

**MONTANORE PROJECT
ADDENDUM TO GEOTECHNICAL REPORT
TAILINGS IMPOUNDMENT SITE
VOLUME 2 OF 2**

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Montanore Project
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APPENDIX C
LABORATORY TEST DATA

APPENDIX C

LABORATORY TEST DATA

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APPENDIX C

LABORATORY TEST DATA

C.1 GENERAL

Laboratory testing of soils, waste rock and tailings was performed by Chen-Northern, Inc., in Great Falls and Billings, Montana. Soil tests were performed on selected bag samples obtained from the test pits, and on Shelby Tube and core samples obtained from the drill holes. Waste rock samples were obtained from a stockpile near the exploration adit. Tailings were provided by Noranda Minerals Corp. Tests include grain size distribution (ASTM D422), Atterberg limits (ASTM D4318), moisture content (ASTM D2216), specific gravity (ASTM D854), moisture-density (ASTM D698), unit weight and moisture content, consolidation (ASTM D2435), triaxial compression (unconsolidated-undrained, UU-test ASTM D2850 and consolidated-undrained, CU-test), permeability (ASTM 2434), specific gravity and absorption (ASTM C127), Los Angeles abrasion (ASTM C535), sodium sulfate soundness (ASTM C88), maximum and minimum density (ASTM D4253 and D4254), and sedimentation density tests. The test results are summarized in Tables C-1 for soils and C-2 for tailings and shown on Figures C-1 through C-26. Results of waste rock tests are shown on Figures C-17 and 18. Additional details on the triaxial tests, tailings sedimentation tests and tailings consolidation tests are provided below.

C.2 TRIAXIAL COMPRESSION TESTS

All triaxial compression tests were performed on samples with diameter of 2.8 to 2.9 inches and a height to diameter ratio of 2.0 to 2.1. The maximum particle size of the compacted samples was 0.5-inch, which is approximately 1/6 of the sample diameter. The samples were back-pressure saturated until a pore pressure response of 95 percent or more was obtained. A confining pressure was then applied and flow out of the sample was monitored. The applied confining pressures are indicated on the figures that present the test results.

For consolidated undrained testing (CU) with pore-pressure measurements, three-stage triaxial tests were performed, each yielding a Mohr envelope. In each three-stage test,

only one sample was tested. After the sample was consolidated to the first level of confining pressure, the drainage ports were closed and the sample was sheared by applying a vertical deviator stress with a controlled strain device. The shearing continued until the axial stress reached a peak. The deviator stress was then removed and the sample was consolidated to the next level of confining pressure. The third and last stage was generally carried out to 20 percent axial strain.

The results of the CU triaxial tests on borrow materials include stress paths and Mohr circles and are presented on Figures C-16A and C-16B, respectively. Stress paths and Mohr circles from CU triaxial tests on foundation materials are presented on Figures C-14A & C-15A and C-14B & C15B, respectively.

Stress paths and Mohr circles from CU triaxial tests on tailings sand are presented in Figures C-21A & C-22A and C-21B & C-22B, respectively.

The results of UU triaxial tests on samples of tailings dam foundation soils, diversion dam foundation soils and compacted clayey borrow soils are presented on Figures C-9 to C-12.

C.3 SLIMES SEDIMENTATION TESTS

Two sedimentation tests were performed. The purpose of these tests was to determine the density of submerged slimes after sedimentation. The test procedure was as follows:

- A known weight of dry slimes was mixed with water to 9.6 percent solids by weight of slurry. The weight of the dry slimes was such that the final height of the slimes column after settlement was about one inch, which is roughly the height of sample needed for the consolidation tests (described below). Slimes gradation, based on the Krebs analyses, was as follows:

<u>U.S. Standard Sieve Size</u>	<u>Percent Passing by Weight</u>
No. 100	100
No. 150	99
No. 200	94
No. 270	76
No. 400	57

- The slurry was poured into a graduated cylinder with an inside diameter of 2.35 inches.
- The content of the cylinder was observed and the time recorded at which the slimes settled to the bottom of the container and a distinct surface observed at the top of the slimes. The height of the column of slimes was measured and the dry density computed.
- The above step was periodically repeated. Measurement frequency was such as required to obtain a good definition of the density-versus-time curve.
- The test was ended when the submerged slimes reached a constant density. A constant density was assumed to occur when it remained unchanged for five hours or more.
- The sediment density versus time is plotted on Figures C-25 and 26.

C.4 SLIMES CONSOLIDATION TESTS

Two consolidation tests (ASTM D2435) were performed on samples of sedimented slimes as discussed below.

Sample Preparation

- The sample was sedimented directly in the consolidation ring. For this purpose, a hollow cylinder was tightly fitted to the upper end of the consolidometer ring to provide enough volume to contain the slimes slurry.
- Using the average dry density of the sedimented slimes obtained from the two sedimentation tests, the weight of dry tailings that would settle to a height equal to that required for the consolidation test (i.e., 1 inch for a 2-1/2 inch diameter ring) was determined.
- The lower porous stone and filter paper were placed in the consolidometer and the drainage valves closed.
- The slurry was mixed and poured into the cylinder-consolidometer ring assembly. The sample was allowed to settle for a period of time no less than the duration of the sedimentation tests. During this step of the procedure, the drainage valves remained closed.
- The water above the specimen was removed without disturbing the specimen.
- The cylinder above the consolidation ring was removed, the height of the specimen measured, the filter paper and upper porous stone placed, and the drainage valves opened.

Testing

After the sample was prepared as described above, the consolidation test was initiated. The procedure prescribed in ASTM D2435 was followed except that the seating pressure was very small to avoid loss of soil through the annulus between the porous stone and the consolidometer ring. The first increment of load was equal to the seating pressure.

The specimen remained saturated during the entire test. Five time-rate curves were provided at pressures of approximately 250, 1000, 4000, 8000 and 16,000 psf. Load increments at these pressure levels were applied for a sufficient time to allow for estimation of secondary consolidation.

Results of the consolidation tests are presented in Appendix C.

TABLE C-1 SUMMARY OF SOIL TEST RESULTS

Project Name — MONTANORE

Job No 8029

SHEET 1 OF 3

Feature LITTLE CHERRY CR Date 10/10/90

Hole or Trench Number	Sample Number	Depth From To	Depth Feet	Laboratory Classification	Mechanical Analysis (2)			Atterberg Limits	Specific Gravity G	Natural W %	Shear Strength	Compaction	Permeability	Consolidation	Notes		
					Gravel	Sand	Fines										
TP-201	1	4	6	GM	32	20	48	22	5	12	SP 9.9	121.4	44	9.9	118.2	6250 0 1.1×10^{-5}	
TP-203	1	10	14	GM	33	28	35			12							
TP-204	1	2	10	GM	42	18	40			11							
TP-205	1	2	5	ML	24	23	53			11	SP 11.3	123.3	111	113	117.1	540 0 1.1×10^{-5}	
TP-205	2	5	9	ML-CL				18	7								
TP-207	1	3	6	GM	62	21	17			2.71	6	SP 3.5	131.9				
TP-208	2	1	3	GM	37	27	36			2.70	6	SP 9.1	123.4				
TP-209	1	4	9 1/2	GM	32	27	41			11	SP 12.6	116.8					
TP-210	1	1	4	GM	30	22	48			B							
TP-211	1	4	9	CL	23	17	60	31	14	2.75	16	SP 12	121.3	111	12.0	115.3	630 0 3×10^{-6}
TP-212	1	4	8	CL	18	20	62	36	16	2.0							
TP-213	1	4	12	GM	41	22	37			9							
TP-214	1	3	10	GM	43	18	39			9	SP 9.5	127					
TP-215	2	5	12	CL	10	19	71	33	16	2.0							
TP-217A	1	5	10 1/2	GM	34	28	33			B							
TP-217C	1	1	3							94%							
TP-217C	2	6	14 1/2	GM	38	31	31			11							
TP-219	2	5	13 1/2	GM	62	22	16										
TP-220	1	4	13	GM	49	29	22			11							
TP-224	1	2	16	GM	42	22	36			16							
TP-226	1	3	16 1/2	SC	29	34	37	31	14		SP 15.7	103.5					
TP-227	1	4	9	CL-ML	20	29	51	21	6	9							
TP-230	2	8	14	GM	61	25	14			13							
TP-233	1	9	14	ML	17	24	59			12							

* Visual Classification

SP = Standard Proctor

Mp = Modified Proctor

UN = Undrained Undrained

CU = Unconfined Compression

Ds = Direct Shear

CD = Consolidated Drained

(1) High moisture content reflects high organic content
(2) Percent gravel includes cobble size (3/8") material

TABLE C-1

SUMMARY OF SOIL TEST RESULTS

SHEET 2 OF 3

Job No. 8029

Project Name MONTANO RE

Feature LITTLE CHERRY CREEK

Date 10/10/90

© 1998 Charlesbridge

SF = Standard Pressure
MF = Modified Pressure
— = Control

TC = Translational Communication
UC = Untranslatable Communication

UJ = Ungeordnete Unterlagen
CD = Computerisierte Unterlagen
CR = Computerisierte Daten

- (1) Percent gravel includes cobble size (3" plus) material

- (1) Percent gravel includes cobble size (3" plus) material
Note: 1. C.U. triaxial values for cohesion (c) and angle of internal friction (ϕ) are effective strength

TABLE C-1

SUMMARY OF SOIL TEST RESULTS

SHEET 3 OF 3

Job No. B029-05

Project Name MONTANO RE

Feature LITTLE CHERRY CREEK

Date 11/6/90

* Vowel Classification

SP = Standard Proctor
MP = Modified Proctor

TC = Triaxial Compression
UC = Unconfined Compression

UU = Unconsolidated Undrained
CU = Consolidated Undrained

HS - Core samples that were wrapped and sealed

* : Bag samples of core drilling

Note: i. C.U triaxial values for cohesion and angle of internal friction are effective strength.

