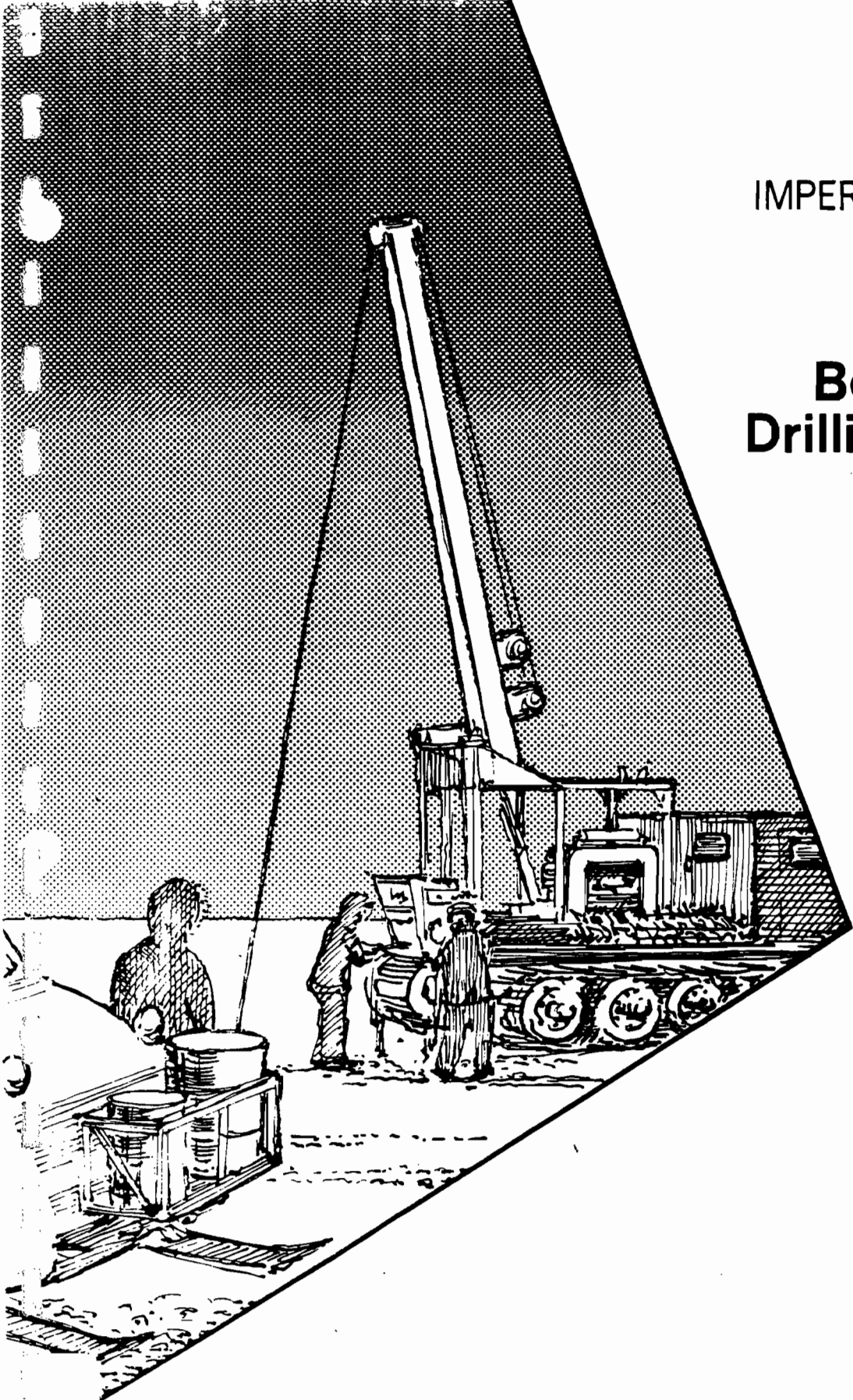


IMPERIAL OIL LIMITED

Beaufort Sea Drilling Program

WINTER 1974

(KADOK)



Volume 1



EBA Engineering Consultants Ltd.

Arctic Geotechnical Group

LIST OF FIGURES

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Appendix 2	Grain Size Curves

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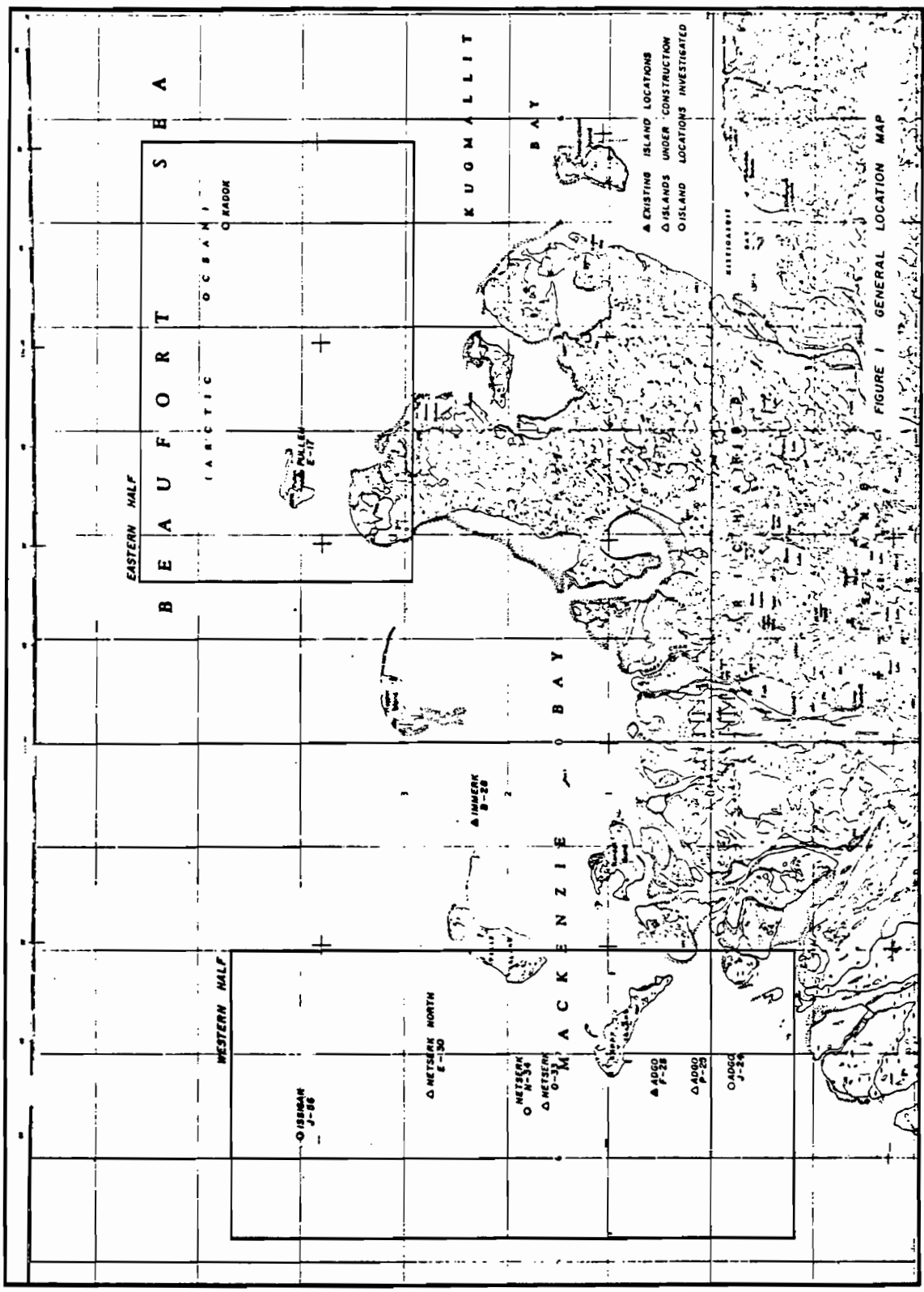
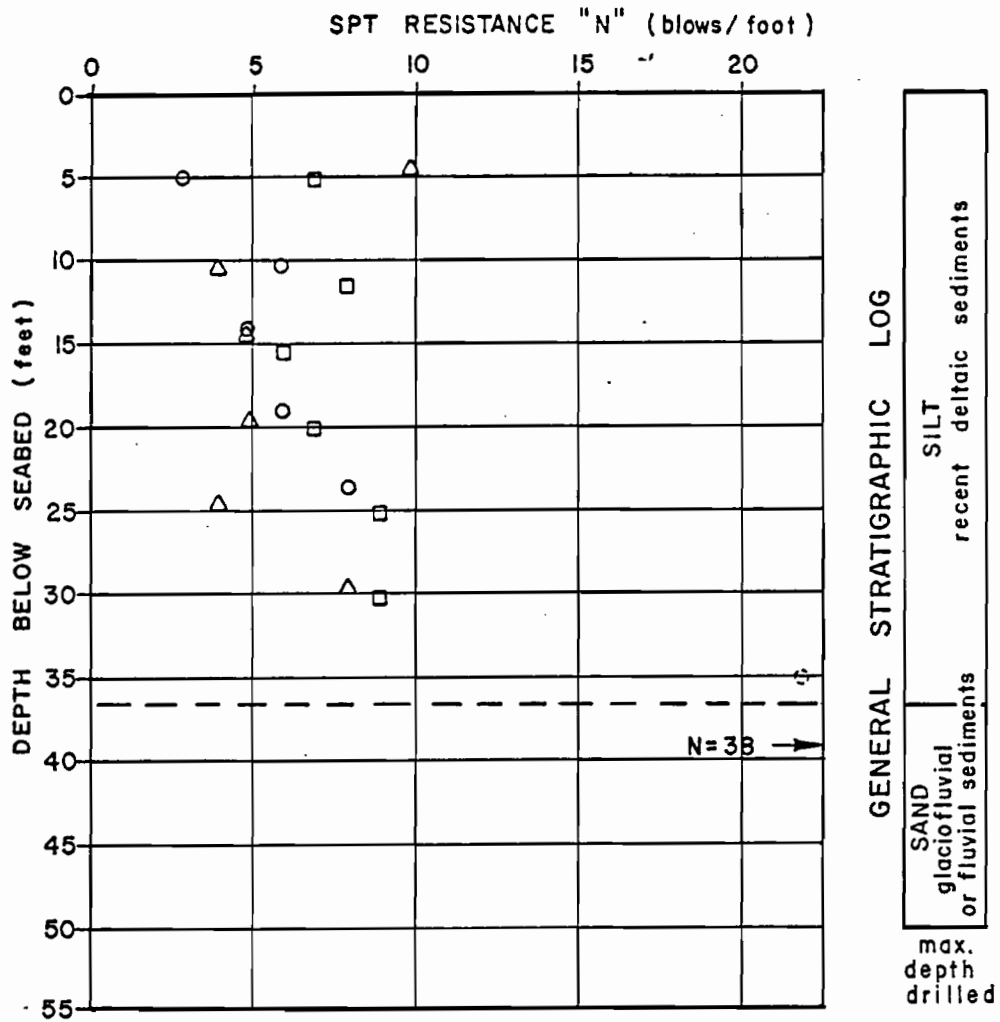


