100	27	
20					NQ	3	100	71	
			Shale, mudstone, siltstone & soft sandstone, thinly bedded with black seams easily split.		NQ	4	83	12	
30			24-28: Soft conglomerate area 29-58: Siltsone thinly bedded						
	13° to 15°				NQ	5	92		
40			42: Mud seam 4"						
					NQ	6	100		
50	15°				NQ	7	100		
60			59-67: Mudstone very broken						
	18°		67-75: Soft sandstone broken thinly bedded		NQ	8	100		
70									
			Sandstone: Medium hard & brown, medium to fine grained with some grey interbeds		NQ	9	98	90	
80			-43° plus 24" long cores -26° plus 36" long cores						
			84-86: Brown sandstone soft bedded with coal		NQ	10	98	91	
90									

LABORATORY AND FIELD TEST RESULTS

△ IN SITU FIELD VANE S_u

□ LABORATORY VANE C_u

○ WATER CONTENT W %

⊢⊣ ATTERBERG LIMIT WP AL

GRAPHIC SCALE %

2-4 in	4-8 in	8-16 in	≥16 in	MAX CORE in
100	100	100	100	
13	0	0	0	
59	27	0	0	
29	71			
0	12			
-	-	-	-	
-	-	-	-	
-	-	-	-	
-	-	-	-	
9	12	9	68	23 / 58
3	24	20	47	36 / 21

DATUM:

VERIFIED BY:

UNDRAINED SHEAR STRENGTH kPa

HOGGAN

OFFICE BOREHOLE RECORD

APPENDIX I

BOREHOLE No: 5

REPORT NO:

CLIENT: Peter Kiewit Sons Company Ltd.

SITE AND/OR PROJECT: Quarry Investigation, Yukon

DATE OF BORING: 9-10 Sept, 1983

DATE OF WL READING: 13 Sept, 1983

SOIL DESCRIPTION 5

Continuation of Borehole #5

DEPTH, FT	ELEVATION DEPTH AND WATER LEVEL	STRATIGRAPHY	CONDITION	TYPE	NUMBER	RECOVERY %	R.Q.D. > 4 in %
90	Dip			NQ	10	98	91
		92-105: Sandstone thinly bedded					
100				NQ	11	100	87
	15°						
110		108-109: Thinly bedded zone with coal		NQ	12	98	80
		112-115: Rusty brown soft sandstone					
		113-116: Vertically fractured		NQ	13	100	89
120		118: Conglomerate bed					
				NQ	14	99	90
130							
		133-136: Sandstone very fractured and sand seams					
140				NQ	15	95	34
		140-143: Rusty brown sand					
150	10°			NQ	16	100	90
				NQ	17	100	91
160							
		163: Mud seam (6")					
		163-168: Sandstone, black soft grey, salt and pepper thinly bedded		NQ	18	100	93
170							
				NQ	19	100	98
180							

SAMPLES

GRAIN SIZE, HYDROMETER, UNIT WEIGHT, CONSOLIDATION

LABORATORY AND FIELD TEST RESULTS

- △ IN SITU FIELD VANE, S_u
- □ LABORATORY VANE, C_u
- ○ WATER CONTENT, W. %
- ATTERBERG LIMIT W_P W_L

GRAPHIC SCALE % 100 100 100 100

G	S	γ	C
3	24	20	47 0
			35
13	28	17	42 17
			38
13	9	0	71 18
			29
			17
9	0	0	89 48
			42
			59
0	6	0	84 31
			18
8	6	10	18 22
			34
3	12	18	60 38
			38
0	7	30	60 42
7	48	45	0
			29
0	5	20	73 59

DATUM:

VERIFIED BY:

UNDRAINED SHEAR STRENGTH kPa

NORMAN WADE TRANSTEX IF

HOGGAN

OFFICE BOREHOLE RECORD

APPENDIX I

BOREHOLE No: 5

REPORT NO:

CLIENT: Peter Kiewit Sons Company Ltd.

DATE OF BORING: 9-10 Sept, 1983

SITE AND/OR PROJECT: Quarry Investigation, Yukon

DATE OF WL READING: 13 Sept, 1983

DEPTH, FT	ELEVATION DEPTH AND WATER LEVEL	STRATIGRAPHY	SOIL DESCRIPTION (5)	CONDITION	TYPE	NUMBER	RECOVERY %	R Q D, > 4 in %	GRAIN SIZE HYDROMETER UNIT WEIGHT CONSOLIDATION G S γ C	LABORATORY AND FIELD TEST RESULTS: △ IN SITU FIELD VANE, S; □ LABORATORY VANE, C_u; ○ WATER CONTENT, W %; ⊣ ATTERBERG LIMIT, WP WL; GRAPHIC SCALE % 100 100 100 100
	Dip		Continuation of Borehole #5							
180			184-186: Thinly bedded sandstone		NQ	19	100	98		0 5 20 73
					NQ	20	100	62		8 16 16 40 24 18 21
190					NQ	21	100	87		8 0 0 91 34 21
200			201-206: Sandstone vertically fractured		NQ	22	100	79		0 7 0 72 23 17 20
					NQ	23	99	96		4 16 13 67 23 16 22
210										
220	16°		220: Conglomerate bed		NQ	24	100	82		8 9 0 73 19 46 24
			230-233: Very soft rusty brown sandstone		NQ	25	99	61		2 0 8 53 29 35
230			End of Borehole @ 233 ft.							

DATUM

VERIFIED BY:

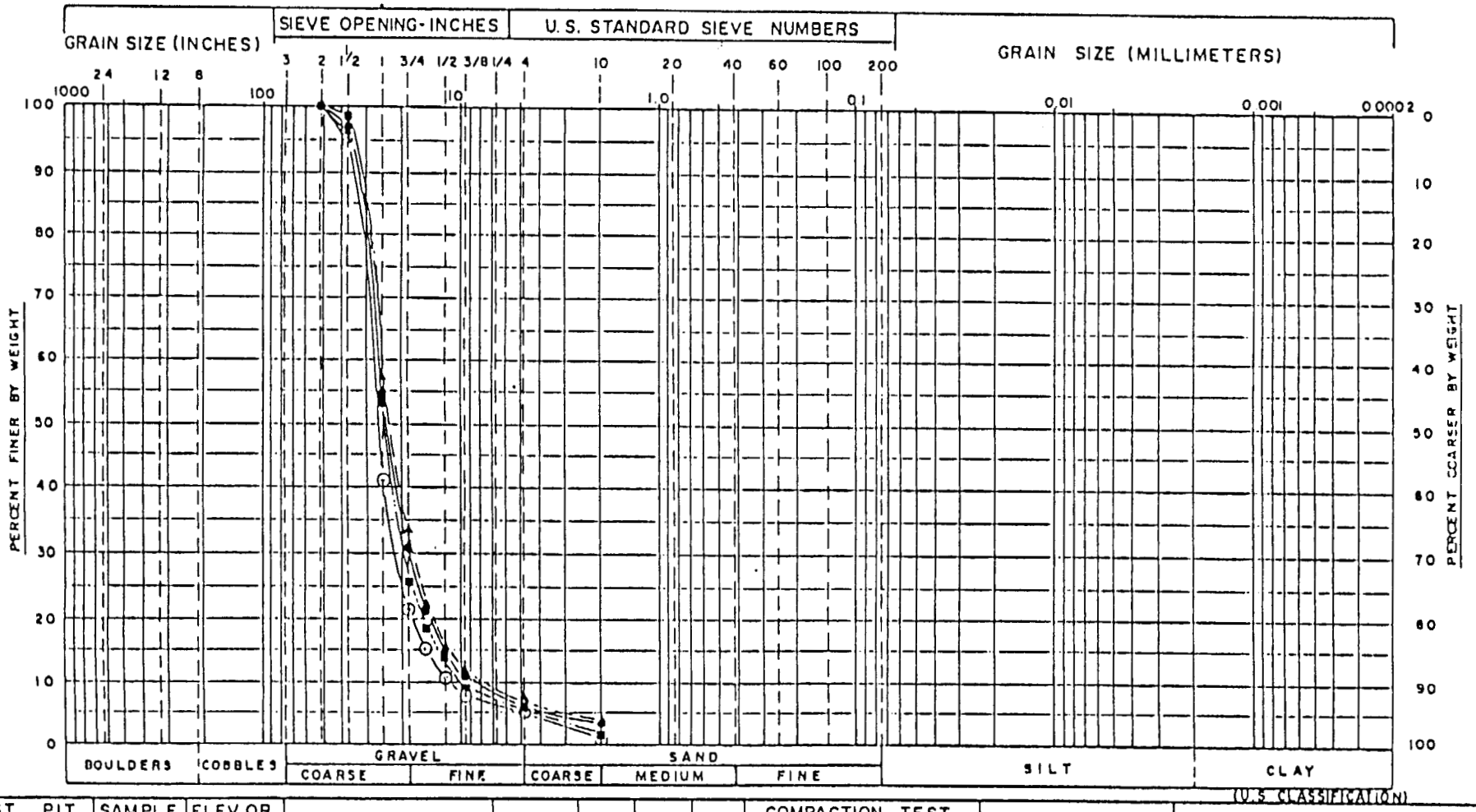
UNDRAINED SHEAR STRENGTH kPa

CLIENT: PETER KIEWIT SONS CO. LTD.
PROJECT: YUKON QUARRY

BOREHOLE 5

Depth (ft)	Description	Bulk Relative Density (lb/ft3)	Bulk Relative Specific Gravity	Absorption (%)	Uniaxial Point Load Compressive Tests Diametral (psi)	Uniaxial Point Load Compressive Tests Axial (psi)	Unconfined Compressive Strength (psi)	Freeze Thaw	Los Angeles Abrasion (% wear)	Sulphate Soundess (% loss)
12'5"-13'5"	Fine grained grey solid sandstone	149.5	2.398	3.00	14300	9300	11700			
21'-21'3"	Fine grained grey solid sandstone	148.2	2.378				7700			
21'3"-21'7"				3.02						
22'-22'5"	Fine grained grey solid sandstone				10900	10700				
23'-23'5"	Fine-medium grained brown solid sandstone	150.9	2.42	3.06	15100	13300	11300			
34'	Fine grained grey soft sandstone, stratified				2800	3300				
34'2"-34'6"	Grey fine grained sandstone	156.8	2.518	4.73			11100			
45'-46'	Identical, very soft sandstone	160.4	2.572	4.05	2500	3300				
69'-69'8"	Grey brown sandstone	147.9	2.372	4.20			10000			
70'	Grey sandstone, trace of conglomerate				9300	7600				
72'-72'8"	Brown sandstone	144.2	2.312	6.34						
73'	Brown-medium grained soft sandstone				5400	2900				
76'-76'8"	Brown sandstone	145.6	2.336	3.94			8600			
77'5"	Brown solid sandstone				12600	11400				
86'-87'5"	Brown soft sandstone, trace of coal	138.5	2.222	6.02	6400	7200	5500			
99'-100'	Grey sandstone	144.7	2.321	4.66	9100	6800	6400			
100'4"-100'8"	Brown grey	146.8	2.354	4.52			6200			
105'9"-106'9"		140.5	2.254	5.57	8200	7500	6600			
119'-120'	Brown solid sandstone fine grained	144.1	2.312	4.02	10700	9700	8000			
132'-133'	Brown solid sandstone fine grained	151.6	2.431	3.03	14900	12900	12800			
146'-147'	Brown solid sandstone fine grained	150.3	2.410	3.22	16300		6900			
158'-159'	Fine grained grey solid sandstone	148.4	2.38	2.87	13200	11400	14200			
164'-165'	Fine grained grey sandstone some stratified	148.1	2.375	3.38	10100	9700	8400			
173'5"-174'5"	Grey sandstone	151.4	2.428	2.91		14800	12000			
175'	Grey fine grained sandstone				20300					
182'-183'		149.4	2.397	2.93	16900	11700	10000			
196'5"-197'	Fine grained grey solid sandstone			2.74	15700	14200	11500			
205'-206'	Fine grained brown sandstone	151.3	2.426	2.95	17300	12300	12000			
221'5"-222'	Brown solid sandstone	150.6	2.416	3.40	15700	10500	10600			
229'-230'	Grey fine grained sandstone	145.2	2.329	4.01	10300	8580	10200			
Crushed Samples										
10'-28'	Sandstone (crushed) (see sieve analysis S.A.#2964 - 2" crushed core (in lab.), 6.4% sand)	80.0							36.1	
82'-126'	Sandstone (crushed) (see sieve analysis S.A.#2965 - 2" crushed core (in lab.), 7.3% sand)	75.0							43.3	
130'-173'	Sandstone (crushed) (see sieve analysis S.A.#2966 - 2" crushed core (in lab.), 5.5% sand)	76.4							38.5	
183'-226'	Sandstone (crushed) (see sieve analysis S.A.#2967 - 2" crushed core (in lab.), 5.0% sand)	76.0							33.9	

GRAIN – SIZE DISTRIBUTION



	TEST PIT OR BORING No.	SAMPLE No.	ELEV OR DEPTH	U.S. CLASSIFICATION	NAT. WC	LL	PL	PI	COMPACTION TEST MAX. DENSITY	COMPACTION TEST OPT. WC
●	5	2964	10-28'	SANDSTONE						
▲	5	2965	82-126'	"						
■	5	2966	130-173'	"						
○	5	2967	183-226'	"						

REMARKS — CRUSHED CORES FORM BOREHOLE #5

PROJECT No. 3761
KIEWIT QUARRY
AREA KING POINT
DATE OCT. 13/83

FIGURE No.

Borehole No. 6 8 ft. - 190 ft.

HOGGAN

OFFICE BOREHOLE RECORD

APPENDIX I

BOREHOLE No: 6

REPORT NO.:

CLIENT: Peter Kiewit Sons Company Ltd.

DATE OF BORING 11-12 Sept/83

SITE AND/OR PROJECT: Quarry Investigation, Yukon

DATE OF WL READING 13 Sept/83

DEPTH FT	ELEVATION DEPTH AND WATER LEVEL	STRATIGRAPHY	SOIL DESCRIPTION 6	CONDITION	TYPE	NUMBER	RECOVERY %	RQD > 4 in %	GRAIN SIZE HYDROMETER UNIT WEIGHT CONSOLIDATION G S γ C
	Dip		Ground Level						
0			Overburden of broken sandstone with voids						
			Water return to bottom of hole						
10			Sandstone: Brown fractured with some broken zones, medium hard sandstone and broken		NQ	1	50	15	
			Poor recovery below 30 ft.		NQ	2	90	43	
20			Some 16 to 24" long cores in 10 to 28 ft. depth						
					NQ	3	83	58	
30					NQ	4	100	0	
			33: Mud seam (2")		NQ	5	92	46	
					NQ	6	92	29	
					NQ	7	58	19	
40					NQ	8	33	7	
	16°		Sandstone: Grey to brown sandstone, fine grained, medium hard.		NQ	9	89	74	
			44: Conglomerate bed (0.5")						
			47: Siltstone pocket						
50			50: Fractured at 45°		NQ	10	58	47	
			Maximum cores usually 20" long with some longer cores below 80ft.						
			-32% Plus 24" long cores		NQ	11	98	93	
60			-17 Plus 36" long cores						
	14°								
					NQ	12	100	97	
70			73: Fractured 60°						
					NQ	13	98	89	
80									
			83-84: Fractured sandstone						
					NQ	14	98	88	
90									

LABORATORY AND FIELD TEST RESULTS

△ IN SITU FIELD VANE, S

□ LABORATORY VANE, C_u

○ WATER CONTENT, W %

⊢ ATTERBERG LIMIT W_P W_L

GRAPHIC SCALE %

2-4 in	4-8 in	8-16 in	>16 in	MAX CORE in
13	15	0	0	
				16
16	13	0	30	29
0	17	11	30	28
33	0	0	0	
25	0	46	0	
25	29	0	0	
11	19	0	0	
5	7	0	0	
				16
10	31	0	43	20
8	0	0	47	17
				35
3	23	26	44	18
				22
2	12	32	53	21
				21
				32
7	13	16	60	17
				23
				19
3	10	7	71	21
				45

DATUM

VERIFIED BY:

UNDRAINED SHEAR STRENGTH kPa

HOGGAN

OFFICE BOREHOLE RECORD

APPENDIX I

BOREHOLE No: 6

REPORT NO:

CLIENT: Peter Kiewit Sons Company Ltd.

DATE OF BORING 11-12 Sept/83

SITE AND/OR PROJECT: Quarry Investigation, Yukon

DATE OF WL READING 13 Sept/83

DEPTH, FT	ELEVATION DEPTH AND WATER LEVEL	STRATIGRAPHY	SOIL DESCRIPTION 6	CONDITION	TYPE	NUMBER	RECOVERY %	R Q D, > 4 in %	GRAIN SIZE HYDROMETER UNIT WEIGHT CONSOLIDATION G S γ C	LABORATORY AND FIELD TEST RESULTS: Δ IN SITU FIELD VANE, S_u; □ LABORATORY VANE, C_u; ○ WATER CONTENT, W, %; ⊣ ATTERBERG LIMIT W_P W_L; GRAPHIC SCALE % 100 100 100 100
	Dip		Continuation of Borehole #6				%	%	G S γ C	
90			Longer cores in this zone		NQ	14	98	88		3 10 7 71
	21°				NQ	15	98	96		2 8 18 70 31 53
100										
	17°		104: Thin sand bed		NQ	16	86	78		2 4 8 67 26 23 31
110										
					NQ	17	100	87		12 18 21 48 33 24
120			121: Thin sand seam							
					NQ	18	94	67		18 46 21 0
130										
			138-143: Rusty brown sand		NQ	19	93	80		12 0 30 50 30
140										
					NQ	20	98	70		3 7 0 63 39 37
150										
					NQ	21	100	36		8 3 33 0 36
160			Formation of grey sandstone with some thin beds of coal and severely broken cores between 160 - 168.							
	12°				NQ	22	100	26		25 23 0 0
170										
					NQ	23	100	81		6 29 47 0
180			178-180: Conglomerate bed							

DATUM: VERIFIED BY:

UNDRAINED SHEAR STRENGTH kPa

HOGGAN

OFFICE BOREHOLE RECORD

APPENDIX
BOREHOLE No: 6
REPORT NO.

CLIENT: Peter Kiewit Sons Company Ltd.
DATE OF BORING: 11-12 Sept/83
SITE AND/OR PROJECT: Quarry Investigation, Yukon
DATE OF WL READING: 13 Sept/83

DEPTH, FT	ELEVATION DEPTH AND WATER LEVEL	STRATIGRAPHY	SOIL DESCRIPTION 6	CONDITION	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY	SAMPLES R Q D. >4 in	GRAIN SIZE HYDROMETER UNIT WEIGHT CONSOLIDATION	LABORATORY AND FIELD TEST RESULTS
	Dip		Continuation of Borehole #6			%	%		G S γ C	GRAPHIC SCALE % 100 100 100 100
180			Continuation of grey medium to coarse grained sandstone		NQ	23	100			
					NQ	24	98	72		7 33 33
190			End of Borehole @ 193 ft.							