TABLE C-2 SUMMARY OF TAILINGS TEST RESULTS

SHEET 1 OF 1

Job No. 8029-02

Project Name MONTANOKE

Feature TAILINGS

Date 8/7/90

Hole or Trench Number	Sample Number	Depth		Laboratory Classification	Mechanical Analysis %		Atterberg Limits		Specific Gravity G	Sedimentation		Compaction		Shear Strength				Permeability		Consolidation			Notes			
		From	To		Gravel	Sand	Fines	LL		w %	γ_d	Test	w %	γ_d	Optimum	Test	Initial w %	C	KSF (°)	γ_d	cm/sec	cm/sec	C	G	E	
TAILINGS FEED				ML				NP	2.713																	
SAND U/F N.5		SM	0 90 10																	90	3.0×10^{-3}				Sample compacted to 95% γ_d max	
		SM	0 77 23*							SP 18.3	96.3									90	1.5×10^{-3}				" "	
		- - -																	CU 20.0	90	0.4	34	90	2.7×10^{-3}		" "
		- - -																		85	1.6×10^{-3}				Sample compacted to 90% γ_d max	
		SM	0 88 12																							Sieve analysis of material from Brenda
SAND U/F N.7		SM	0 86 14																	88.2	3.3×10^{-3}				Sample compacted to 95% γ_d max	
		SM	0 78 22*							SP 20.2	92.8									88.2	2.0×10^{-3}				" "	
		- - -																	CU 20.0	88.2	0.3	34	88.2	2.8×10^{-3}		" "
		- - -																		83.5	2.9×10^{-3}				Sample compacted to 90% γ_d max	
SAND U/F N.9		SM	0 92 8							SP 20.5	92.0															Max. Density = 99.8 PCF Min. Density = 75.5 PCF
		SM	0 84 16*																							
SLIMES		ML								70.5																Sedimentation Test
										69.0																Sedimentation Test #1
										66.9																Consolidation Test #1
										68.7																Sedimentation Test
																										Sedimentation Test #2

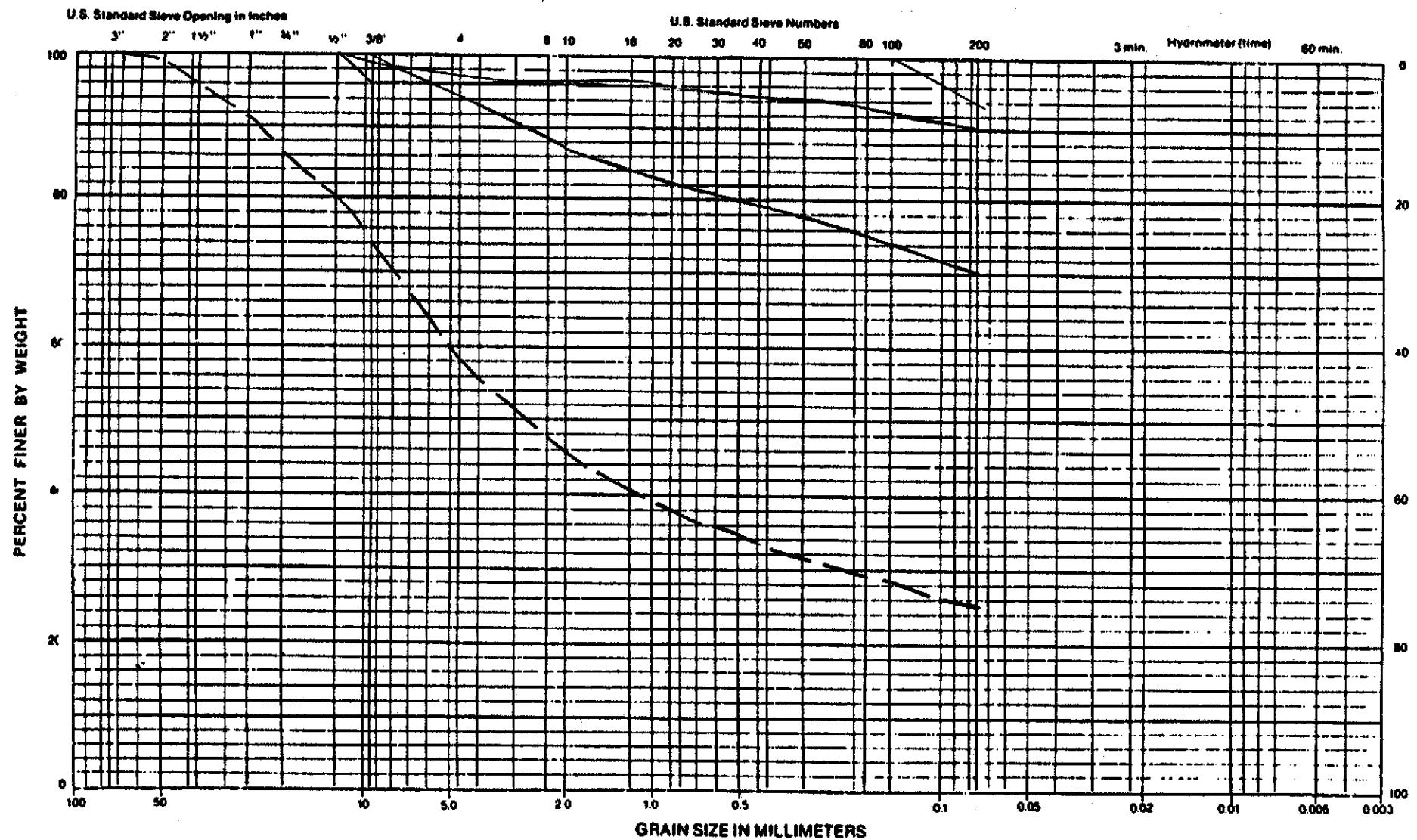
*Virtual Classification

SP = Standard Proctor
MP = Modified Proctor
F = Failure

TC = Throat Compression
UC = Unconfined Compression
SC = Surface Compression

UU = Unconsolidated Undrained
 CU = Consolidated Undrained
 CD = Consolidated Drained

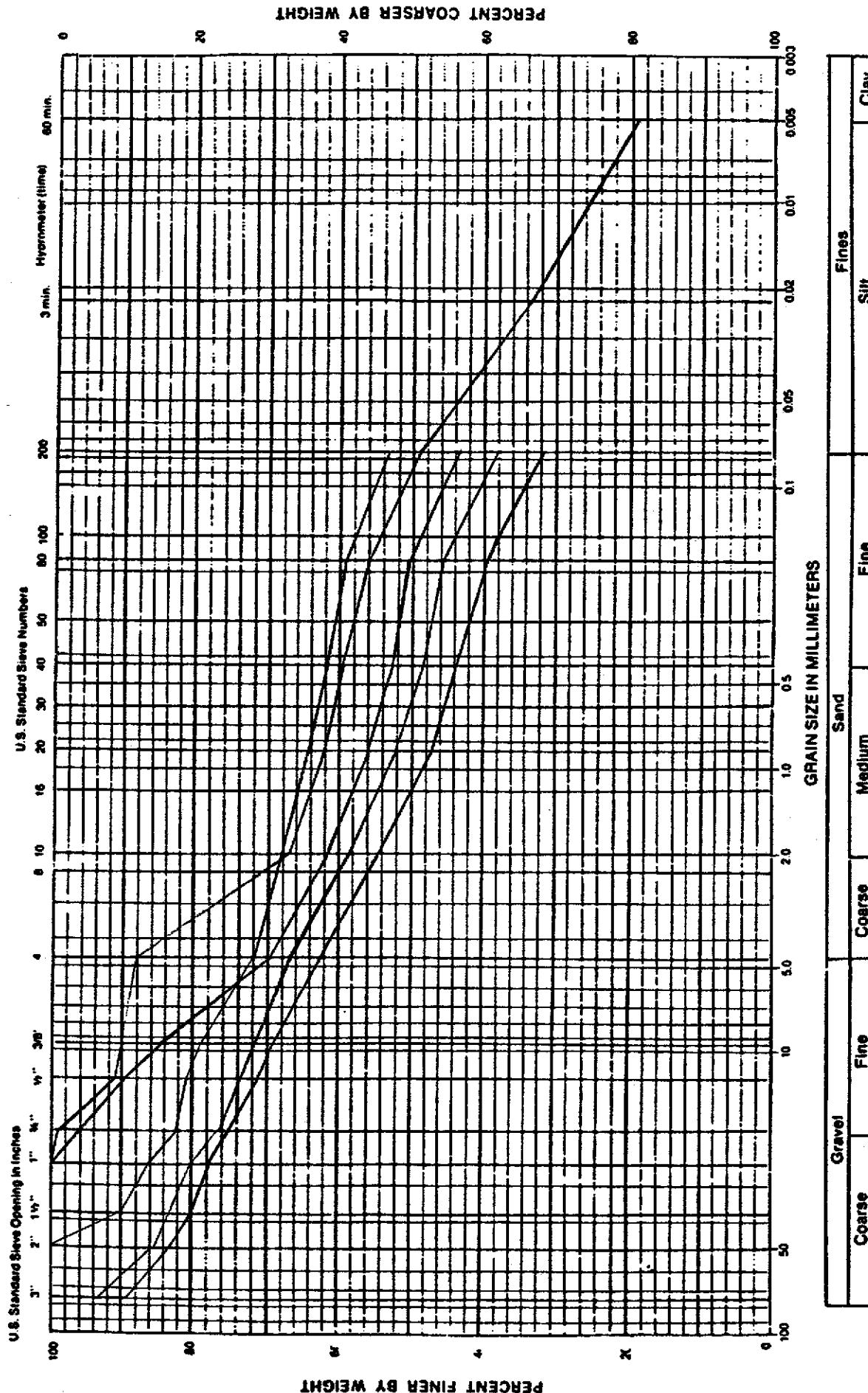
(*) Gradation determined after compaction, shear strength and permeability tests