FIGURE 1 GENERAL LOCATION MAP

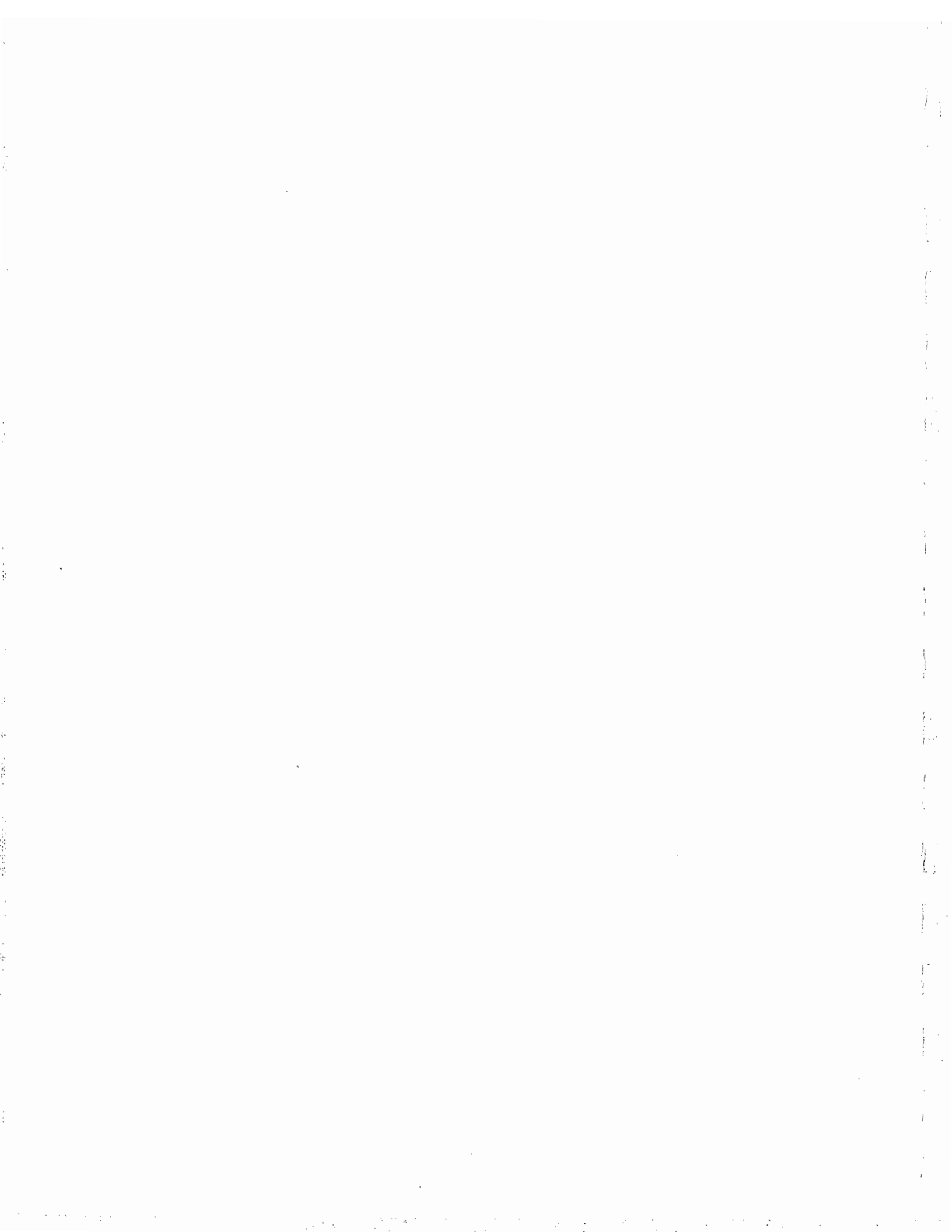


BOREHOLE DESIGNATION

KADOK	
BH	SYMBOL
416	○
419	△
420	□

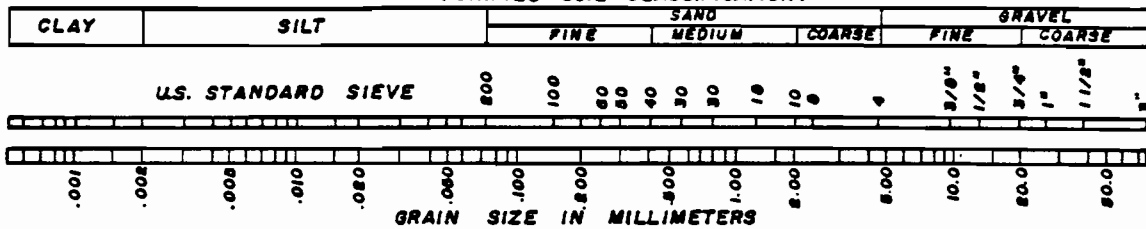
FIGURE 2
 DEPTH - DENSITY
 RELATIONSHIP for
 KADOK ISLAND SITE
 WATER DEPTH 33 FEET

APPENDIX 1
BOREHOLE LOGS



SYMBOLS AND TERMS USED IN LOGGING BOREHOLES

GRAIN SIZE DISTRIBUTION (UNIFIED SOIL CLASSIFICATION)



TERMS DESCRIBING CONSISTENCY OR CONDITION

COARSE GRAINED SOILS (major portion retained on N^o 200 sieve): includes (1) clean gravels and sands, and (2) silty or clayey gravels and sands. Condition is rated according to relative density, as determined by laboratory tests.