DATUM:
VERIFIED BY:

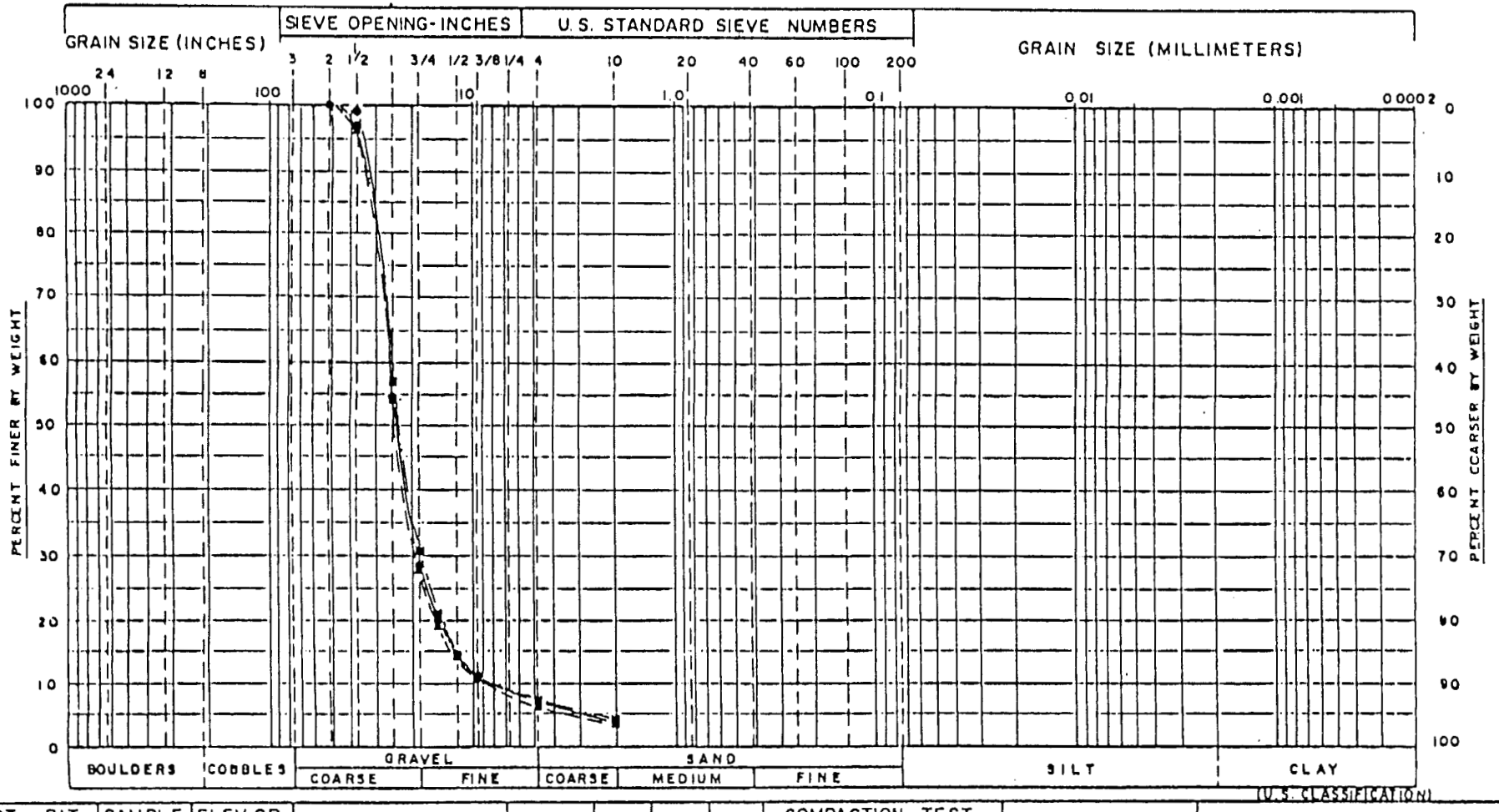
UNDRAINED SHEAR STRENGTH kPa

CLIENT: PETER KIEWIT SONS CO. LTD.
PROJECT: YUKON QUARRY

BOREHOLE 6

Depth (ft)	Description	Bulk Relative Density (lb/ft3)	Bulk Relative Specific Gravity	Absorption (%)	Uniaxial Point Load Compressive Tests Diametral (psi)	Axial (psi)	Unconfined Compressive Strength (psi)	Freeze Thaw	Los Angeles Abrasion (% wear)	Sulphate Soundess (% loss)
19'	Brown moderately hard sandstone	150.2	2.407		14600	10400	10500			
26'-26'6"	Grey sandstone	153.3	2.457		14900	13800	12000			
47'-48'	Brown fine grained sandstone	151.6	2.430		16300	14800	12900			
55'	Grey fine grained sandstone	152.0	2.436		16300	14200	13200			
66'	Grey fine grained sandstone	150.9	2.418		16000	13000	12600			
75'	Grey brown sandstone, moderately hard	152.4	2.442		16300	8300	11800			
85'	Fine grained solid sandstone	148.8	2.385		14100	8300	9100			
93'6"-94'	Grey fine grained sandstone	151.6	2.429		13900	12000	10300			
101'6"-102'	Fine grained solid sandstone	153.5	2.460		15100	11400	12200			
108'		153.0	2.452			10800	9800			
125'-125'6"	Brown sandstone	155.8	2.496		13900		14400			
149'	Grey to brown sandstone fine grained, long core	152.7	2.447		15100	12000	11900			
158'6"	Brown fine-medium grained sandstone; trace of conglomerate	151.0	2.422		16000	12100	10600			
168'6"		160.8	2.576		6100		8700			
176'0"	Grey conglomerate	160.0	2.565				6200			
179'0"	Grey sandstone with coal				9400	7100				
182'6"		153.9	2.466				11200			
189'		154.0	2.467				8100			
Crushed Samples										
0'-60'	Sandstone (crushed) (see sieve analyses S.A.#2961 6.6% #4 sieve)	79.5 (loose density of crushed samples)	2.376	3.93					39.9	
60'-120'	Sandstone (crushed) (see sieve analysis S.A.#2962 6.5% #4 sieve)	79.3 (loose density of crushed samples)	2.355	4.12					41.6	
167'-190'	Sandstone (crushed) (see sieve analysis S.A.#2963 6.9% #4 sieve)	78.6 (loose density of crushed samples)	2.371	4.84					38.6	

GRAIN – SIZE DISTRIBUTION



	TEST PIT OR BORING No.	SAMPLE No.	ELEV OR DEPTH	U.S. CLASSIFICATION	NAT. WC	LL	PL	PI	COMPACTION TEST MAX. DENSITY	COMPACTION TEST OPT. WC	
●	6	2961	0-60'	SANDSTONE							
▲	6	2962	60-120'	"							
■	6	2963	167-190'	"							

REMARKS — CRUSHED CORES FROM BOREHOLE #6

PROJECT No. 3761

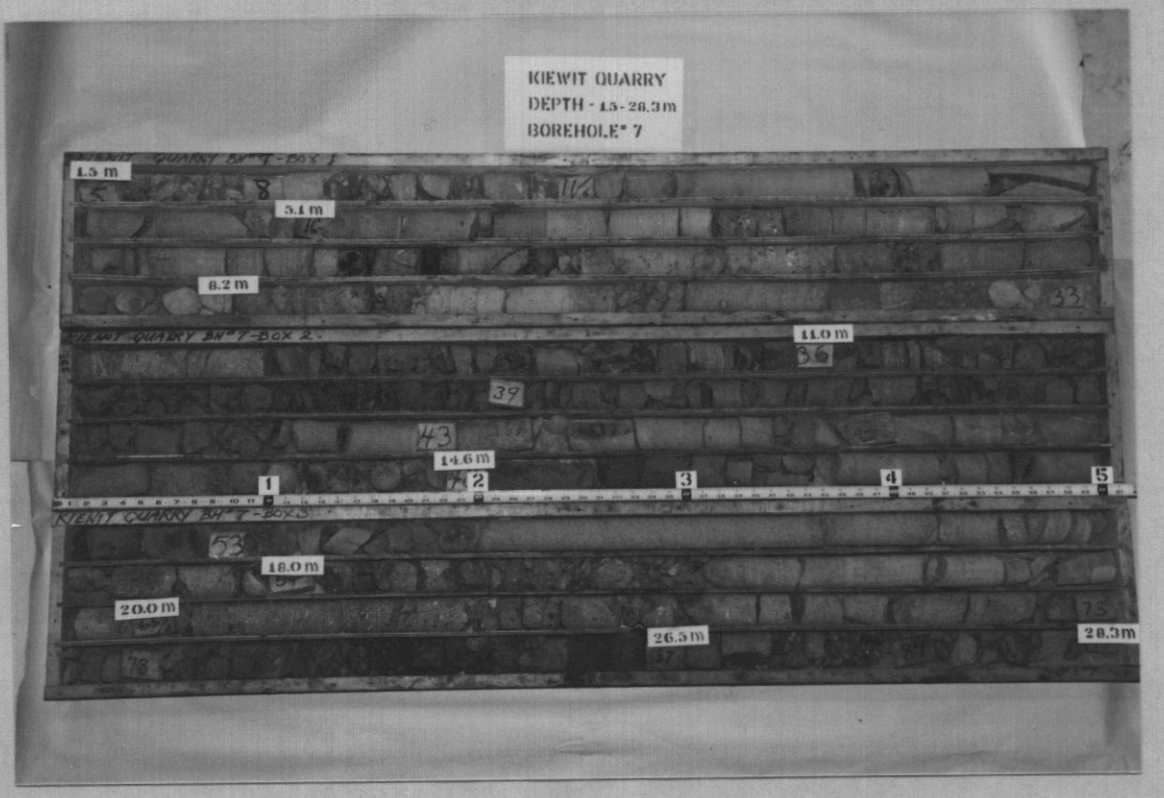
KIEWIT QUARRY

KING POINT

AREA

DATE OCT. 13/83

FIGURE No.



Note: Very poor recovery
See borehole record description

Borehole No. 7 5 ft. - 93 ft.