Gravel		Sand			Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

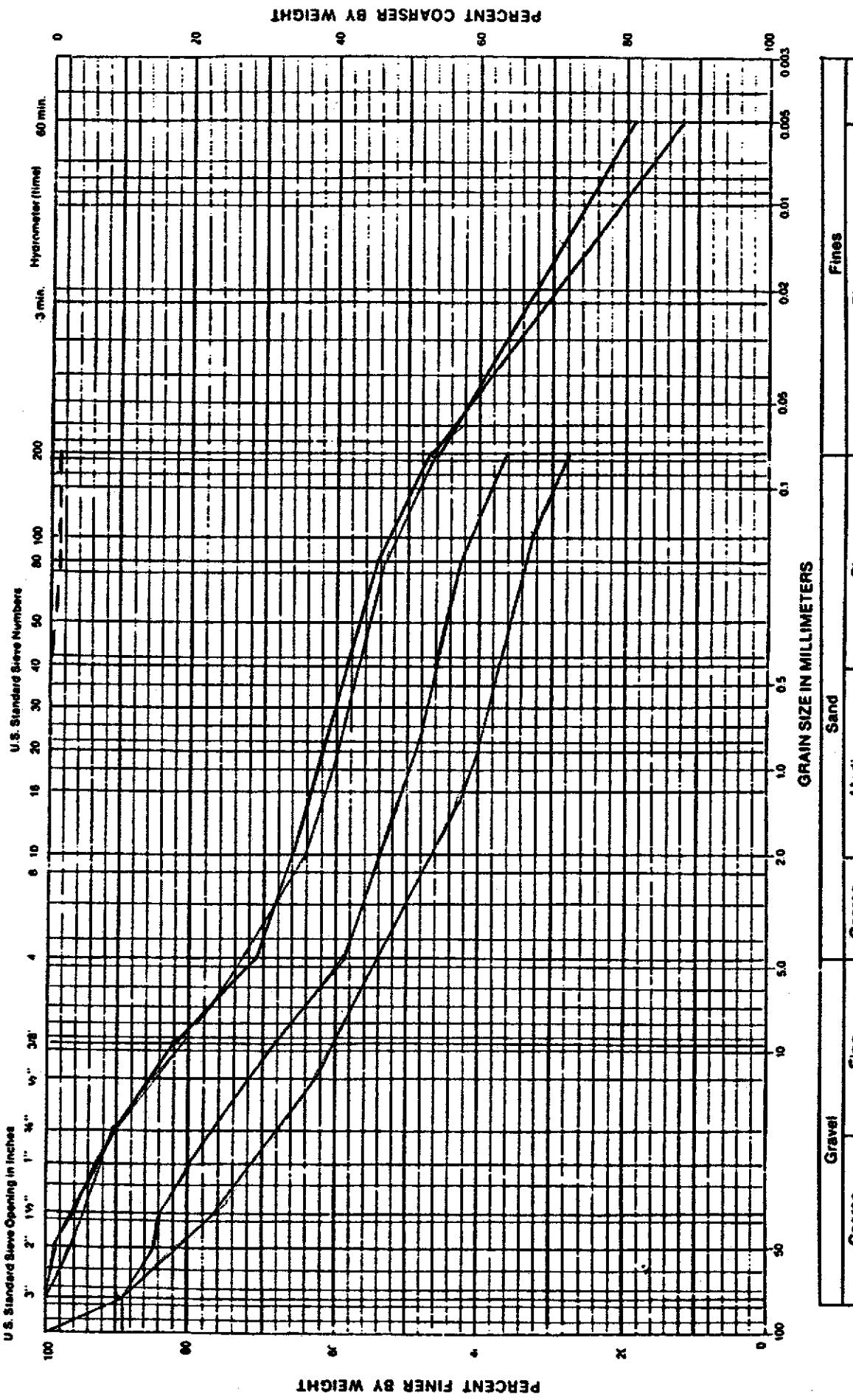
— — — TP-246 SOUTH SADDLE DAM

MONTANORE PROJECT
TAILINGS RETENTION DAM
FOUNDATION GRADATIONS
FIGURE C-1



MONTANORE PROJECT

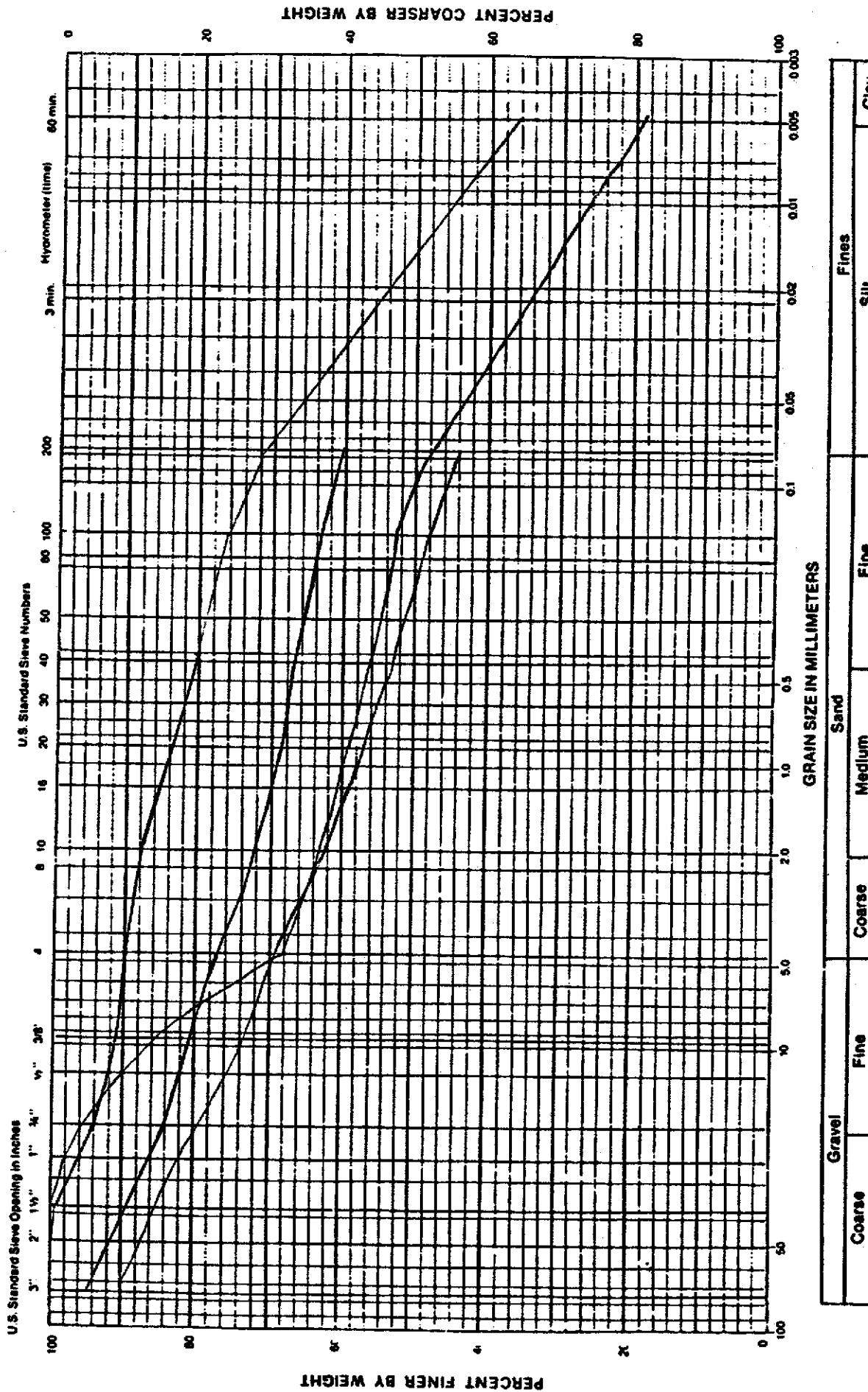
**DIVERSION DAM
FOUNDATION GRADATIONS**



Gravel						Sand						Fines					
Coarse			Fine			Coarse			Medium			Fine			Silt		
100	80	60	50	40	30	20	10	5	2	1	0.5	0.1	0.05	0.01	0.005	0.003	

— DH-38 (33.5'-34.2') SEEPAGE COLLECTION
DAM FOUNDATION - 99 % PASSING NO. 200
SIEVE.

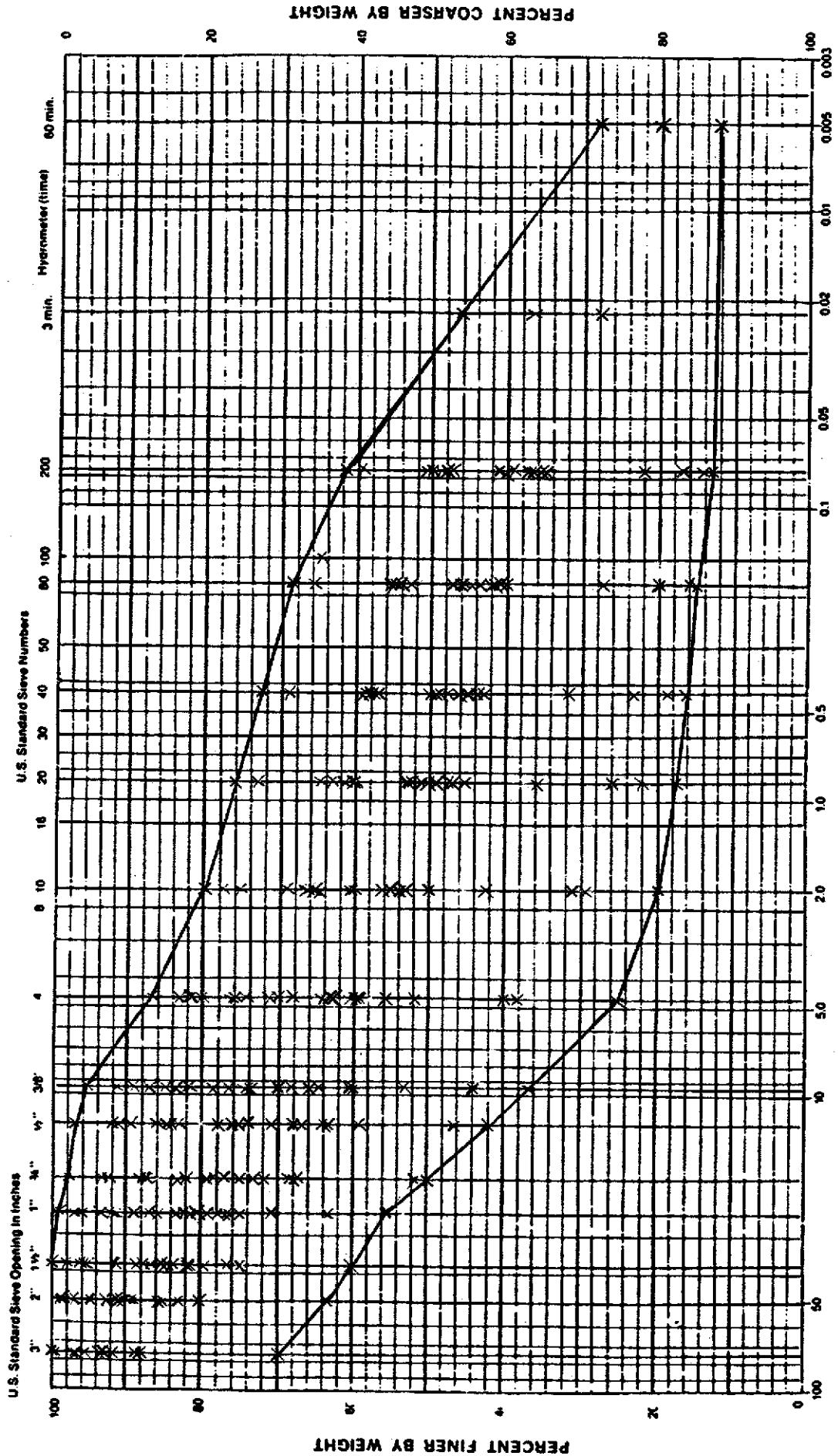
MONTANORE PROJECT
SEEPAGE COLLECTION DAM
FOUNDATION / IMPOUNDMENT GRADATIONS
FIGURE C-3