DESCRIPTIVE TERM	RELATIVE DENSITY	N BLOWS PER FOOT
Very loose	0 - 20 %	0 - 4
Loose	20 - 40 %	4 - 10
Compact, or Medium	40 - 75 %	10 - 30
Dense	70 - 90 %	30 - 50
Very dense	90 - 100 %	> 50

The number of blows, N, on a 2" O.D. split spoon sampler of a 140 lb. wt. falling 30" required to drive the sample a distance of 1' from 6" to 18".

FINE GRAINED SOILS (major portion passing N^o 200 sieve): includes (1) inorganic and organic silty and clays, (2) gravelly, sandy, or silty, clays, and (3) clayey silt. Consistency is rated according to shearing strength, as indicated by penetrometer readings or by unconfined compression tests.

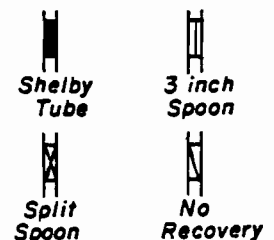
DESCRIPTIVE TERM	UNCONFINED COMPRESSIVE STRENGTH TON/SQ. FT.	N BLOWS PER FOOT
Very soft	less than 0.25	< 2
Soft	0.25 to 0.50	2 - 4
Firm	0.50 to 1.00	4 - 8
Stiff	1.00 to 2.00	8 - 15
Very stiff	2.00 to 4.00	15 - 30
Hard	4.00 and higher	> 30

ICE DESCRIPTION

(AFTER NRC TM N^o 79)


Non Visible Ice	Nf	Poorly bonded
	Nbn	Well bonded
	Nbe	Excess ice
Visible Ice Less than linch thick	Vx	Individual ice crystals or inclusions
	Vc	Ice coatings or particles
	Vr	Random or irregularly oriented ice formations
	Vs	Stratified or distinctly oriented ice formations
Visible Ice Greater Than linch thick	ICE	Ice with soil inclusions
	ICE	Ice without soil inclusions

SAMPLER TYPE (SHOWN IN SAMPLES COLUMN)



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BEAUFORT SEA DRILLING PROGRAM - 1974

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE	GROUND ICE CONDITION	MOISTURE CONTENT % ●														
				SPT RESISTANCE ▲														
				10 20 30 40 50 60 70			COMP. STRENGTH T.S.F. ■											
				1			2			3								
	SEA BOTTOM																	
2			NOT FROZEN															
4	-no recovery	X																
6		X																
8																		
10		X																
12	SILT -moist, medium plastic	X																
14		X																
16	-stratified																	
18	CLAY SILT																	
20	-moist, some organics	X																
22																		
24	-trace of organics, moist stratified, med. grey-brown non-plastic	X																
26																		
28																		
30																		

	ICE THICKNESS (ft.)	6	DATE DRILLED	11/4/74	HOLE No.	416
	WATER DEPTH (ft.)	33½	TECH	CME		
	COMPLETION DEPTH (ft.)	69½	REGION	KADOK		PAGE 1 OF 2

IMPERIAL OIL LIMITED
BEAUFORT SEA DRILLING PROGRAM - 1974

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE	GROUND ICE CONDITION	MOISTURE CONTENT % ●						
				SPT RESISTANCE ▲						
				10	20	30	40	50	60	70
				COMP. STRENGTH			T.S.F. ■			
				1	2		3			
32			NOT FROZEN							
34	SAND -clean, med. to fine, trace of silt, uniform	X								
36		X								
38	END OF HOLE									
40	-Sand sloughed up the inside of the hollow stem									



ICE THICKNESS (ft.) 6

DATE DRILLED 11/4/74

HOLE No.

WATER DEPTH (ft.) 33½

TECH CME

416


COMPLETION DEPTH (ft.) 69½

REGION KADOK

PAGE 2 OF 2

IMPERIAL OIL LIMITED
BEAUFORT SEA DRILLING PROGRAM - 1974

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE	GROUND ICE CONDITION	MOISTURE CONTENT % ●					
				SPT RESISTANCE ▲					
				10	20	30	40	50	60
				COMP. STRENGTH			T.S.F. ■		
				1	2	3	1	2	3
	SEA BOTTOM								
2			NOT FROZEN						
4	SILT -trace of clay , trace of fine sand, slight plasticity medium grey-brown	X							
6		X							
8		X							
10	CLAY -medium plastic SILT	●							
12		X							
14		X							
16		X							
18		X							
20		X							
22		X							
24		X							
26		X							
28		X							
30	-low plasticity	X							

	ICE THICKNESS (ft.)	5½	DATE DRILLED	16/4/74	HOLE No.	419
	WATER DEPTH (ft.)	33	TECH	KOS		
	COMPLETION DEPTH (ft.)	83½	REGION	KADOK		

IMPERIAL OIL LIMITED
BEAUFORT SEA DRILLING PROGRAM - 1974

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE	GROUND ICE CONDITION	MOISTURE CONTENT % ●						
				SPT RESISTANCE ▲			COMP. STRENGTH T.S.F. ■			
				10	20	30	40	50	60	70
				1	2	3				
32	CLAY SILT -as above		NOT FROZEN							
34										
36										
38										
40		X								
42	SAND -medium grain size, trace of silt									
44										
46										
48										
50										
52	END OF HOLE -sand sloughed up the inside of the hollow stem									
54										
56										
58										
60										




ICE THICKNESS (ft.) 5½
 WATER DEPTH (ft.) 33
 COMPLETION DEPTH (ft.) 83½

DATE DRILLED 16/4/74
 TECH KOS
 REGION KADOK

HOLE No. 419
 PAGE 2 OF 2

IMPERIAL OIL LIMITED
BEAUFORT SEA DRILLING PROGRAM - 1974

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE	GROUND ICE CONDITION	MOISTURE CONTENT % ●							
				SPT RESISTANCE ▲							
				10	20	30	40	50	60	70	
				COMP. STRENGTH T.S.F. ■							
SEA BOTTOM				1	2	3					
2			NOT FROZEN								
4	SILT -some organics, moist, medium grey	X									
6		X		▲							
8		X									
10		X									
12		X		▲							
14											
16		X		▲							
18											
20		X		▲							
22											
24	-some marine shells										
26		X	▲								
28											
30	SILT - CLAY -trace of fine sand	X	▲								

	ICE THICKNESS (ft.)	5½	DATE DRILLED	12/4/74	HOLE No.	
	WATER DEPTH (ft.)	32½	TECH	CME	420	
	COMPLETION DEPTH (ft.)	73±	REGION	KADOK	PAGE	1 OF 2