HOGGAN

OFFICE BOREHOLE RECORD

APPENDIX I

BOREHOLE No: 7

REPORT NO.:

CLIENT: Peter Kiewit Sons Company Ltd.

DATE OF BORING: 13-14 Sept, 1983

SITE AND/OR PROJECT: Quarry Investigation, Yukon

DATE OF WL READING 14 Sept, 1983

DEPTH, FT	ELEVATION DEPTH AND WATER LEVEL	STRATIGRAPHY	SOIL DESCRIPTION (7)	CONDITION	TYPE	NUMBER	RECOVERY %	RQD, >4 in %	GRAIN SIZE HYDROMETER UNIT WEIGHT CONSOLIDATION G S γ C	LABORATORY AND FIELD TEST RESULTS: △ IN SITU FIELD VANE, S_u; □ LABORATORY VANE, C_u; ○ WATER CONTENT, W %; ⊢ ATTERBERG LIMIT W_P W_L
	Dip						%	%		GRAPHIC SCALE % 100 100 100 100
0			Overburden of soft broken sandstone							2-4 in; 4-8 in; 8-16 in; >16 in
					NQ	1	19			– – – –
10			Fractured sandstone Medium hard		NQ	2	38	0		0 0 0
					NQ	3	67	42		13 25 17 –
	18°		Mudstone, shale, soft grey sandstone and sand layers							
20			18: Conglomerate seam (1")		NQ	4	13			– – – –
			18-33: Very soft sandstone		NQ	5	83			– – – –
30					NQ	6	72			– – – –
			33-42: Mudstone		NQ	7	100			– – – –
					NQ	8	94			– – – –
40					NQ	9	100			– – – –
			42-65: Very soft coarse sandstone		NQ	10	100			– – – –
50					NQ	11	67			– – – –
	16°				NQ	12	83			– – – –
60					NQ	13	40			– – – –
					NQ	14	83			– – – –
			65-78: Very soft conglomerate							
70					NQ	15	74			– – – –
					NQ	16	5			– – – –
			78-93: Sand, mud seam and soft sandstone		NQ	17	38			– – – –
80					NQ	18	13			– – – –
					NQ	19	42			– – – –
			End of Borehole @ 92 ft.		NQ	20	8			– – – –
90										
100										

DATUM: VERIFIED BY:

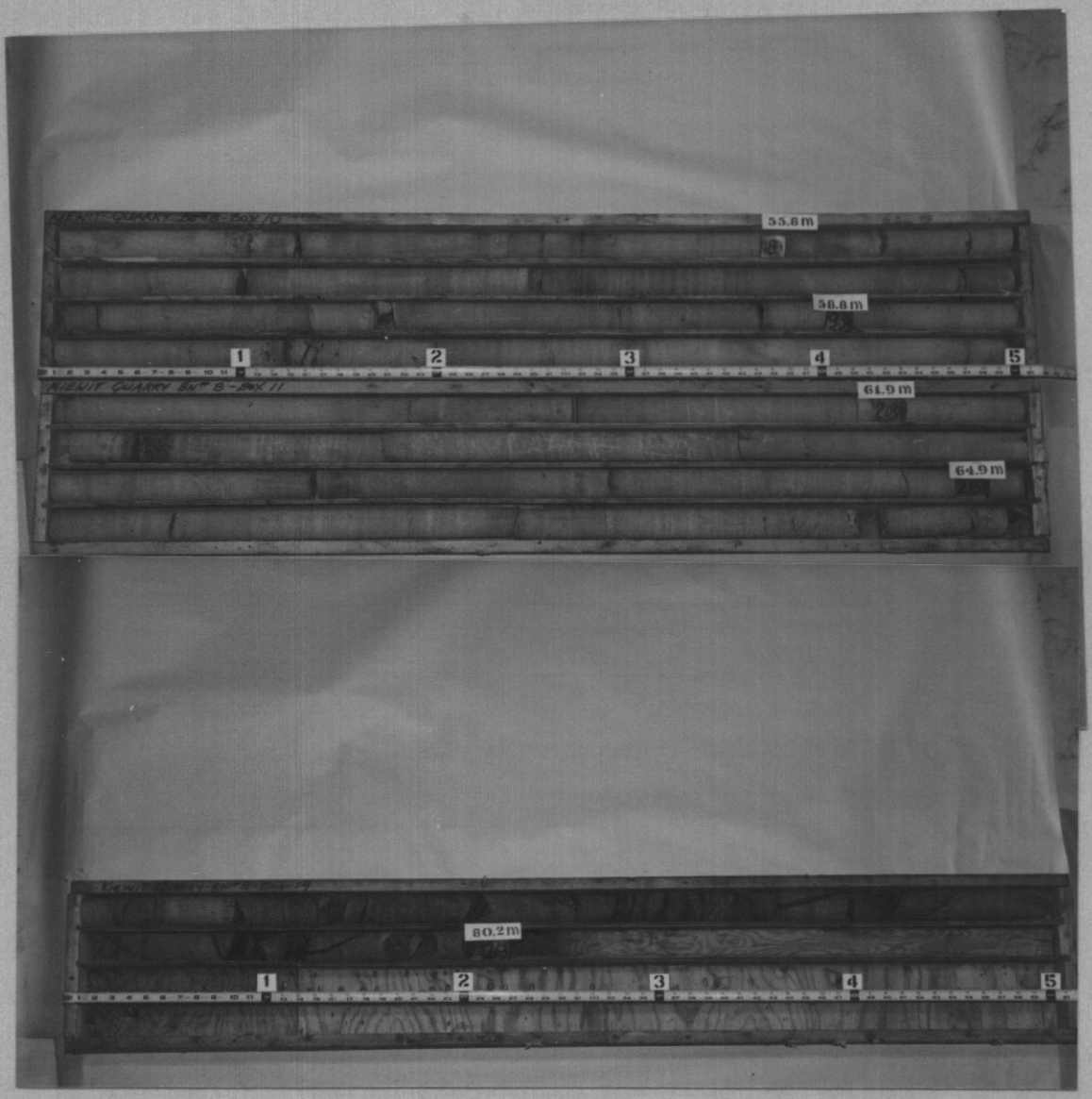
UNDRAINED SHEAR STRENGTH kPa

CLIENT: PETER KIEWIT SONS CO. LTD.
PROJECT: YUKON QUARRY

BOREHOLE 7

Depth (ft)	Description	Bulk Relative Density (lb/ft3)	Bulk Relative Specific Gravity	Absorption (%)	Uniaxial Point Load Compressive Tests Diametral (psi)	Axial (psi)	Unconfined Compressive Strength (psi)	Freeze Thaw	Los Angeles Abrasion (% wear)	Sulphate Soundess (% loss)
11.5'	Fine grained brown sandstone				15700					
11'11"-12'3"	Fine grained light brown solid sandstone	151.3	2.426			10700	10900			
12'3"-12'10"				3.54						
24'-24'4"	Fine to medium grained brown sandstone, medium hard	139.3	2.235							
24'4"-24'7"				5.39			7600			
25'	Soft conglomerated (not enough material)				5300	8200	6900			
29'	Very soft grey sandstone				1300					
29'3"-29'10"	Soft brown sandstone			5.97						
55'	Medium soft sandstone				17300					
55'-55'4"	Medium soft sandstone	148.7	2.386							
55'4"-55'8"				4.19						

Borehole No. 8 6 ft. - 160 ft.



Note: 3 Coreboxes missing

Borehole No. 8 Continuation 179 ft. - 218 ft., 256 ft. - 263 ft.

HOGGAN

OFFICE BOREHOLE RECORD

APPENDIX I

BOREHOLE No: 8

REPORT NO.

CLIENT: Peter Kiewit Sons Company Ltd. DATE OF BORING: 15-16 Sept, 1983

SITE AND/OR PROJECT: Quarry Investigation, Yukon DATE OF WL READING: 16 Sept, 1983

DEPTH, FT	ELEVATION DEPTH AND WATER LEVEL	STRATIGRAPHY	SOIL DESCRIPTION (8)	CONDITION	TYPE	NUMBER	RECOVERY %	R Q D, > 4 in %	GRAIN SIZE HYDROMETER UNIT WEIGHT CONSOLIDATION G S γ C
0	Dip								
	▽		Overburden of broken Sandstone		NQ	1	7	0	
10	12°		Fractured brown sandstone		NQ	2	90	0	
			13: Conglomerate seam (0.5")						
			Sandstone: Brown to grey sandstone, medium hard, fine grained		NQ	3	100	84	
20	19°		19-20: Vertical fracture						
			23: Rusty brown sand (4")						
			23-24: Soft sandstone very Fractured		NQ	4	99	85	
	10°		28: Conglomerate seam (0.5")						
30									
			40: Lost of drilling water		NQ	5	100	79	
40			-29' Plus 24" long cores						
			-16' Plus 36" long cores		NQ	6	98	86	
50									
					NQ	7	100	96	
60									
			65-77: Fractured sandstone Bralso break, vertically		NQ	8	98	79	
70			73-74: Sand and soft sandstone						
			74: Conglomerate seam (0.5")						
					NQ	9	100	82	
80			82-84: Soft sandstone, very broken and brown rusty sand						
					NQ	10	97	57	
90									

SAMPLES

LABORATORY AND FIELD TEST RESULTS

△ IN SITU FIELD VANE, S_u

□ LABORATORY VANE, C_u

○ WATER CONTENT, W. %

⊢ ATTERBERG LIMIT WP WL

GRAPHIC SCALE %

2-4 in	4-8 in	8-16 in	>16 in	MAX CORE in
100	100	100	100	
0	0	0	0	
0	0	0	0	
6	19	52	13	
				20
6	28	10	47	18
				16
				25
8	21	19	39	22
				20
4	0	18	68	31
				31
				27
4	3	36	57	41
10	40	23	16	19
				36
0	21	13	48	21
				17
23	18	0	39	30