MONTANORE PROJECT

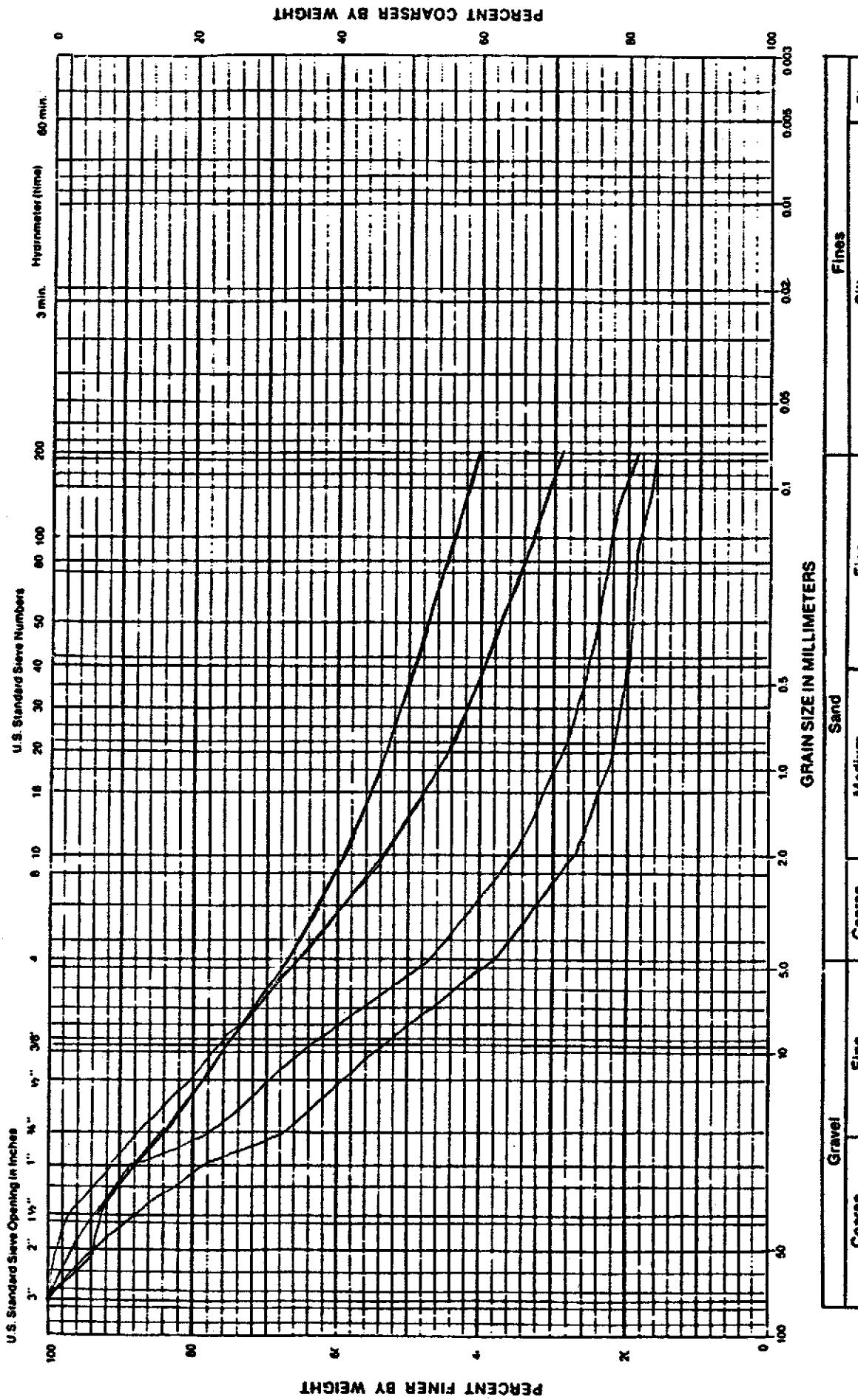
BORROW AREA A GRADATIONS

FIGURE C-4



Gravel	Sand	Coarse	Medium	Fine	Silt	Fines	Clay
Coarse							

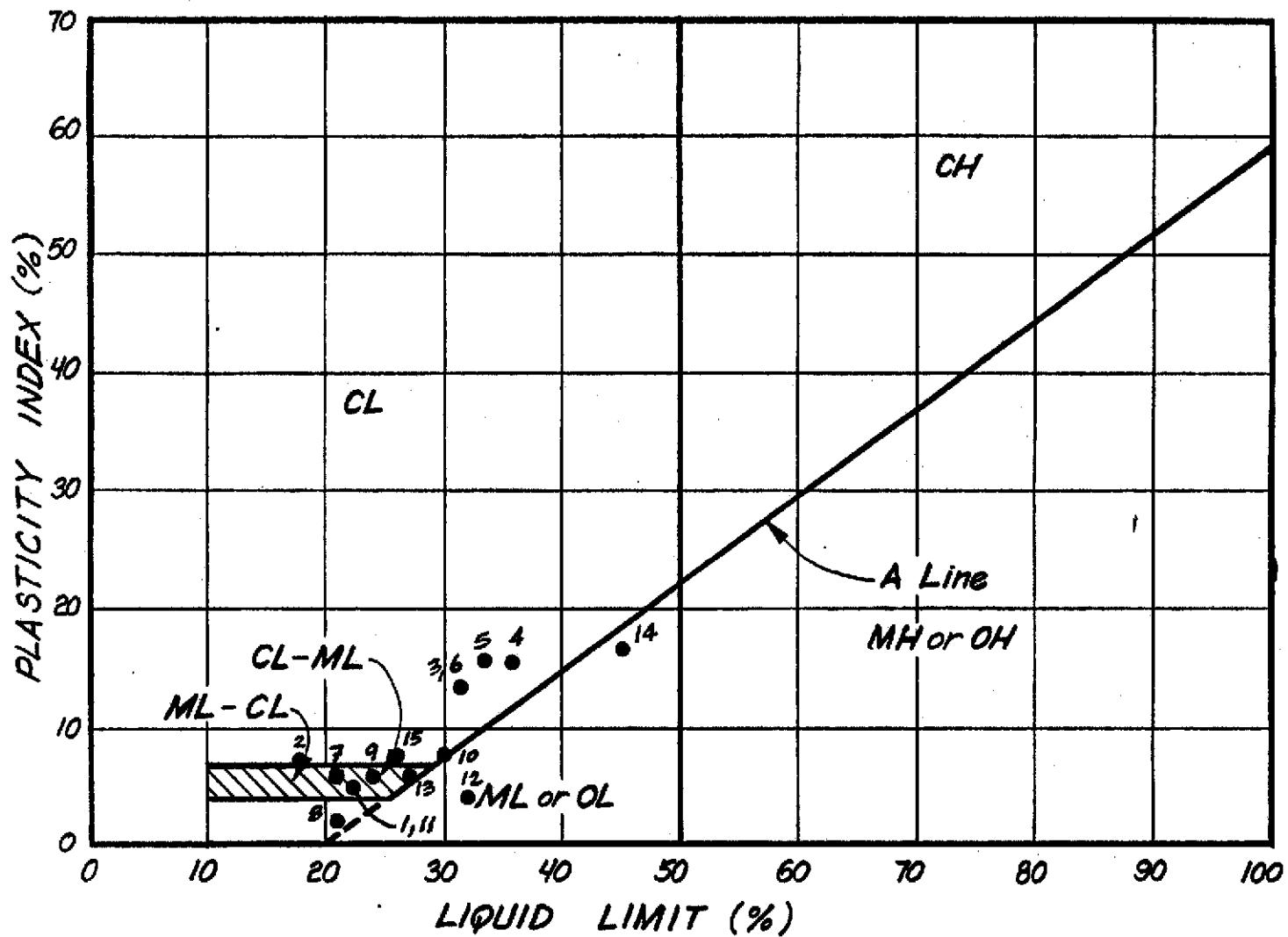
MONTANDRE PROJECT
BORROW AREAS B, C AND D
GRADATIONS
FIGURE C-5



MONTANDORE PROJECT

DIVERSION CHANNEL GRADATIONS

FIGURE C-6



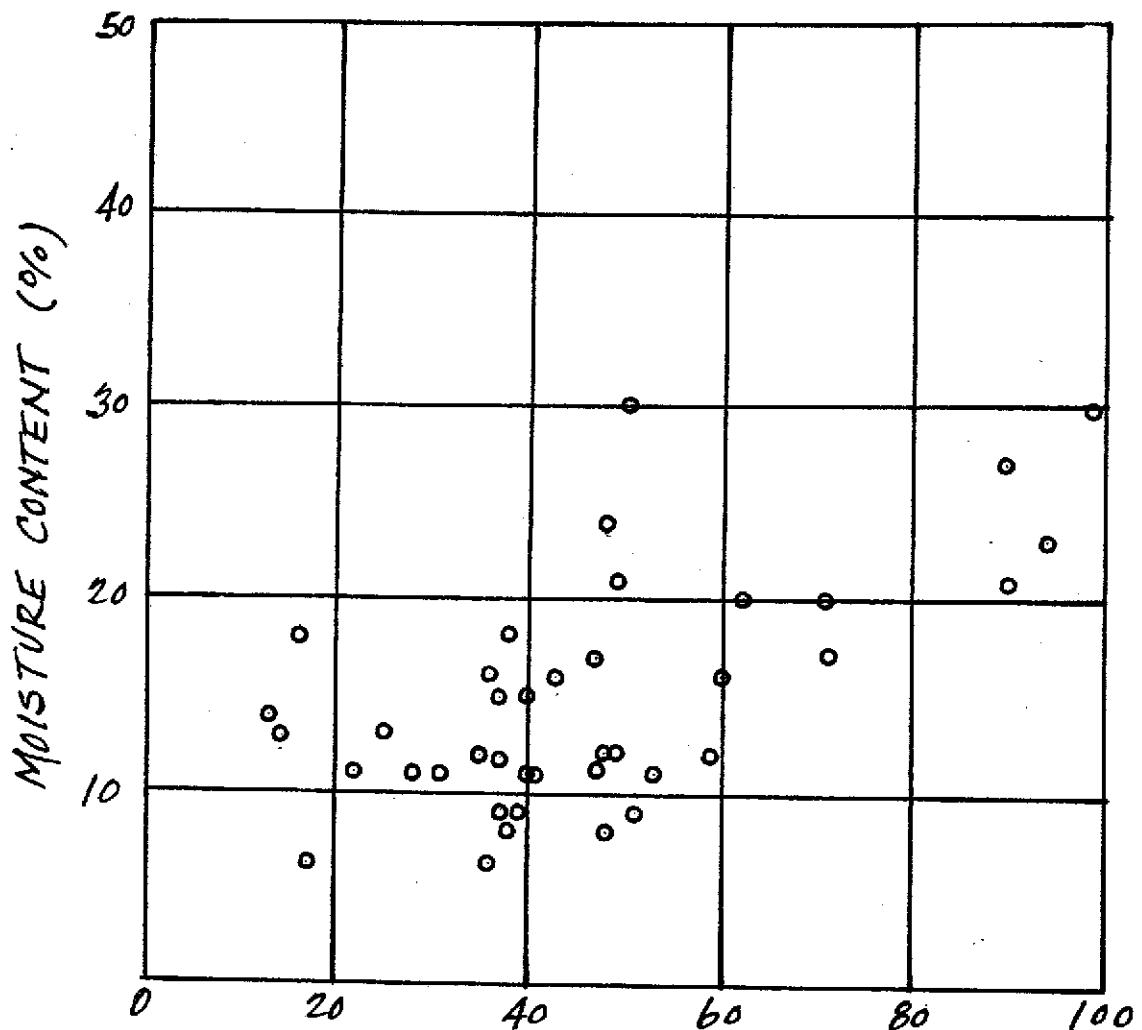
NOTE : SEE SHEET 2 OF 2 FOR KEY

MONTANORE PROJECT

SUMMARY OF ATTERBERG LIMITS
(SHEET 1 OF 2)
FIGURE C-7

Symbol	Classification and Source	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	% Passing #200 Sieve
1	TP-201 6' - 4' (GM)	22	17	5	48
2	TP-205 5' - 9' (ML-CL)	18	11	7	-
3	TP-211 4' - 9' (CL)	31	17	14	60
4	TP-212 4' - 8' (CL)	36	20	16	62
5	TP-215 5' - 12' (CL)	33	17	16	71
6	TP-226 3' - 16.5' (SC)	31	17	14	37
7	TP-227 4' - 9' (CL-ML)	21	15	6	51
	TP-247 2' - 12' (GM)			Non-Plastic	47
	TP-248 2' - 12' (GM)			Non-Plastic	37
8	TP-249 1' - 12.5' (GM)	21	19	2	28
	TP-250 2' - 11.5' (GM)			Non-Plastic	47
	DH-23 60.8' - 61.5' (ML)			Non-Plastic	94
9	DH-29 10' - 29.8' (GC-GM)	24	18	6	40
10	DH-30 5' - 13.5' (GC)	30	22	8	19
11	DH-32 23' - 25' (GC-CM)	22	17	5	43
12	DH-38 33.5' - 34.2' (ML)	32	28	4	99