IMPERIAL OIL LIMITED
BEAUFORT SEA DRILLING PROGRAM - 1974

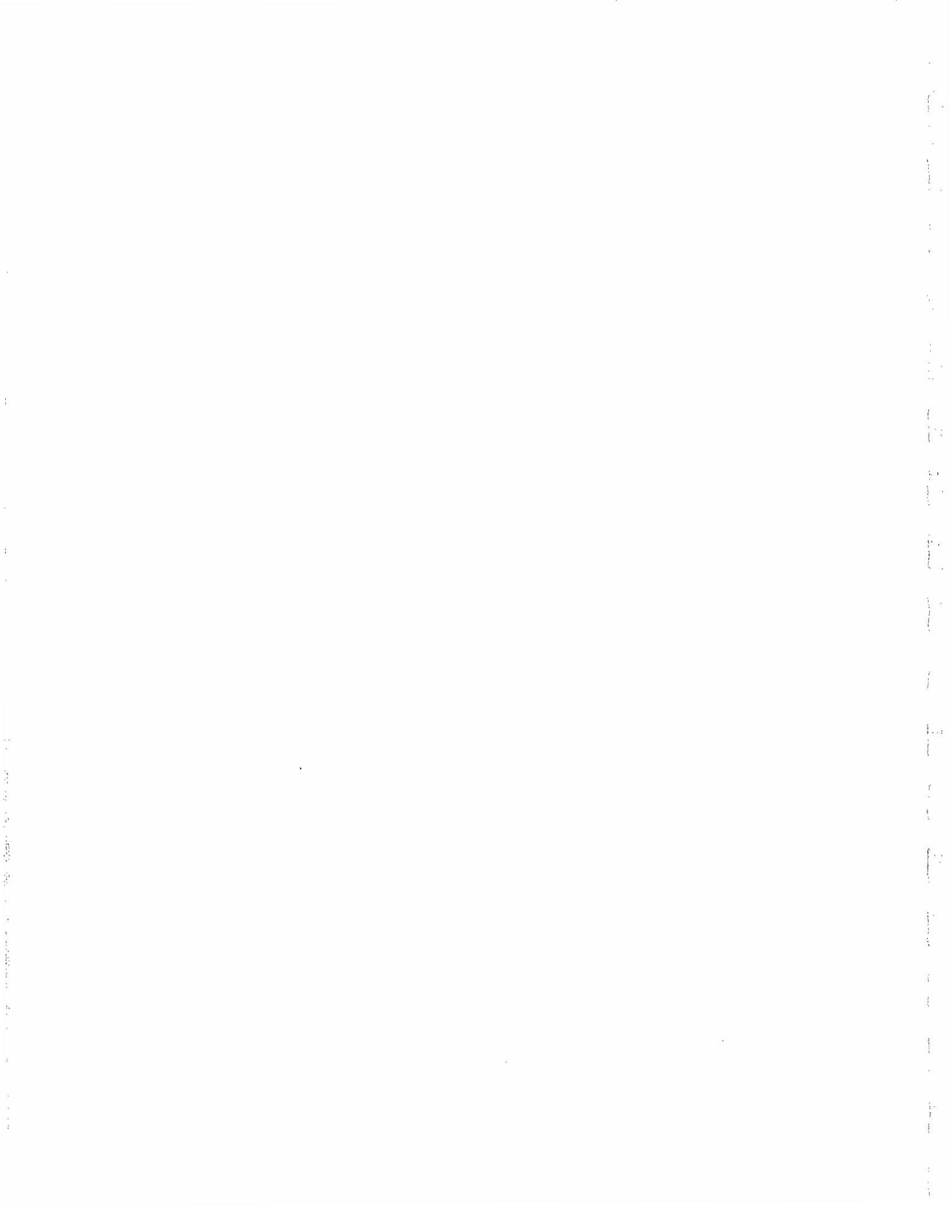
DEPTH (feet)	SOIL DESCRIPTION	SAMPLE	GROUND ICE CONDITION	MOISTURE CONTENT % ●							
				SPT RESISTANCE ▲			COMP. STRENGTH T.S.F. ■				
				10	20	30	40	50	60	70	
				1	2	3					
32	SILT -as above		NOT FROZEN								
34											
36											
38											
40	SAND										
42	END OF HOLE -sand sloughed up inside of hollow stem auger										
44											
46											
48											



ICE THICKNESS (ft.)	5½	DATE DRILLED	12/4/74	HOLE No.
WATER DEPTH (ft.)	32½	TECH	CME	420
COMPLETION DEPTH (ft.)	73½	REGION	KADOK	PAGE 2 OF 2