UNDRAINED SHEAR STRENGTH kPa

DATUM: VERIFIED BY:

NORMAN WADE TRANSTEX 15

		APPENDIX I
HOGGAN	**OFFICE BOREHOLE RECORD**	BOREHOLE No: (8)
		REPORT NO.:

CLIENT: Peter Kiewit Sons Company Ltd. DATE OF BORING: 15-16 Sept, 1983

SITE AND/OR PROJECT: Quarry Investigation, Yukon DATE OF WL READING: 16 Sept, 1983

SOIL PROFILE

SOIL DESCRIPTION (8)

Continuation of Borehole #8

DEPTH FT	ELEVATION DEPTH AND WATER LEVEL (Dip)	SOIL DESCRIPTION
98		98: Conglomerate seam (0.5")
100		100-104: Very fractured sandstone in thin bed
105		105-112: Vertical fracture
114		114-117: Vertical fracture
118		118-120: Vertical fracture oxydate
120	15°	
133		133-140: Fractured sandstone with vertical fracture
134		134: Very soft rusty brown sandstone
145		145: Conglomerate seam (0.5")
150	12°	
152		152: Conglomerate seam (0.5")
162		162: Conglomerate seam
171		171: Conglomerate seam
180		180: Conglomerate seam (0.5")

SAMPLES / LABORATORY AND FIELD TEST RESULTS

Legend: △ IN SITU FIELD VANE, S_u; □ LABORATORY VANE, C_u; ○ WATER CONTENT, W, %; ⊢ ATTERBERG LIMIT w_P w_L

Other columns: GRAIN SIZE (G), HYDROMETER (S), UNIT WEIGHT (γ), CONSOLIDATION (C)

TYPE	NUMBER	RECOVERY %	RQD, >4 in %	GRAPHIC SCALE % (100 / 100 / 100 / 100)	
NQ	10	97	57	23, 18, 0, 39	
NQ	11	100	68	3, 22, 10, 36	24, 19
NQ	12	100	85	0, 5, 45, 35	20, 22
NQ	13	100	73	18, 4, 38, 41	16, 16, 17
NQ	14	100	82	4, 3, 17, 62	30, 17, 27
NQ	15	100	75	8, 0, 7, 18	22
NQ	16	100	95	0, 16, 24, 55	18, 48
NQ	17	100	90	6, 10, 9, 71	16, 30, 22, 17
NQ	18	99	98	0, 6, 33, 59	21, 27, 23
NQ	19	100	98	2, 6, 0, 92	81, 29

UNDRAINED SHEAR STRENGTH kPa

DATUM: VERIFIED BY:

HOGGAN

OFFICE BOREHOLE RECORD

APPENDIX I
BOREHOLE No. 8
REPORT NO.

CLIENT: Peter Kiewit Sons Company Ltd.
DATE OF BORING: 15-16 Sept, 1983
SITE AND/OR PROJECT: Quarry Investigation, Yukon
DATE OF WL READING: 16 Sept, 1983

DEPTH FT	ELEVATION DEPTH AND WATER LEVEL	STRATIGRAPHY	SOIL DESCRIPTION (8)	CONDITION	TYPE	NUMBER	RECOVERY %	RQD > 4 in %	GRAIN SIZE HYDROMETER UNIT WEIGHT CONSOLIDATION G S γ C	LABORATORY AND FIELD TEST RESULTS
	Dip		Continuation of Borehole #8							△ IN SITU FIELD VANE, S_u □ LABORATORY VANE, C_u ○ WATER CONTENT, W, % ⊢ ATTERBERG LIMIT W_P W_L GRAPHIC SCALE % 100 100 100 100
180	12°				NQ	19	100	98		2 6 0 92 25
					NQ	20	100	99		0 7 19 73 18 27 18
190	12°		190: Conglomerate seam (0.25")							
					NQ	21	99	98		0 0 7 91 24 67 18
200			201: Conglomerate seam (0.5")							
	14°		204: Conglomerate seam (2") fractured							
			208: Thin conglomerate seam (0.5"		NQ	22	100	99		0 9 30 17 21
210			216: Thin mudseam							
			Mudstone, soft sandstone Shale and conglomerate		NQ	23	100	82		0 13 0 69 51 32
220										
					NQ	24	100			— — — —
230										
					NQ	25	100			— — — —
240										
					NQ	26	100			— — — —
250			253: Coal bed (0.5")							
	20°				NQ	27	100			— — — —
260										
			End of Borehole @ 263 ft.							
270										

DATUM: VERIFIED BY:

UNDRAINED SHEAR STRENGTH kPa

CLIENT: PETER KIEWIT SONS CO. LTD.
PROJECT: YUKON QUARRY

BOREHOLE 8

Depth (ft)	Description	Bulk Relative Density (lb/ft3)	Bulk Relative Specific Gravity	Absorption (%)	Uniaxial Point Load Compressive Tests Diametral (psi)	Axial (psi)	Unconfined Compressive Strength (psi)	Freeze Thaw	Los Angeles Abrasion (% wear)	Sulphate Soundess (% loss)
14'-14'5"	Fine grained brown solid (very hard) sandstone	151.3	2.426	3.05	13800	13200	9100			
26'5"-27'	Fine grained grey solid sandstone	150.4	2.412	3.55	10300	7800	6000			
34'5"-35'5"	Fine grained brown solid sandstone	152.2	2.441	3.13	16600	14000	12700			
56'5"-57'	Grey solid sandstone	152.1	2.439	2.77	19400	13300	13800			
71'5"-72'	Brown solid sandstone	152.7	2.449	3.03	19400	12700	9600			
84'5"-85'	Brown solid sandstone very hard	152.6	2.447	2.51	24200	19105	10200			
98'-98'5"	Brown solid sandstone, very hard	154.8	2.484	2.80	20100	11000	10900			
112'-112'5"	Brown solid sandstone	150.7	2.416	2.92	20700	11600	14500			
125'-126'	Fine grained grey solid sandstone	150.9	2.42	2.92	16100	10800	12700			
141'-142'	Brown solid sandstone fine grained	151.7	2.433	2.89	15900	11000	12400			
149'-149'5"	Grey sandstone fine grained	150.8	2.419	3.18	15700	1100	10200			
159'-160'	Brown solid sandstone - fine grained	153.1	2.456	3.29	13200	8000	10200			
179'-180'	Fine grained brown solid sandstone	151.5	2.429	3.04	16300	10900	11600			
196'-197'	Grey sandstone fine grained	151.1	2.424	3.00	14400	8400	13800			
205'-206'	Brown solid sandstone fine grained	151.3	2.426	3.07	18800	10800	13100			
215'-216'	Fine-medium grey sandstone some conglomerate	149.3	2.394	2.82	16900	13600	11100			
261'	Shale				4800					

HOGGAN

OFFICE BOREHOLE RECORD

APPENDIX I

BOREHOLE No: 9

REPORT NO.:

CLIENT: Peter Kiewit Sons Company Ltd.

DATE OF BORING 18-19 Sept, 1983

SITE AND/OR PROJECT: Quarry Investigation, Yukon

DATE OF WL READING 24 Sept, 1983

DEPTH, FT	ELEVATION DEPTH AND WATER LEVEL	STRATIGRAPHY	SOIL DESCRIPTION (9)	CONDITION	TYPE	NUMBER	RECOVERY %	R Q D, >4 in %	GRAIN SIZE HYDROMETER UNIT WEIGHT CONSOLIDATION G S γ C	LABORATORY AND FIELD TEST RESULTS: △ IN SITU FIELD VANE, S; □ LABORATORY VANE, C_u; ○ WATER CONTENT, W, %; ⊢ ATTERBERG LIMIT, W_P W_L
0	▽		Permafrost: Frozen silty and clayey Glacial till with some grey silty clay in bottom 10 feet. -no loss of water during drilling of this hole							GRAPHIC SCALE % 100 100 100 100; 2-4 in, 4-8 in, 8-16 in, >16 in, MAX CORE in
10										
20										
30										
40										
50										
60					NQ	1	67	0		0 0 0 0
	Dip									
70			Very soft grey sandstone thinly bedded, shale, fractured in 2-4" long pieces		NQ	2	100	0		0 0 0 0
					NQ	3	70	0		0 0 0 0
80					NQ	4	100	0		0 0 0 0
					NQ	5	100			0 0 0 0
90					NQ	6	83	22		0 22 0 0

DATUM: VERIFIED BY

UNDRAINED SHEAR STRENGTH kPa

HOGGAN

OFFICE BOREHOLE RECORD

APPENDIX I

BOREHOLE No: 9

REPORT NO.:

CLIENT: Peter Kiewit Sons Company Ltd.

DATE OF BORING: 18-19 Sept, 1983

SITE AND/OR PROJECT Quarry Investigation, Yukon

DATE OF WL READING: 24 Sept, 1983

DEPTH, FT	ELEVATION DEPTH AND WATER LEVEL	STRATIGRAPHY	SOIL DESCRIPTION (9)	CONDITION	TYPE	NUMBER	RECOVERY %	RQD, > 4 in %	GRAIN SIZE HYDROMETER UNIT WEIGHT CONSOLIDATION S Y C	LABORATORY AND FIELD TEST RESULTS: △ IN SITU FIELD VANE, S_v; □ LABORATORY VANE, C_u; ○ WATER CONTENT, W, %; ⊢⊣ ATTERBERG LIMIT W_P W_L — GRAPHIC SCALE % 100 100 100 100
90			Continuation of Borehole #9							
			Soft grey sandstone, thinly bedded with shale.		NQ	6	83	22		0 22 0 0
					NQ	7	100	0		0 0 0 0
100			Sandstone: Grey brown sandstone, fine grained, medium hard		NQ	8	96	37		6 0 0 37 27
					NQ	9	100	96		4 9 23 64 77
110			-50% plus 24" long cores -37 plus 36" long cores							
					NQ	10	86	86		0 0 9 77 71 21
120			120: Conglomerate seam (0.5")							
			127: Conglomerate seam (4")		NQ	11	98	81		12 3 43 35 25
130										
					NQ	12	100	99		3 8 28 63 31 49
140										
					NQ	13	100	97		0 13 36 48 16 41
150			End of Borehole @ 153 ft.							