13	DH-44 14.3' - 15' (CL-ML)	27	21	6	71
14	DH-45 22.6' - 23.2' (ML)	45	28	17	90
15	DH-49 17' - 19' (CL)	26	18	8	49

MONTANORE PROJECT
SUMMARY OF ATTERBERG LIMITS
Sheet 2 of 2
FIGURE C-7

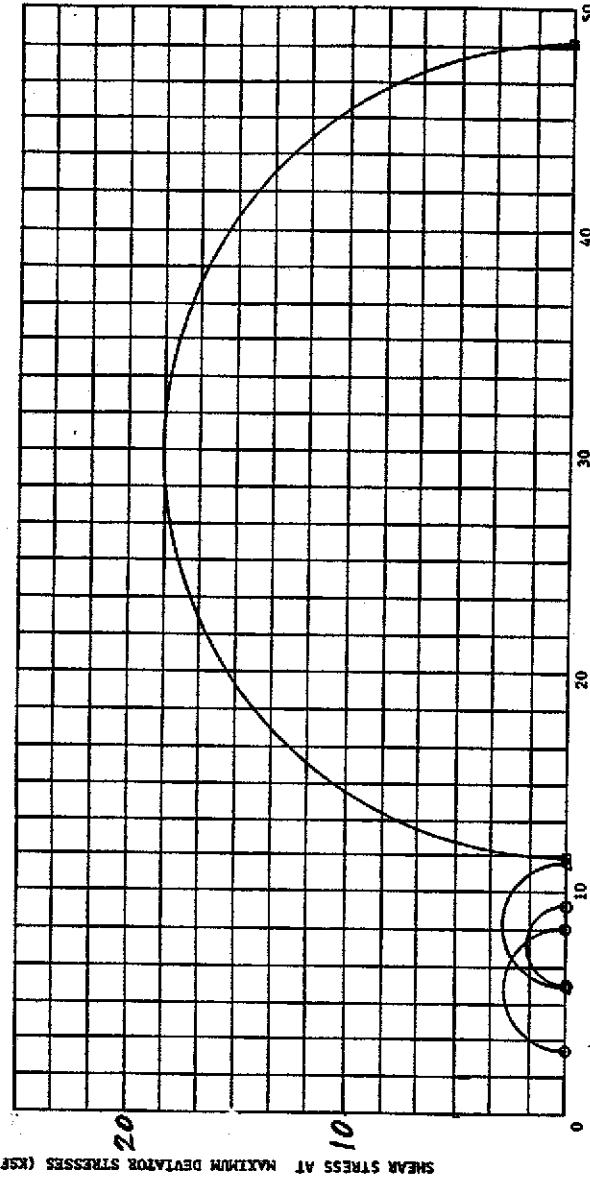


SOIL PASSING #200 SIEVE (%)

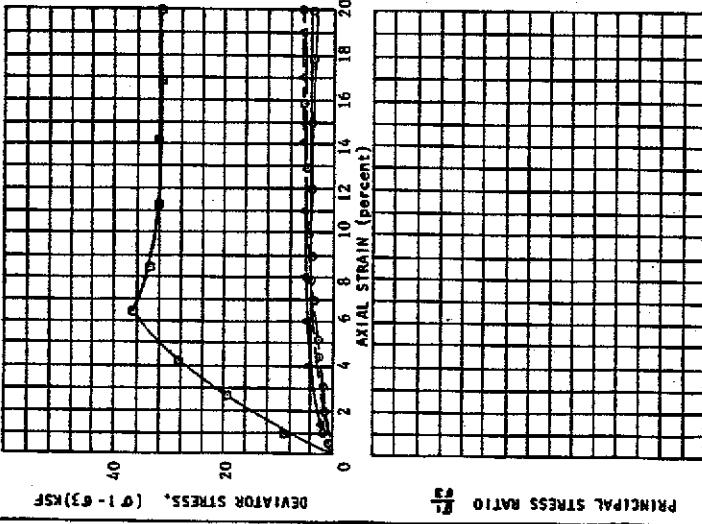
MONTANORE PROJECT
MOISTURE CONTENT VS.
PERCENT FINE-GRAINED SOIL
FIGURE C-8

UU TRIAXIAL TESTS – DAM FOUNDATIONS

UNCONSOLIDATED UNDRAINED TRIAXIAL SHEAR TEST (UNDISTURBED)



TOTAL NORMAL STRESSES @ 100% (kSF)



PRINCIPAL STRESS RATIO (0.1 - 0.3) ksf

AXIAL STRAIN (percent)

CHANGE IN

FAILURE SKETCHES



○ 20 psi □ 10 psi ○ 40 psi □ 80 psi

NOTE: SAMPLE DH-38, DEPTH 33.5' - 34'
IS FROM THE SEEPAGE COLLECTION DAM

TEST NO. OR SYMBOL	BORING NO. AND DEPTH (FT)	SAMPLE DATA		MAXIMUM CONFINING PRESSURE (0.3 ksf)	MAXIMUM PRINCIPAL STRESS @ 100% (kSF)	MAXIMUM DEVIATOR STRESS (kSF)	HEIGHT TO DIAMETER RATIO	RATE OF STRAIN (INCHES/MINUTE)
		DRY DENSITY (pcf)	MOISTURE CONTENT (percent)					
○ DH-45	22.8-23.4	98.4	26.9	21.1	98	20	5.55	—
○ DH-38	13.5-14.0	96.3	25.5	32.2	99	40	3.94	—
△ DH-44	16.5-17.0	109.3	21.2	20.8	99	40	5.69	—
□ DH-23	0.5-6.1	105.5	22.9	23.6	99	80	36.89	—
						11.32	48.41	2.15
								0.030