APPENDIX 2
GRAIN SIZE CURVES



UNIFIED SOIL CLASSIFICATION INCLUDING IDENTIFICATION AND DESCRIPTION

FIELD IDENTIFICATION PROCEDURES (Including particles larger than 3 inches and bearing fractions on estimated weight)		TYPICAL NAMES																																																																
COARSE GRAINED SOILS More than half of material is larger than No. 200 sieve size 12 (The No. 200 sieve size is about the smallest particle visible to the naked eye)	<table border="1"> <tr> <th colspan="2">SANDS</th> <th colspan="2">GRAVELS</th> </tr> <tr> <td>More than half of coarse fraction is smaller than No. 4 sieve size (For visual classifications the ϕ size may be used as equivalent to the No. 4 sieve size)</td> <td>More than half of coarse fraction is larger than No. 4 sieve size</td> <td></td> <td></td> </tr> <tr> <th>SANDS WITH FINES (Appreciable amount of fines)</th> <th>CLEAN SANDS (Little or no fines)</th> <th>GRAVELS WITH FINES (Appreciable amount of fines)</th> <th>CLEAN GRAVELS (Little or no fines)</th> </tr> <tr> <td>Plastic fines (for identification procedures see CL below.)</td> <td>Non plastic fines (for identification procedures see ML below.)</td> <td>Plastic fines (for identification procedures see CL below.)</td> <td>Non plastic fines (for identification procedures see ML below.)</td> </tr> <tr> <td>SP</td> <td>SM</td> <td>GP</td> <td>GM</td> </tr> <tr> <td>Wide range in grain sizes and substantial amounts of all intermediate particle sizes</td> <td>Predominantly one size or a range of sizes with some intermediate sizes missing.</td> <td>Predominantly one size or a range of sizes with some intermediate sizes missing</td> <td>Wide range in grain size and substantial amounts of all intermediate particle sizes</td> </tr> <tr> <td>SW</td> <td>SW</td> <td>GC</td> <td>GW</td> </tr> <tr> <td>Well graded sands, gravelly sands, little or no fines.</td> <td>Poorly graded sands, gravelly sands, little or no fines.</td> <td>Clayey gravels, poorly graded gravel-sand-clay mixtures.</td> <td>Silty gravels, poorly graded gravel-sand-silt mixtures.</td> </tr> <tr> <td>SP</td> <td>SM</td> <td>GC</td> <td>GM</td> </tr> <tr> <td>Poorly graded sands, gravelly sands, little or no fines.</td> <td>Silty sands, poorly graded sand-silt mixtures.</td> <td>Clayey gravels, poorly graded gravel-sand-clay mixtures.</td> <td>Silty gravels, poorly graded gravel-sand-silt mixtures.</td> </tr> <tr> <td>SC</td> <td>SC</td> <td>GM</td> <td>GM</td> </tr> <tr> <td>Clayey sands, poorly graded sand-clay mixtures.</td> <td>Clayey sands, poorly graded sand-clay mixtures.</td> <td>Silty silts and very fine sand, rock flour, silt or clayey fine sand with slight plasticity</td> <td>Inorganic silts and organic silt-clays of low plasticity.</td> </tr> <tr> <td></td> <td></td> <td>ML</td> <td>ML</td> </tr> <tr> <td></td> <td></td> <td>CL</td> <td>CL</td> </tr> <tr> <td></td> <td></td> <td>CH</td> <td>CH</td> </tr> <tr> <td></td> <td></td> <td>OH</td> <td>OH</td> </tr> </table>	SANDS		GRAVELS		More than half of coarse fraction is smaller than No. 4 sieve size (For visual classifications the ϕ size may be used as equivalent to the No. 4 sieve size)	More than half of coarse fraction is larger than No. 4 sieve size			SANDS WITH FINES (Appreciable amount of fines)	CLEAN SANDS (Little or no fines)	GRAVELS WITH FINES (Appreciable amount of fines)	CLEAN GRAVELS (Little or no fines)	Plastic fines (for identification procedures see CL below.)	Non plastic fines (for identification procedures see ML below.)	Plastic fines (for identification procedures see CL below.)	Non plastic fines (for identification procedures see ML below.)	SP	SM	GP	GM	Wide range in grain sizes and substantial amounts of all intermediate particle sizes	Predominantly one size or a range of sizes with some intermediate sizes missing.	Predominantly one size or a range of sizes with some intermediate sizes missing	Wide range in grain size and substantial amounts of all intermediate particle sizes	SW	SW	GC	GW	Well graded sands, gravelly sands, little or no fines.	Poorly graded sands, gravelly sands, little or no fines.	Clayey gravels, poorly graded gravel-sand-clay mixtures.	Silty gravels, poorly graded gravel-sand-silt mixtures.	SP	SM	GC	GM	Poorly graded sands, gravelly sands, little or no fines.	Silty sands, poorly graded sand-silt mixtures.	Clayey gravels, poorly graded gravel-sand-clay mixtures.	Silty gravels, poorly graded gravel-sand-silt mixtures.	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ML	ML			CL	CL			CH	CH			OH	OH	<p>Well graded gravel, gravel-sand mixture, little or no fines.</p> <p>Poorly graded gravel, gravel-sand mixture, little or no fines.</p> <p>Silty gravel, poorly graded gravel-sand-silt mixtures.</p> <p>Clayey gravels, poorly graded gravel-sand-clay mixtures.</p> <p>Well graded sands, gravelly sands, little or no fines.</p> <p>Poorly graded sands, gravelly sands, little or no fines.</p> <p>Silty sands, poorly graded sand-silt mixtures.</p> <p>Clayey sands, poorly graded sand-clay mixtures.</p> <p>Inorganic silts and very fine sand, rock flour, silt or clayey fine sand with slight plasticity</p> <p>Inorganic silts and organic silt-clays of low plasticity.</p> <p>Inorganic silts, micaceous or distomaceous fine sandy or silty soils, elastic silts.</p> <p>Inorganic clays of high plasticity, fat clays.</p> <p>Organic clays of medium to high plasticity.</p> <p>Peat and other highly organic soils.</p>
SANDS		GRAVELS																																																																
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<p>IDENTIFICATION PROCEDURES ON FRACTION SMALLER THAN NO. 40 SIEVE SIZE</p> <table border="1"> <tr> <th>SHRINKAGE (Free Shrinkage)</th> <th>SWELLING (Free Swelling)</th> <th>FLUIDITY (Flow Value)</th> </tr> <tr> <td>None to slight</td> <td>Duct to slow</td> <td>None</td> </tr> <tr> <td>Medium to high</td> <td>None to very slow</td> <td>Medium</td> </tr> <tr> <td>Slight to medium</td> <td>Slow</td> <td>Slight</td> </tr> <tr> <td>Slight to medium</td> <td>Slow to none</td> <td>Slight to medium</td> </tr> <tr> <td>High to very high</td> <td>None</td> <td>High</td> </tr> <tr> <td>Medium to high</td> <td>None to very slow</td> <td>Slight to medium</td> </tr> </table>		SHRINKAGE (Free Shrinkage)	SWELLING (Free Swelling)	FLUIDITY (Flow Value)	None to slight	Duct to slow	None	Medium to high	None to very slow	Medium	Slight to medium	Slow	Slight	Slight to medium	Slow to none	Slight to medium	High to very high	None	High	Medium to high	None to very slow	Slight to medium	<p>LABORATORY CLASSIFICATION CRITERIA</p> <p>Cu - D₆₀ Greater than 4 Cc - (D₃₀)² / (D₆₀)² Between one and 3</p> <p>Not meeting all gradation requirements for Gw</p> <p>Atterberg limits below "A" line, or PI less than 4</p> <p>Atterberg limits above "A" line with PI greater than 7</p> <p>Cu - D₆₀ Greater than 4 Cc - (D₃₀)² / (D₆₀)² Between one and 3</p> <p>Not meeting all gradation requirements for SW</p> <p>Atterberg limits below "A" line or PI less than 4</p> <p>Atterberg limits above "A" line with PI greater than 7</p> <p>Above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols</p>																																											
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<p>FINE GRAINED SOILS More than half of material is smaller than No. 200 sieve size (The No. 200 sieve size is about the smallest particle visible to the naked eye)</p> <p>SILTS AND CLAYS Liquid limit less than 50</p> <p>SILTS AND CLAYS Liquid limit less than 50</p>		<p>PLASTICITY CHART</p> <p>The Extended Unified Soil Classification defines Intermediate or medium plastic silt or clay (i.e. ML or CI) for soils having a liquid limit between 35 and 50%.</p>																																																																
<p>HIGHLY ORGANIC SOILS</p> <p>Readily identified by color, odor, spongy feel and heaviness by Robert Terzaghi</p>		<p>LABORATORY CLASSIFICATION CRITERIA</p> <p>Cu - D₆₀ Greater than 4 Cc - (D₃₀)² / (D₆₀)² Between one and 3</p> <p>Not meeting all gradation requirements for Gw</p> <p>Atterberg limits below "A" line, or PI less than 4</p> <p>Atterberg limits above "A" line with PI greater than 7</p> <p>Cu - D₆₀ Greater than 4 Cc - (D₃₀)² / (D₆₀)² Between one and 3</p> <p>Not meeting all gradation requirements for SW</p> <p>Atterberg limits below "A" line or PI less than 4</p> <p>Atterberg limits above "A" line with PI greater than 7</p> <p>Above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols</p>																																																																

11 Boundary classifications - Soils possessing characteristics of two groups are designated by combinations of group symbols. For example, GM-CC, well graded gravel sand mixture with clay binder.