DATUM: VERIFIED BY:

UNDRAINED SHEAR STRENGTH kPa

NORMAN WADE FRANSTEX 15

Borehole No. 10 5 ft. - 203 ft.

HOGGAN

OFFICE BOREHOLE RECORD

APPENDIX I

BOREHOLE No: 10

REPORT NO.:

CLIENT: Peter Kiewit Sons Company Ltd.

DATE OF BORING: 17-18 Sept, 1983

SITE AND/OR PROJECT: Quarry Investigation, Yukon

DATE OF WL READING:

DEPTH, FT	ELEVATION DEPTH AND WATER LEVEL	STRATIGRAPHY	SOIL DESCRIPTION (10)	CONDITION	TYPE	NUMBER	RECOVERY %	RQD, > 4 in %	GRAIN SIZE HYDROMETER UNIT WEIGHT CONSOLIDATION G S γ C
	Dip								
0			Overburden of sandstone broken with many voids						
			Water return to full depth of hole.		NQ	1	50	0	
10					NQ	2	45	0	
			Sandstone: Brown to grey, medium hard, fine grained		NQ	3	100	66	
20					NQ	4	100	72	
			-48' Plus 24" long cores						
			-37' Plus 36" long cores						
			19-20: Very fractured		NQ	5	96	90	
30	16°								
			36-38: Very fractured and thinly bedded		NQ	6	100	83	
40			40-42: Very fractured and thinly bedded sandstone						
	17°		46: Conglomerate seam (0.5")		NQ	7	100	81	
50			50-52: Very fractured						
					NQ	8	100	98	
60									
			65-66: Very fractured zone		NQ	9	98	76	
70			69-70: Very fractured and thinly bedded soft sandstone						
					NQ	10	100	90	
80									
	16°		84: Conglomerate seam (0.5")						
			86-88: Fractured soft sandstone		NQ	11	100	86	
90			88: Conglomerate seam						

LABORATORY AND FIELD TEST RESULTS

△ IN SITU FIELD VANE, S_u

□ LABORATORY VANE, C_u

○ WATER CONTENT, W, %

I ATTERBERG LIMIT W_P W_L

GRAPHIC SCALE %

2-4 in	4-8 in	8-16 in	>16 in	max core in
0	0	0	0	
0	0	0	0	
25	33	33	0	
13	17	37	19	20
				35
2	22	7	61	16
				22
				21
10	29	8	33	18
15	3	22	56	67
				78
0	0	7	91	31
				21
5	10	0	66	41
				17
				72
3	4	9	77	20
				33
6	0	13	73	55

DATUM: VERIFIED BY:

UNDRAINED SHEAR STRENGTH kPa

HOGGAN

OFFICE BOREHOLE RECORD

APPENDIX I

BOREHOLE No: 10

REPORT NO.:

CLIENT: Peter Kiewit Sons Company Ltd.

DATE OF BORING: 17-18 Sept, 1983

SITE AND/OR PROJECT: Quarry Investigation, Yukon

DATE OF WL READING:

DEPTH FT	ELEVATION DEPTH AND WATER LEVEL	STRATIGRAPHY	SOIL DESCRIPTION 10	CONDITION	TYPE	NUMBER	RECOVERY %	RQD, > 4 in %	GRAIN SIZE HYDROMETER UNIT WEIGHT CONSOLIDATION G S γ C	LABORATORY AND FIELD TEST RESULTS
			Continuation of Borehole #10							△ IN SITU FIELD VANE, S_u ▽ LABORATORY VANE, C_u ○ WATER CONTENT, W, % ⊢ ATTERBERG LIMIT W_P W_L
90	Dip		90: Conglomerate seam		NQ	11	100	86		GRAPHIC SCALE % 100 100 100 100
			93.5-96: Thinly bedded sandstone fractured							6 0 13 73 67
100					NQ	12	100	87		5 10 8 69 16
					NQ	13	100	84		3 16 10 58 39 30
110			111-112: Thinly bedded soft sandstone							
					NQ	14	100	83		7 6 9 68 61 20
120			119-121: Thinly bedded soft sandstone fractured							
	17°		128-130: Soft sandstone thinly bedded and rusty brown sand		NQ	15	90	64		7 8 15 41 24 25
130										
					NQ	16	100	94		2 10 10 74 72 17
140			141-142: Thinly bedded and fractured sandstone							
	16°		146: Conglomerate seam							
					NQ	17	100	88		6 4 7 77 48 44
150			153: Soft sandstone Conglomerate seam (1")							
			154-155: Rusty brown sand and thinly bedded sandstone		NQ	18	100	89		0 7 23 59 18 32 39
160										
			165: Conglomerate seam (1")							
			167: Conglomerate seam (0.5")		NQ	19	100	95		0 8 29 58 39 30
170										
	16°		175: Conglomerate seam		NQ	20	100	84		10 30 8 47 26 30
180										

DATUM:

VERIFIED BY:

UNDRAINED SHEAR STRENGTH kPa

HOGGAN

OFFICE BOREHOLE RECORD

APPENDIX I

BOREHOLE No: 10

REPORT NO.:

CLIENT: Peter Kiewit Sons Company Ltd. DATE OF BORING: 17-18 Sept, 1983

SITE AND/OR PROJECT: Quarry Investigation, Yukon DATE OF WL READING:

SOIL PROFILE				SAMPLES						LABORATORY AND FIELD TEST RESULTS
DEPTH FT	ELEVATION DEPTH AND WATER LEVEL	STRATIGRAPHY	SOIL DESCRIPTION (10)	CONDITION	TYPE	NUMBER	RECOVERY %	RQD, >4 in %	GRAIN SIZE HYDROMETER UNIT WEIGHT CONSOLIDATION G S γ C	△ IN SITU FIELD VANE, S ▲ LABORATORY VANE, C_u ○ WATER CONTENT, W, % ⊢⊣ ATTERBERG LIMIT W_P W_L GRAPHIC SCALE % 100 100 100 100
180	Dip		Continuation of Borehole #10							
			Hard Sandstone		NQ	20	100	84		10 x 8 47
			Soft formation of sandstone coarse grain, salt & pepper colored		NQ	21	100	63		17 20 37 8 18 22
190										
					NQ	22	100	78		o 9 56 13 16
200			End of Borehole @ 203 ft.							
210										

DATUM

UNDRAINED SHEAR STRENGTH

CLIENT: PETER KIEWIT SONS CO. LTD.
PROJECT: YUKON QUARRY

BOREHOLE 10

Depth (ft)	Description	Bulk Relative Density (lb/ft3)	Bulk Relative Specific Gravity	Absorption (%)	Uniaxial Point Load Compressive Tests Diametral (psi)	Axial (psi)	Unconfined Compressive Strength (psi)	Freeze Thaw	Los Angeles Abrasion (% wear)	Sulphate Soundess (% loss)
12'6"-12'10"	Fine grained brown sandstone	151.5	2.43				12000			
12'10"13'1"	Solid brown sandstone			3.17	12900	11300				
20'-20'4"	Fine grained grey sandstone	149.7	2.401				12000			
20'4"-21'	Grey sandstone			2.97	13200	11800				
36'5"-37'	Brown-reddish fine grained solid sandstone	151.3	2.426	2.74	11400	1300	13100			
45'-45'4"	Fine grained grey solid sandstone	152.9	2.453				13100			
45'4"-46'	Grey solid sandstone, trace of conglomerate			2.6	17700	16500				
50'5"	Brown solid sandstone, trace of conglomerate				11900	12600				
51'10"-52'5"	Fine grained light brown solid sandstone	151.7	2.433	3.22			14400			
59'5"-60'	Brown solid sandstone, trace of conglomerate	150.6	2.416	2.6	18100	18100	12400			
67'-68'	Grey sandstone, fine grained	151.3	2.427	2.98	12600	11400	13800			
81'-82'2"	Grey sandstone, fine grained	153.3	2.459	2.97	16800	9100	13800			
89'-90'	Grey sandstone, fine grained trace of conglomerate	151.2	2.425		15700	13800	14200			
94'8"-95'	Grey sandstone	152.9	2.453				11600			
95'-95'4"	Grey sandstone			2.5						
104'-105'	Grey sandstone, fine grained trace of conglomerate	151.5	2.429	3.09	14300	12600	10200			
118'-118'8"	Grey solid sandstone	154.3	2.475	2.92	12800	13000	13500			
126'5"-127'5"	Grey brown sandstone & conglomerate	151.4	2.428	2.73	16400	12500	5800			
134'4"-134'8"				3.02						
136'-136'5"	Grey solid sandstone, trace of conglomerate	152.2	2.441		16700	14400	14400			
150'-151'	Grey solid sandstone	151.1	2.423	2.92	13300	11100	12700			
163'5"-164'5"	Grey solid sandstone	151.1	2.423	2.91	15700	11400	14400			
173'-174'	Brown sandstone	150.2	2.408	3.16	13700	14100	11100			
184'5"	Grey medium grained soft sandstone				6200					
185'-185'10"	Medium to fine grained grey sandstone	152.8	2.451	4.07		7200	5460			
198'-199'	Medium fine grained grey sandstone & conglomerate	153.7	2.465	2.65	8100	5600	5090			

HOGGAN

OFFICE BOREHOLE RECORD

APPENDIX I

BOREHOLE No: 11

REPORT NO.:

CLIENT: Peter Kiewit Sons Company Ltd. DATE OF BORING:

SITE AND/OR PROJECT: Quarry Investigation, Yukon DATE OF WL READING: 20 Sept/83

DEPTH, FT	ELEVATION DEPTH AND WATER LEVEL	STRATIGRAPHY	SOIL DESCRIPTION (11)	CONDITION	TYPE	NUMBER	RECOVERY %	RQD, > 4 in %	GRAIN SIZE HYDROMETER UNIT WEIGHT CONSOLIDATION
0			Overburden of broken sandstone slabs with sand and silt towards bottom		NQ	1	28	0	
	Dip		No water loss in this hole						
			Sand stone: Brown to grey, hard fine grained		NQ	2	100	42	
					NQ	3	95	77	
20			-44: Plus 24" long cores -33: Plus 36" long cores						
					NQ	4	100	100	
			20: Conglomerate seam						
			28: Fractured zone		NQ	5	100	82	
30									
			35-37: Sub vertical fractured		NQ	6	91	81	
40									
			50: Conglomerate seam		NQ	7	98	92	
50									
					NQ	8	99	98	
60									
					NQ	9	100	98	
70			72: Conglomerate seam (1")						
			76: Conglomerate seam						
					NQ	10	100	98	
80			84:						
			86: Conglomerate seam		NQ	11	100	100	
			88:						
90									

LABORATORY AND FIELD TEST RESULTS

△ IN SITU FIELD VANE, S_u

□ LABORATORY VANE, C_u

○ WATER CONTENT, W, %

⊢⊣ ATTERBERG LIMIT W_P W_L

GRAPHIC SCALE % 100 100 100 100

	2–4 in	4–8 in	8–16 in	>16 in	max core in
	0	0	0	0	
	58	42	0	0	
	7	43	34	0	
	0	33	67	0	
	3	11	20	51	19 30
	7	13	11	73	20 53
	4	5	18	69	53 30
	0	0	0	98	118
	0	20	16	63	40 35
	2	4	45	49	59
	3	20	34	43	53

DATUM: VERIFIED BY:

UNDRAINED SHEAR STRENGTH kPa

HOGGAN

OFFICE BOREHOLE RECORD

APPENDIX I

BOREHOLE No: 11

REPORT NO.:

CLIENT: Peter Kiewit Sons Company Ltd.

DATE OF BORING:

SITE AND/OR PROJECT: Quarry Investigation, Yukon

DATE OF WL READING: 20 Sept/83

DEPTH FT	ELEVATION DEPTH AND WATER LEVEL	STRATIGRAPHY	SOIL DESCRIPTION (11)	CONDITION	TYPE	NUMBER	RECOVERY %	RQD, > 4 in %	GRAIN SIZE HYDROMETER UNIT WEIGHT CONSOLIDATION G S γ C	LABORATORY AND FIELD TEST RESULTS
	Dip		Continuation of Borehole #11							GRAPHIC SCALE % 100 100 100 100
90		•••	92: Conglomerate seam		NQ	11	100	100		3 20 34 43
		•••	94: Conglomerate seam							26
					NQ	12	100	95		3 12 33 50 17
100		•••	100: Conglomerate seam (1")							17
			Mudstone, shale and soft sandstone		NQ	13	98	74		
110										
					NQ	14	100			
120										
			124: Mud seam		NQ	15	100			
130										
			132: Mud seam							
			137-139: Broken up		NQ	16	100			
140										
					NQ	17	100			
150										
			153: Mud seam							
					NQ	18	100			
160										
					NQ	19	100			
170										
					NQ	20	100			
180										

DATUM:

VERIFIED BY:

UNDRAINED SHEAR STRENGTH kPa

HOGGAN

OFFICE BOREHOLE RECORD

APPENDIX I

BOREHOLE No: 11

REPORT NO: ...

CLIENT: Peter Kiewit Sons Company Ltd. DATE OF BORING:

SITE AND/OR PROJECT: Quarry Investigation, Yukon DATE OF WL READING: 20 Sept/83

DEPTH FT	ELEVATION DEPTH AND WATER LEVEL	STRATIGRAPHY	SOIL DESCRIPTION (11)	CONDITION	TYPE	NUMBER	RECOVERY %	RQD, > 4 in %	GRAIN SIZE HYDROMETER UNIT WEIGHT CONSOLIDATION G S γ C	LABORATORY AND FIELD TEST RESULTS: △ IN SITU FIELD VANE, S_i; ▲ LABORATORY VANE, C_u; ○ WATER CONTENT, W, %; ⊢ ATTERBERG LIMIT W_P W_L; GRAPHIC SCALE % 100 100 100 100
	Dip		Continuation of Borehole #11							
180					NQ	20	100			
			188-193: Coal bed		NQ	21	100			
190										
					NQ	22	100			
200										
					NQ	23	100			
210										
					NQ	24	100			
			End of Borehole @ 217 ft.							
220										

DATUM: VERIFIED BY:

UNDRAINED SHEAR STRENGTH kPa

Fig. 1 General view of Moose Channel formation, King Point, Yukon

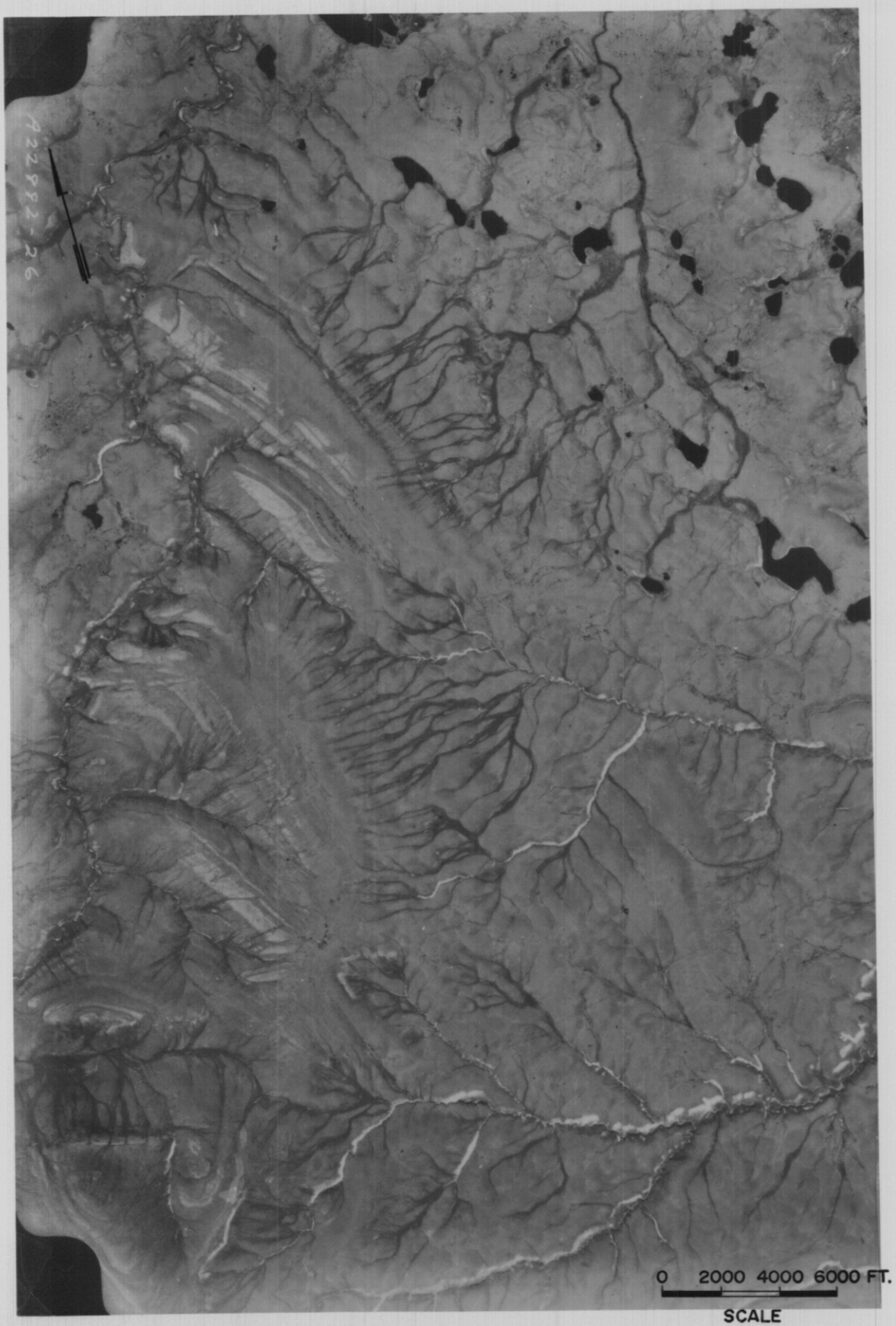


Fig. 1 General view of Moose Channel formation, King Point, Yukon

HOGGAN
Edmonton – Alberta

BOREHOLE LOCATION PLAN

CLIENT : PETER KIEWIT SONS CO. LTD.
PROJECT : KIEWIT QUARRY
SITE : KING POINT YUKON
DATE : SEPTEMBER 1983

SCALE

HOGGAN

Edmonton – Alberta

BOREHOLE LOCATION PLAN

CLIENT : PETER KIEWIT SONS CO. LTD.
PROJECT : KIEWIT QUARRY
SITE : KING POINT YUKON
DATE : SEPTEMBER 1983

HOGGAN

Edmonton — Alberta

BOREHOLE LOCATION PLAN

CLIENT : PETER KIEWIT SONS CO. LTD.-
PROJECT : KIEWIT QUARRY
SITE : KING POINT YUKON
DATE : SEPTEMBER 1983

TRANSLAR 003

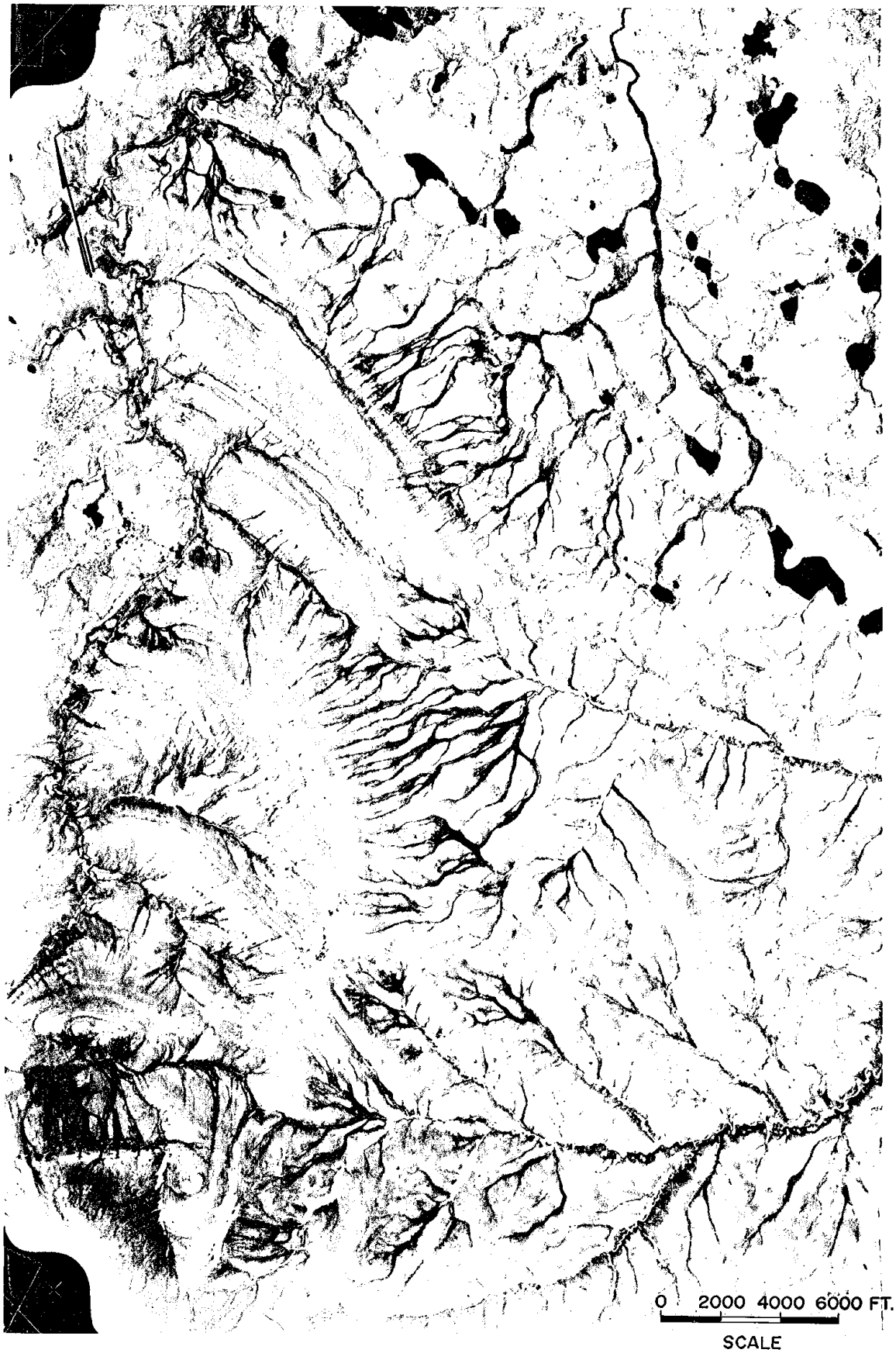
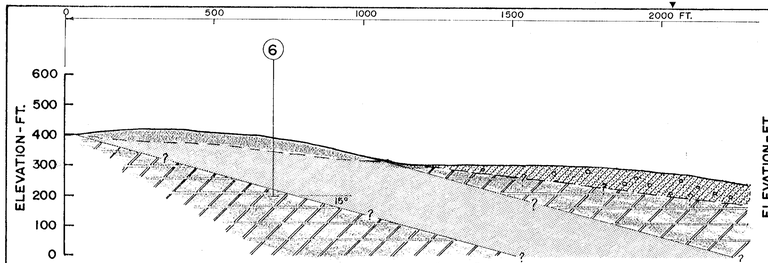
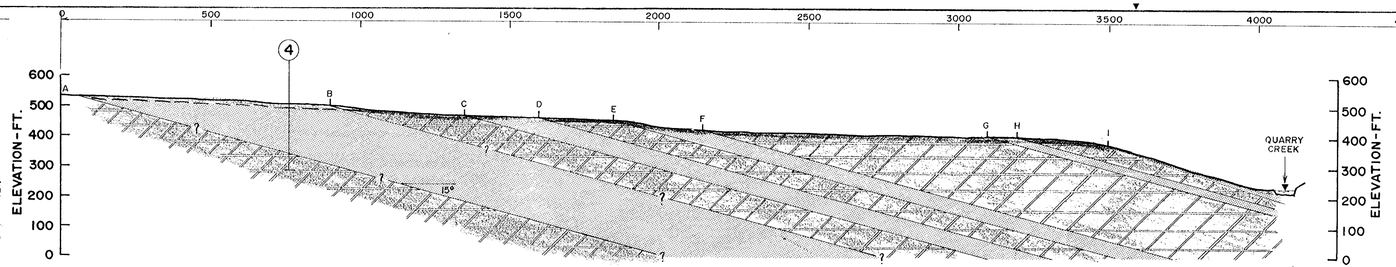


Fig. 1 General view of Moose Channel formation, King Point, Yukon



CROSS-SECTION "A-A"



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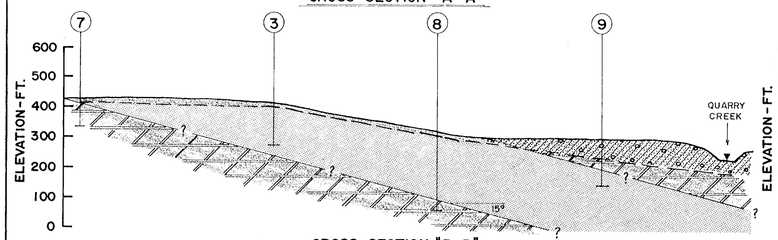
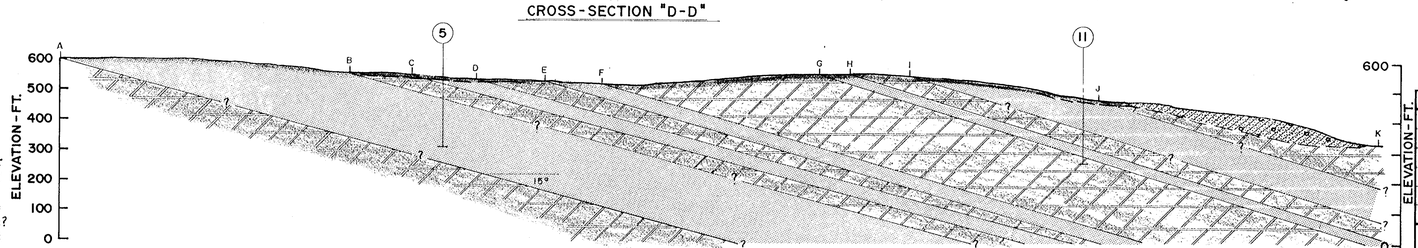
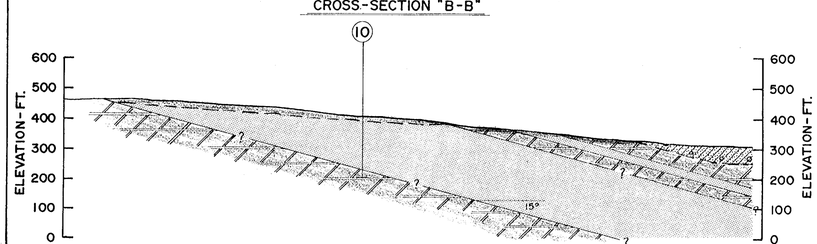


CROSS-SECTION "B-B"



CROSS-SECTION "E-E"



CROSS-SECTION "C-C"

LEGEND

(6) BOREHOLE IN CROSS-SECTION

STRATIGRAPHY

- OVERBURDEN, TALUS
- PERMAFROST, GLACIAL TILL
- WASTE ROCK, SHALES, MUDSTONES ETC.
- SANDSTONE FORMATION

NOTES

- CROSS-SECTIONS ARE DRAWN FROM AIR-PHOTO INTERPRETATION SUPPLEMENTED WITH BOREHOLE INFORMATION, AND ARE SCHEMATIC ONLY. CONTACTS AND STRATIGRAPHY IS ACCURATE AT BOREHOLE LOCATIONS ONLY AND MAY VARY CONSIDERABLY BETWEEN HOLES.
- ELEVATIONS ARE ARBITRARY AND ARE FROM SOGEAM'S TOPOGRAPHIC SURVEY PLAN WHICH IS UNDERSTOOD TO REFER TO SEA LEVEL.

0 100 200 300 400 500 FT.
SCALE

REFERENCES

DRAWING NO.	DESCRIPTION	DATE

PETER KIEWIT SONS CO. LTD

KIEWIT QUARRY

KING POINT, YUKON

TYPICAL CROSS-SECTIONS

HOGGAN

DATE: OCT. /83	SCALE: AS SHOWN	DRAWN BY: S.TURCOTTE T.Sc.A
APPROVED BY:		
DRAWING NO.	376-1	