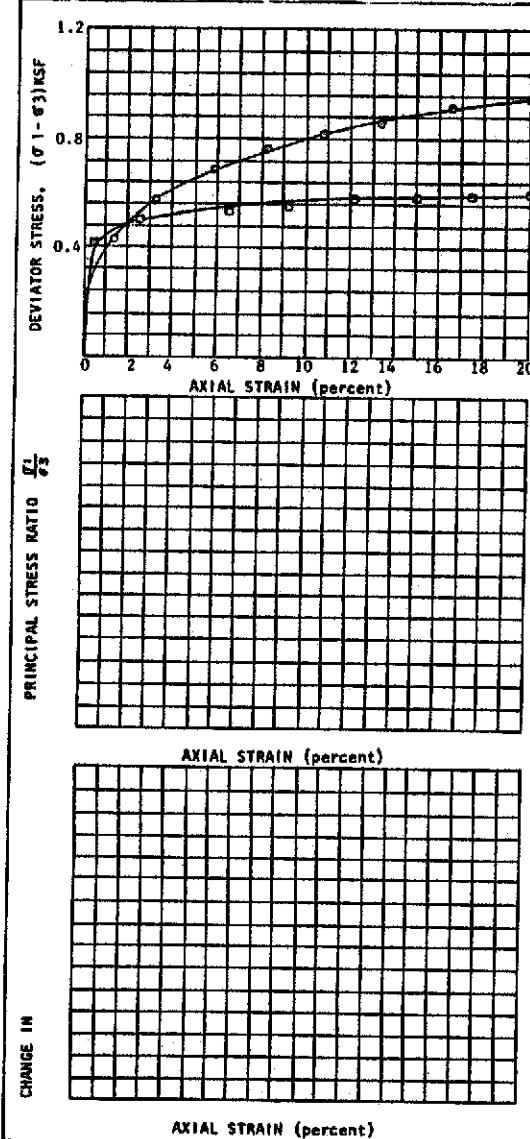
TRIAXIAL SHEAR TEST RESULTS

Chene Northern, Inc.
528 Senator Ave.
P.O. Box 519
Great Falls, MT 59403

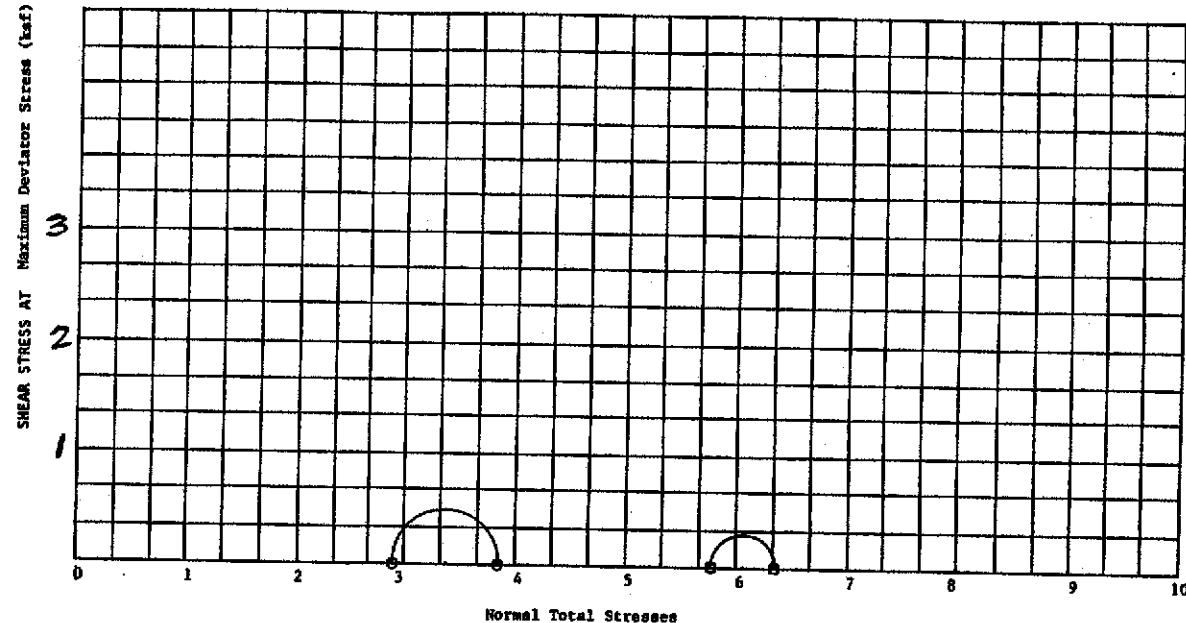
Job No. 45120, 45118, 45119 and 45117 Date 90-207 Plate No. 90-197

NET 157

MONTAURE PROJECT
Montaure Project, Libby, MT
TAILINGS RETENTION DAM FOUNDATION
UU TRIAXIAL TESTS
FIGURE C-9



UNCONSOLIDATED UNDRAINED TRIAXIAL SHEAR TEST (UNDISTURBED)



TEST NO. OR SYMBOL	BORING NO. AND DEPTH	SAMPLE DATA				MAXIMUM DEVIATOR STRESS $\sigma_1 - \sigma_3$ KSF	MAXIMUM PRINCIPAL STRESS RATIO σ_1 / σ_3	VALUES AT MOHR-COULOMB FAILURE		HEIGHT TO DIAMETER RATIO	RATE OF STRAIN INCHES/MINUTE
		DRY DENSITY (pcf)	MOISTURE CONTENT (percent)		PORE PRESSURE RESPONSE (percent)			MINOR PRINCIPAL STRESS σ_3 KSF	MAJOR PRINCIPAL STRESS σ_1 KSF		
○ DH-49 17'-19'	123	21	Initial	Final	99	20	0.95	---	2.88	3.83	2.02
□ DH-32 23'-25'	117	16	Initial	Final	99	40	0.60	---	5.76	6.36	2.02

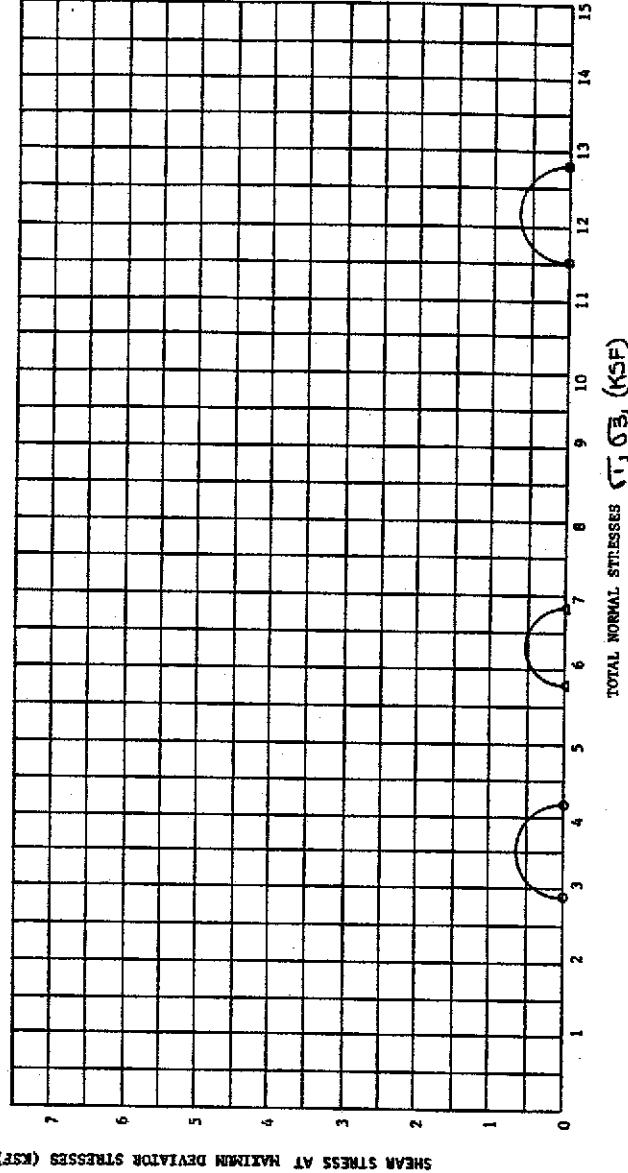
TRIAXIAL SHEAR TEST RESULTS		
Montanore Project, Libby, MT		
JOB NO.	DATE	PLATE NO.
90-207	November 1990	

NET 107

MONTANORE PROJECT
DIVERSION DAM FOUNDATION
UU TRIAXIAL TESTS
FIGURE C-10

UU TRIAXIAL TESTS – COMPACTED EARTHFILL

UNCONSOLIDATED-UNDRAINED TRIAXIAL SHEAR TEST - REBRODOL



TOTAL NORMAL STRESSES ($\sigma_1 \sigma_3$) (kSF)

SHEAR STRESS AT MAXIMUM DEVIATOR STRESSES (kSF)

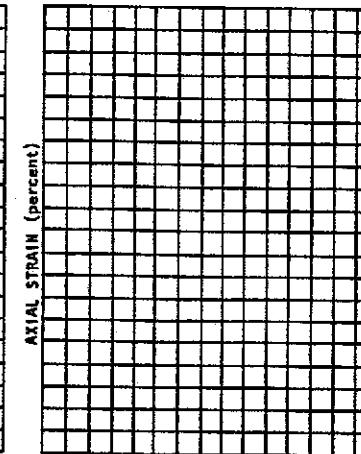
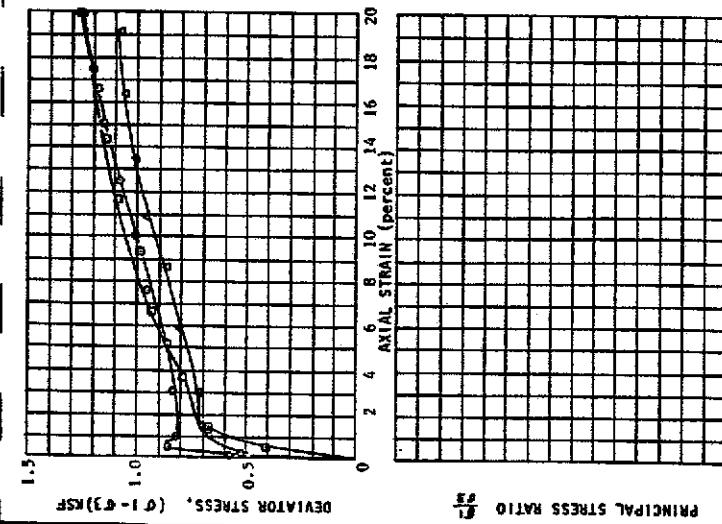
TEST NO. OR SYMBOL	BORING NO. AND DEPTH	SAMPLE DATA		VALUES AT MOHR-COULOMB FAILURE		HEIGHT TO DIAMETER RATIO	RATE OF STRAIN INCHES/MINUTE	COEFFICIENT OF PERMEABILITY CM/SEC.
		DRY DENSITY (pcf)	MOISTURE CONTENT (percent)	DEVIATOR STRESS σ'_1 / σ'_3	MAJOR PRINCIPAL STRESS σ'_1 kSF			
TP-211	4.0-9.0'	115.3	12.0	19.0	99	20	1.26	—
TP-205	2.0-5.0'	117.1	11.3	18.2	99	40	1.08	—
TP-201	6.0-6.0'	118.2	9.9	16.0	98	80	1.25	—
						11.52	2.77	2.14
								0.030
								2x10 ⁻⁵