12 As above sizes on this chart are U.S. standard.

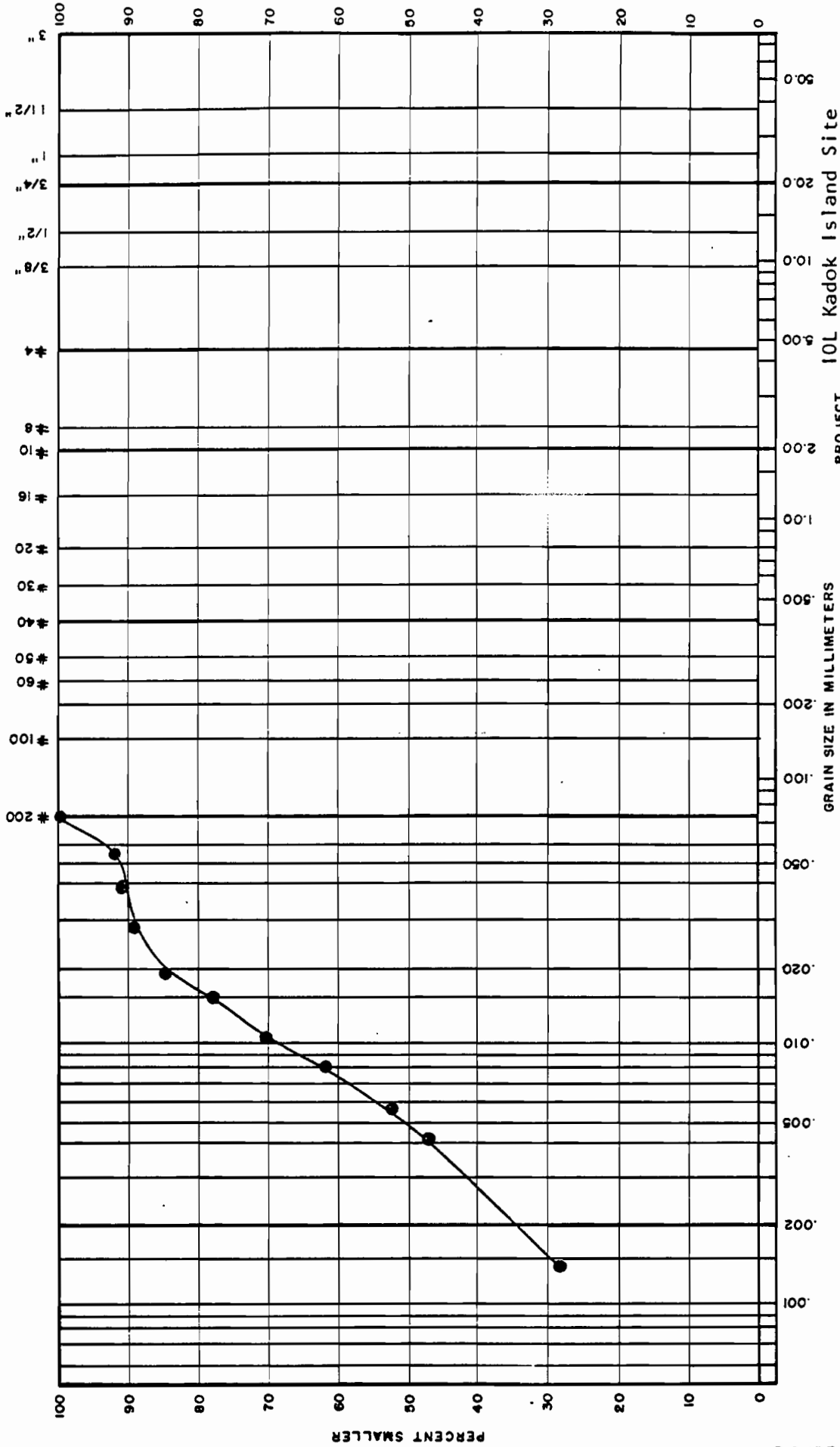
UNIFIED SOIL CLASSIFICATION CHART



EOC Engineering Consultants Ltd.

GRAIN SIZE DISTRIBUTION (UNIFIED SOIL CLASSIFICATION)

CLAY	SILT	SAND	GRAVEL
		FINE	COARSE
		MEDIUM	FINE
		COARSE	COARSE



PROJECT 10L Kadok Island Site
 JOB No. E-660 DATE April 26/74
 HOLE No. 416 SAMPLE No. _____
 DEPTH 18 1/2 - 20'

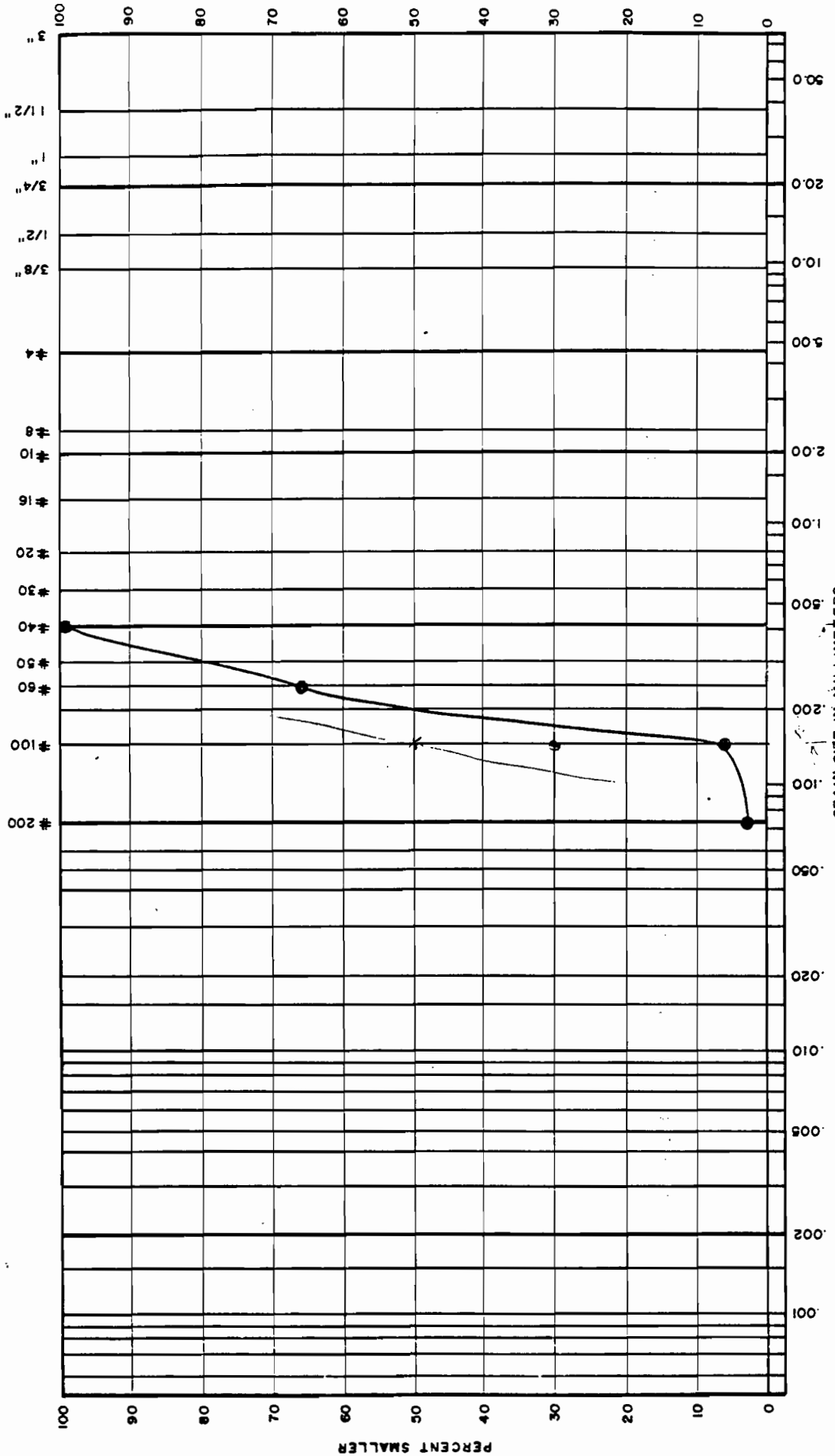
SAMPLE DESCRIPTION Clay Silt

 EBA Engineering Consultants Ltd.

FIGURE _____

GRAIN SIZE DISTRIBUTION (UNIFIED SOIL CLASSIFICATION)