TRIAXIAL SHEAR TEST RESULTS

Chene Northern, Inc.
521 Sander Ave.
Rte 3 Box 340
Great Falls, MT 59403

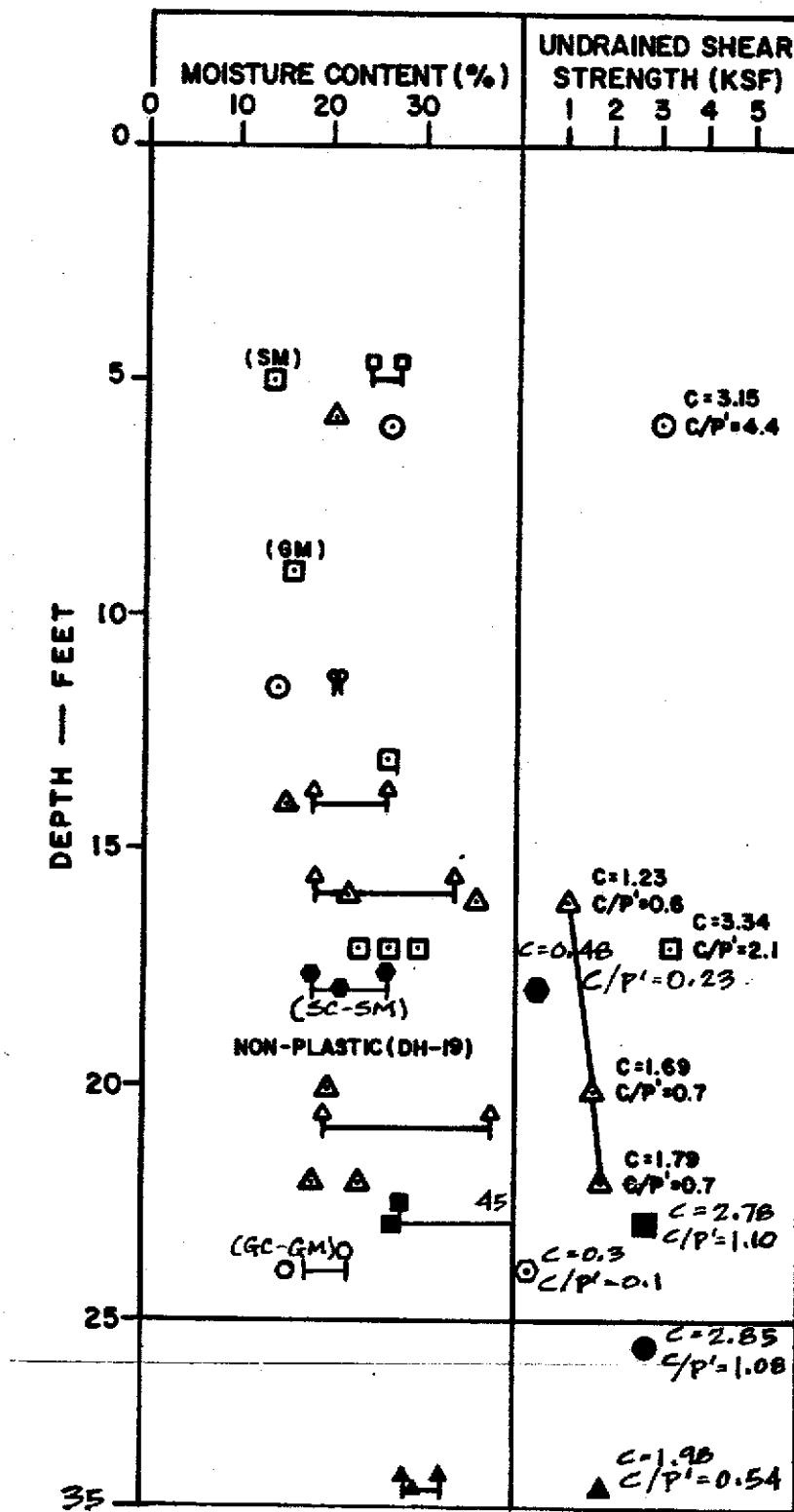
Montanore Project, Libby, MT
Lab Nos. 45361, 45352, and 45347
Job No. 90-207
Date November 1990

PLATE NO.
NET 157

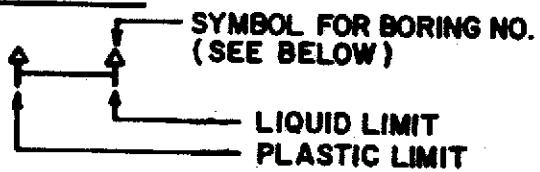


CHANGE IN

MONTANORE PROJECT
COMPACTED BORROW AREA A EARTHFILL
UV TRIAXIAL TESTS
FIGURE C-12



LEGEND:



MOISTURE CONTENT OR UNDRAINED SHEAR STRENGTH:

SYMBOL	BORING
▲	DH-3 & DH-3A
○	DH-19
□	DH-20
◎	DH-32
△	DH-38
●	DH-44
■	DH-45
◐	DH-49

NOTES:

1. ALL TESTS WERE PERFORMED ON FINE-GRAINED (ML OR CL) SOIL, EXCEPT AS NOTED OTHERWISE.

2. $\frac{C}{P'} = \frac{\text{COHESION FROM UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST}}{\text{EFFECTIVE VERTICAL OVERBURDEN PRESSURE}}$