CLAY	SILT	SAND		GRAVEL
		FINE	MEDIUM	COARSE
		FINE	MEDIUM	COARSE
		FINE	MEDIUM	COARSE



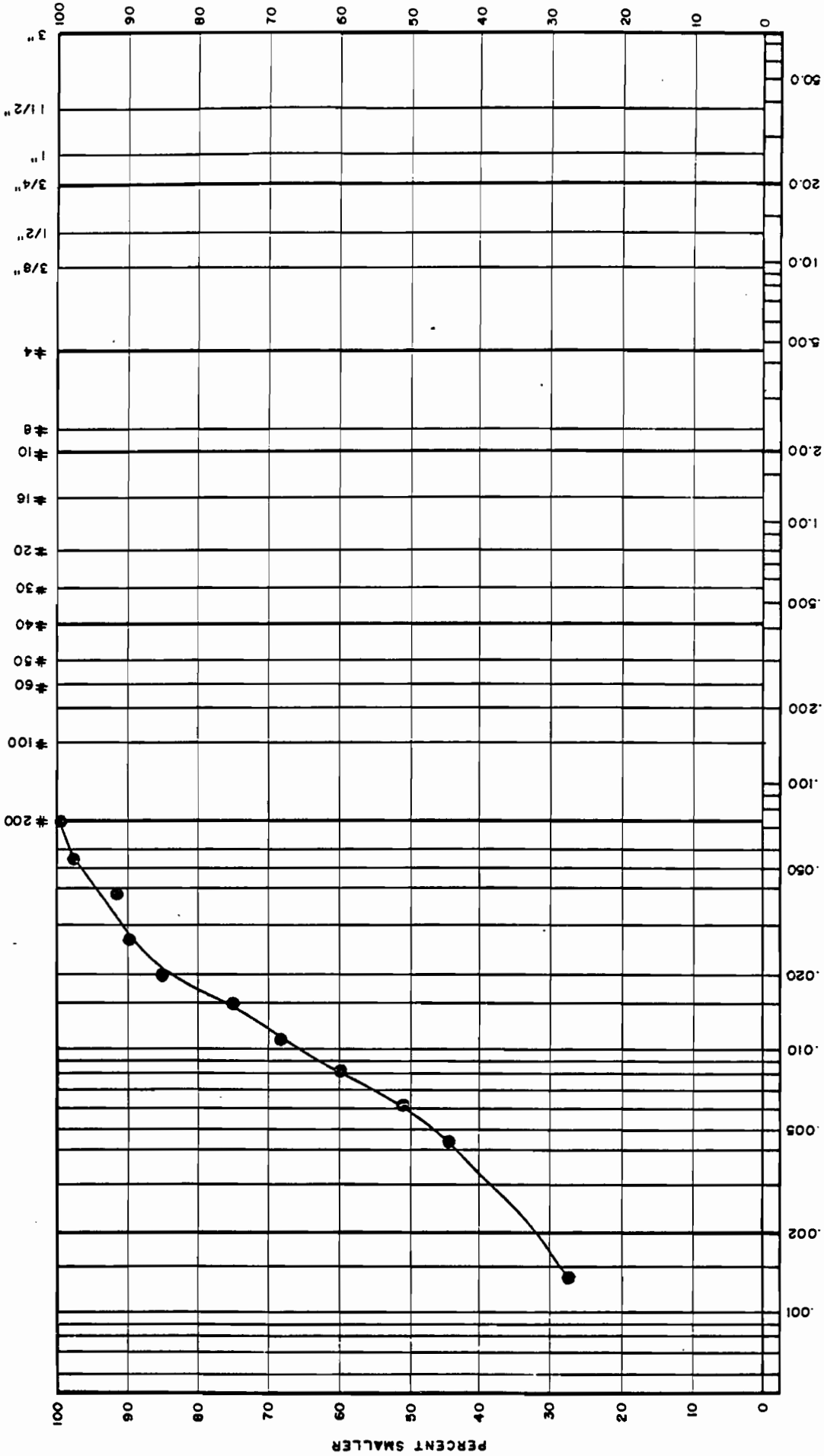
PROJECT 101 Kadok Island Site
 JOB No. E-660 DATE April 26/74
 HOLE No. 416 SAMPLE No. _____
 DEPTH 33'

SAMPLE DESCRIPTION Sand with a Trace of Silt

FIGURE _____

GRAIN SIZE DISTRIBUTION (UNIFIED SOIL CLASSIFICATION)

CLAY	SILT	SAND	GRAVEL
		FINE	FINE
		MEDIUM	COARSE
		COARSE	COARSE



GRAIN SIZE IN MILLIMETERS

PROJECT 101 Kadok Island Site
 JOB No. E-660 DATE April 26/74
 HOLE No. 419 SAMPLE No. _____
 DEPTH 14'

SAMPLE DESCRIPTION Clay Silt

 EBA Engineering Consultants Ltd.

FIGURE _____

**GRAIN SIZE DISTRIBUTION
(UNIFIED SOIL CLASSIFICATION)**

CLAY	SILT	SAND		GRAVEL	
		FINE	MEDIUM	COARSE	FINE
				# 4	COARSE

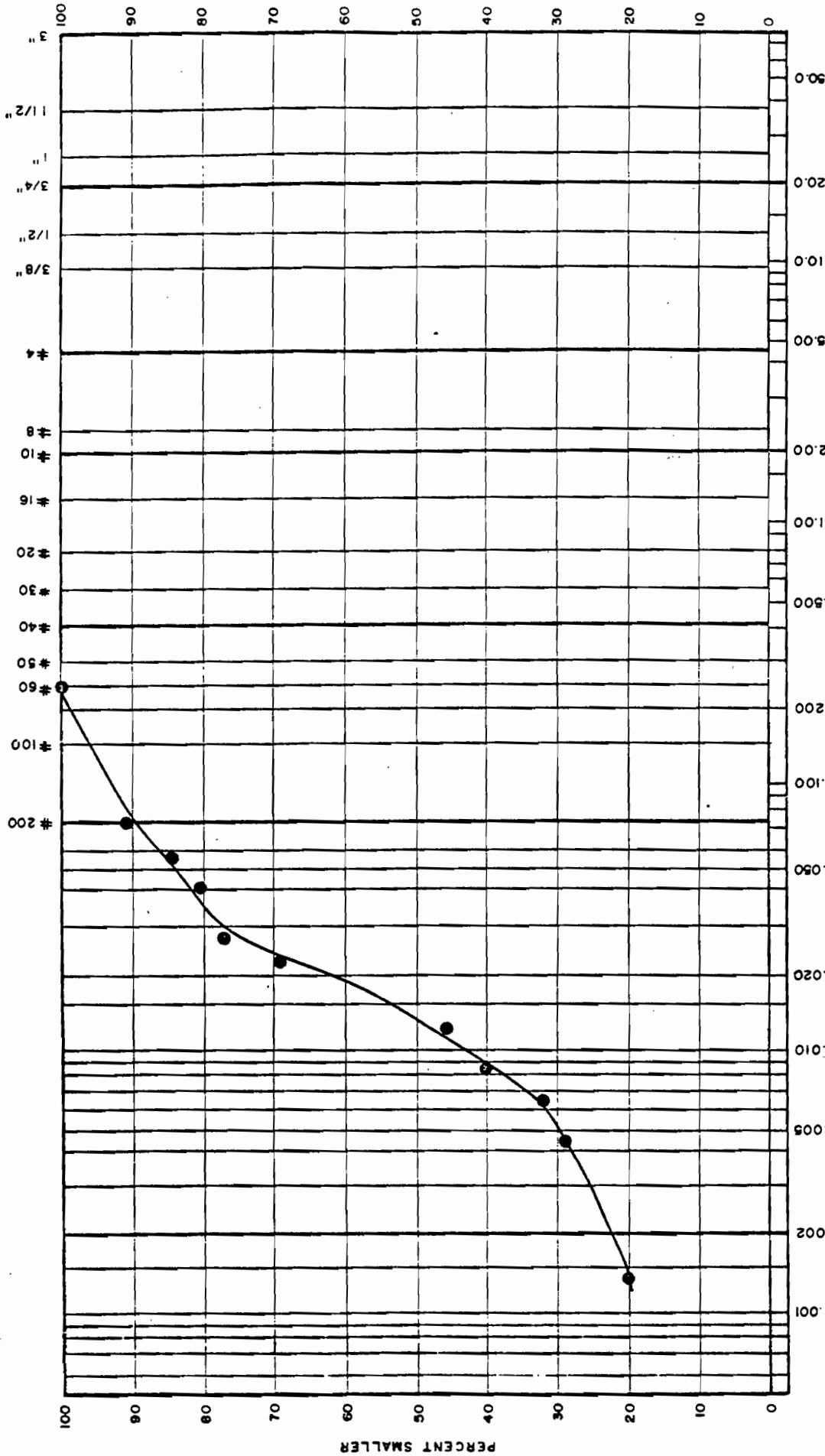


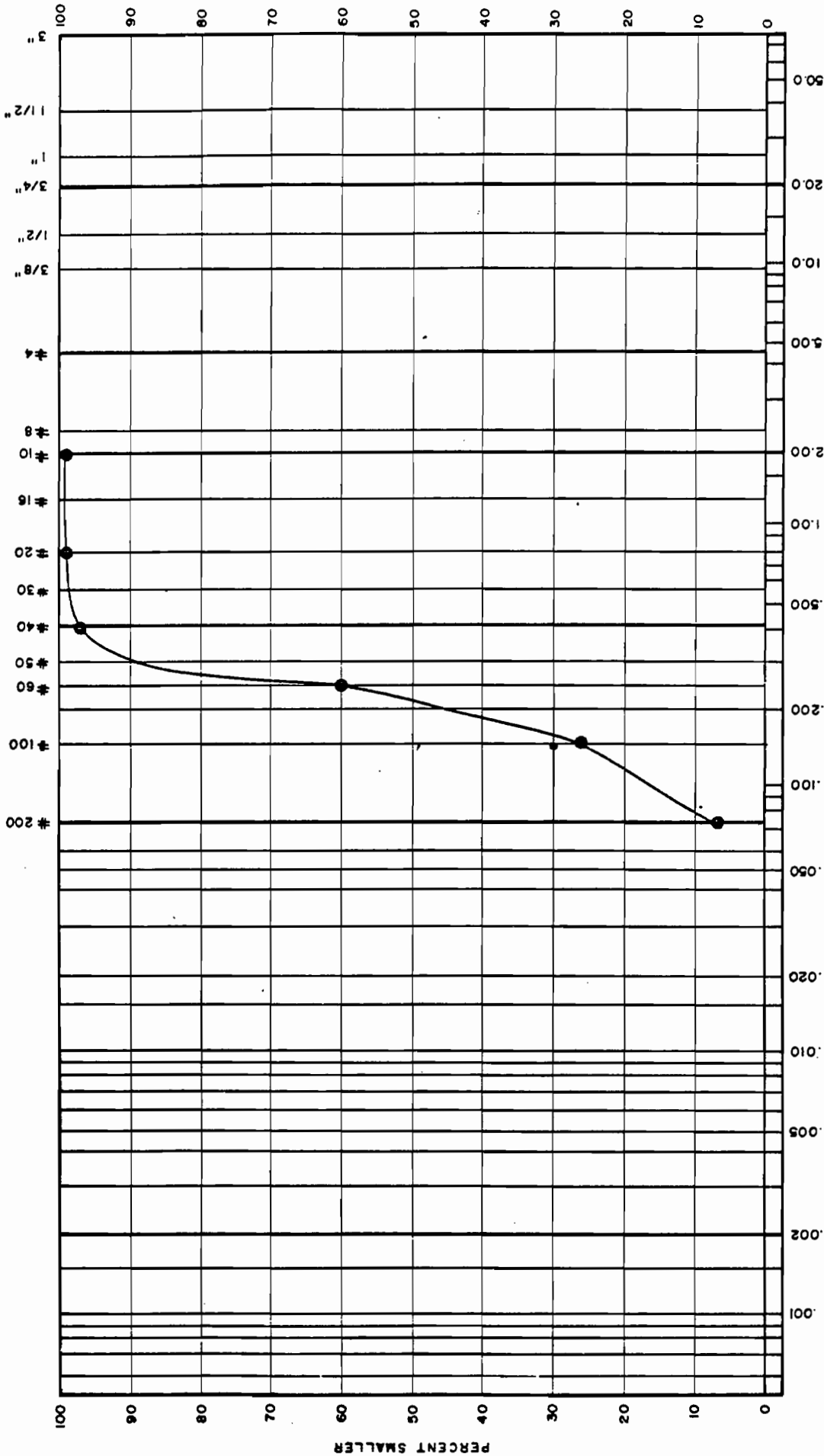
FIGURE _____

PROJECT 101 Kadok Island Site
 JOB No. E-660 DATE April 26/74
 HOLE No. 419 SAMPLE No. 39T
 DEPTH _____

SAMPLE DESCRIPTION Clayey, with some Sand

GRAIN SIZE DISTRIBUTION (UNIFIED SOIL CLASSIFICATION)

CLAY	SILT	SAND		GRAVEL	COARSE
		FINE	MEDIUM	FINE	COARSE



PROJECT 101 Kadok Island Site
 JOB No. E-660 DATE April 26/74
 HOLE No. 419 SAMPLE No. 49
 DEPTH 49'

SAMPLE DESCRIPTION Sand with a Trace
of Silt

FIGURE _____

GRAIN SIZE DISTRIBUTION (UNIFIED SOIL CLASSIFICATION)

CLAY	SILT	SAND		GRAVEL
		FINE	MEDIUM	COARSE
		FINE	MEDIUM	COARSE

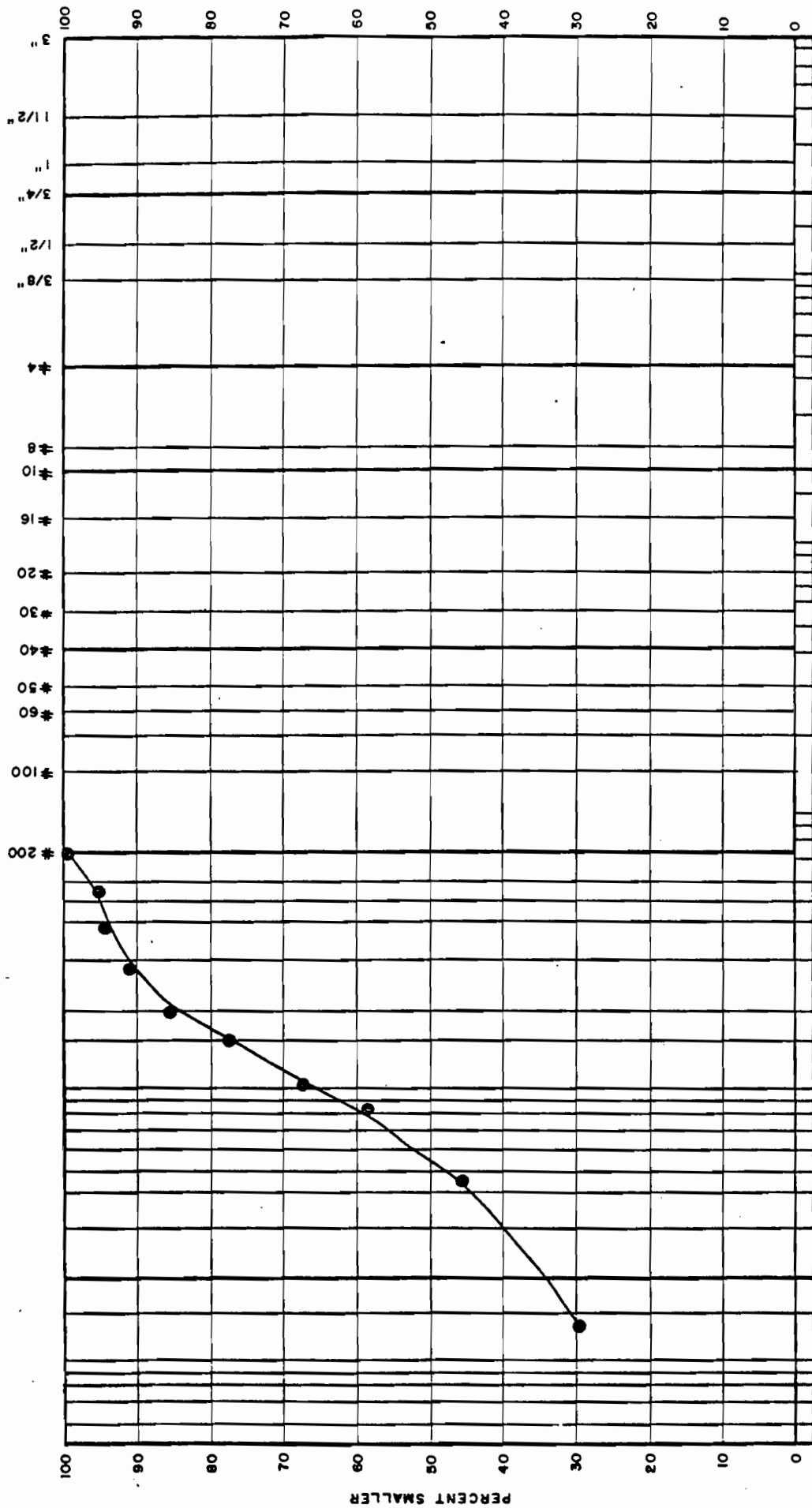


FIGURE _____

PROJECT 10L Kadok Island Site
 JOB No. E-660 DATE April 26/74
 HOLE No. 420 SAMPLE No. _____
 DEPTH 29' - 31'

SAMPLE DESCRIPTION Clay Silt

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