MONTANORE PROJECT

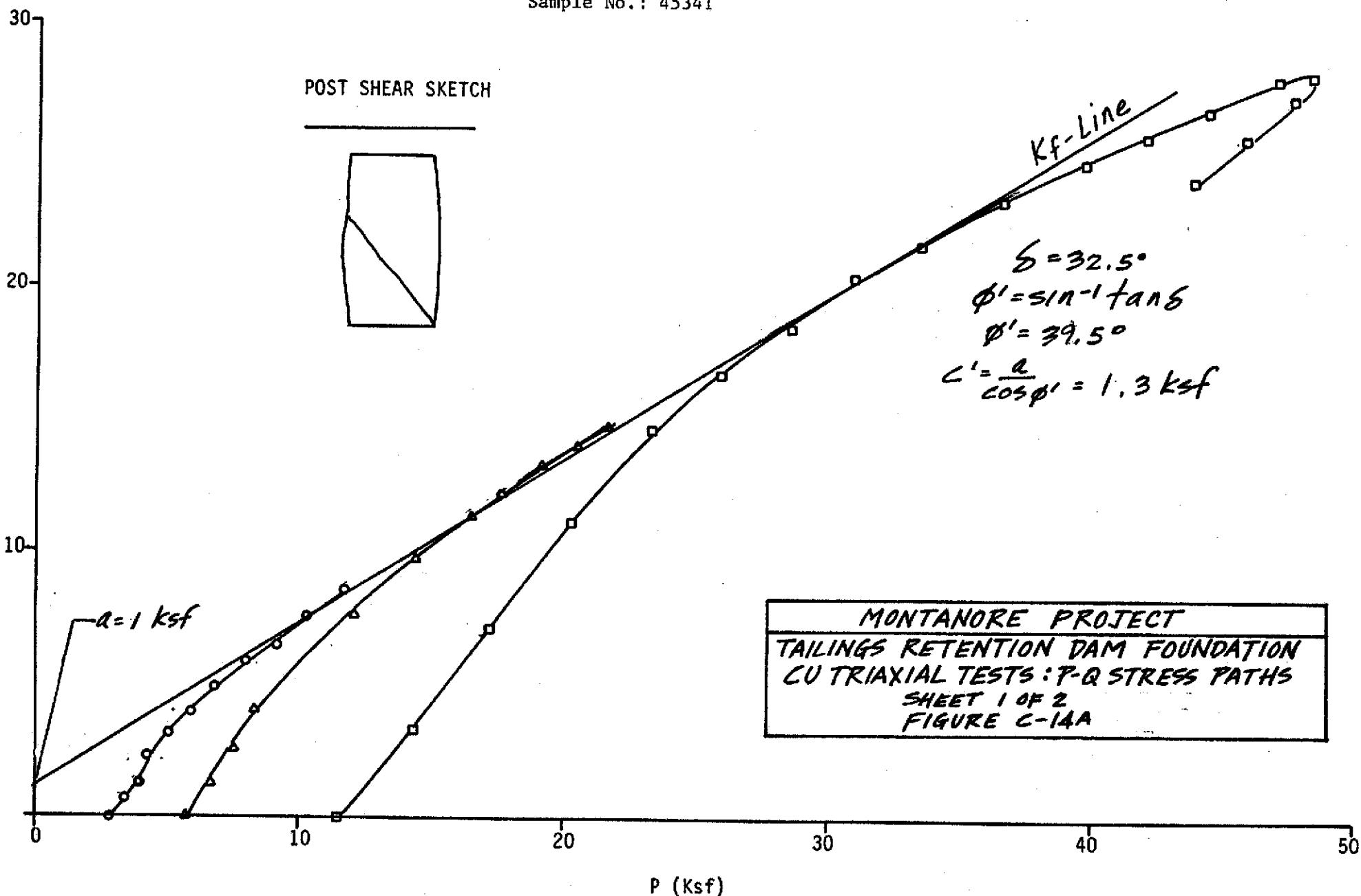
UNDRAINED SHEAR STRENGTH AND
MOISTURE CONTENT VS. DEPTH

FIGURE C-13

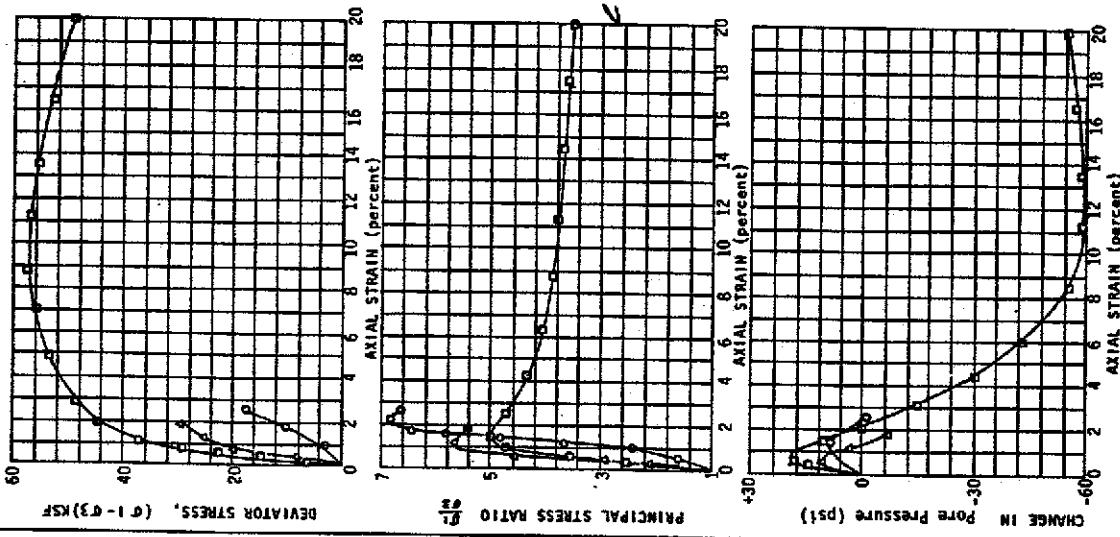
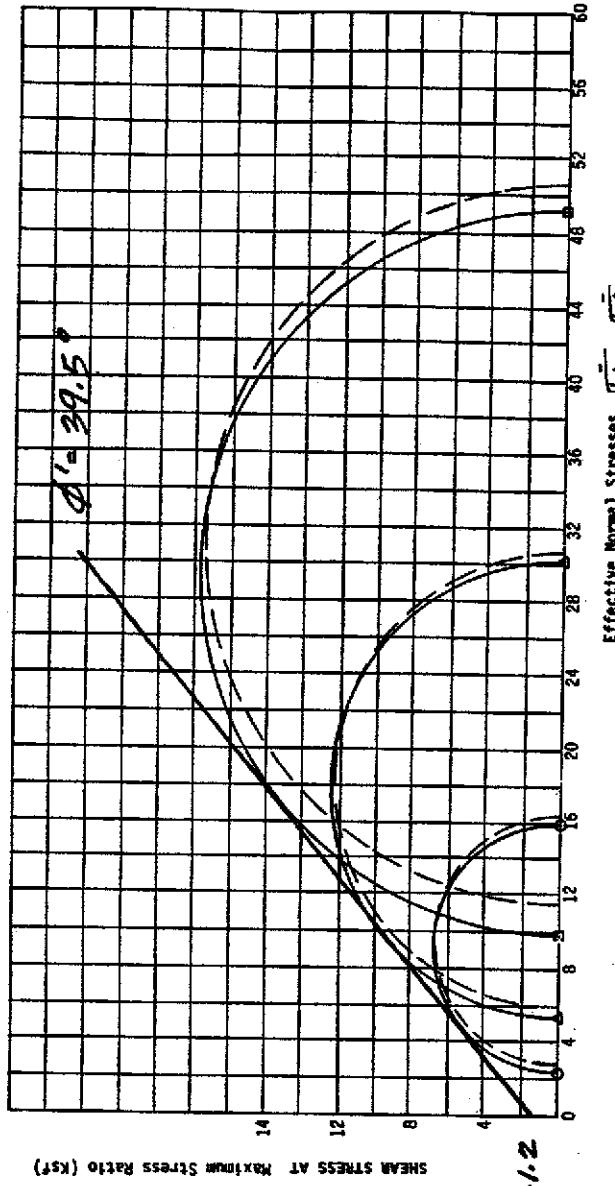
CU TRIAXIAL TEST - TAILINGS RETENTION DAM FOUNDATION

CONSOLIDATED UNDRAINED TRIAXIAL SHEAR TEST - P-Q STRESS PATH PLOT

Project: Montanore
 Sample: Hs 1
 Drill Hole: DH44
 Depth: 14.3 - 15.0
 Sample No.: 45341



MULTI-STAGED CONSOLIDATED UNDRAINED TRIAXIAL SHEAR TEST (UNDISTURBED)



TEST NO. OR SYMBOL	SAMPLE DATA		$\frac{P}{P_0}$		VALUES AT MONITORED FAILURE		HEIGHT TO DIAMETER RATIO	RATE OF STRAIN INCHES MINUTE		
	BORING NO. AND DEPTH	DRY DENSITY (psf)	MOISTURE CONTENT (percent)	INITIAL DENsity (psf)	MAXIMUM PRINCIPAL STRESS σ_1 (psf)	MINOR PRINCIPAL STRESS σ_3 (psf)				
O DH4	119.9	16.8	99	20	13.53	6.80	2.33	15.86	2.09	0.004
△ 14.3 to	---	---	---	40	26.79	5.66	5.33	32.12	---	---
□ 15.0	---	---	13.5	---	60	39.37	4.95	9.95	49.32	---

TRIAXIAL SHEAR TEST RESULTS

Montanore Project
Chen-Northern, Inc.

JOB NO.	DATE	PLATE NO.
90-207	October 1990	

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MONTANO RE PROJECT

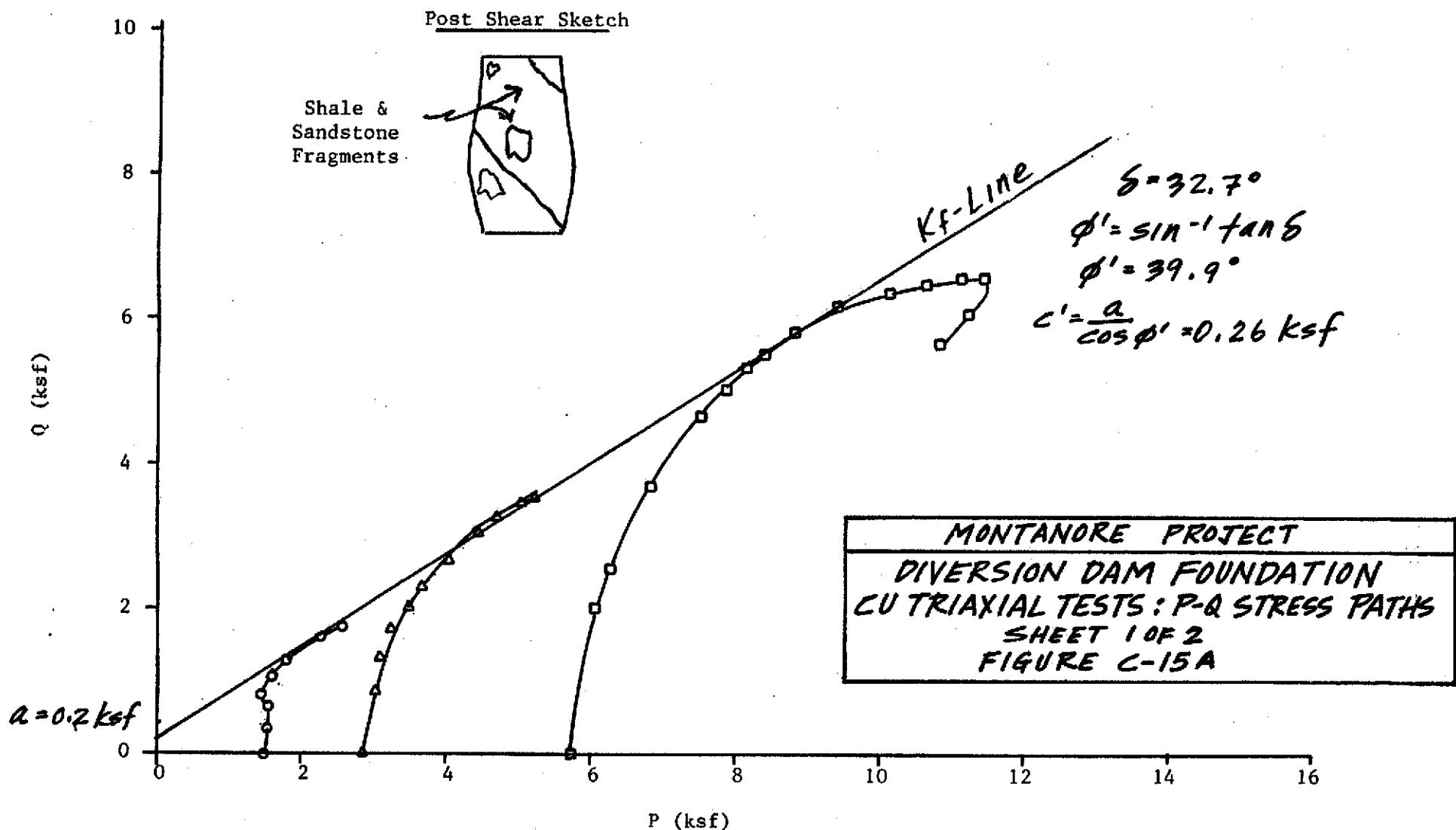
TAILINGS RETENTION DAM FOUNDATION CU TRIAXIAL TESTS: MOHR ENVELOPE

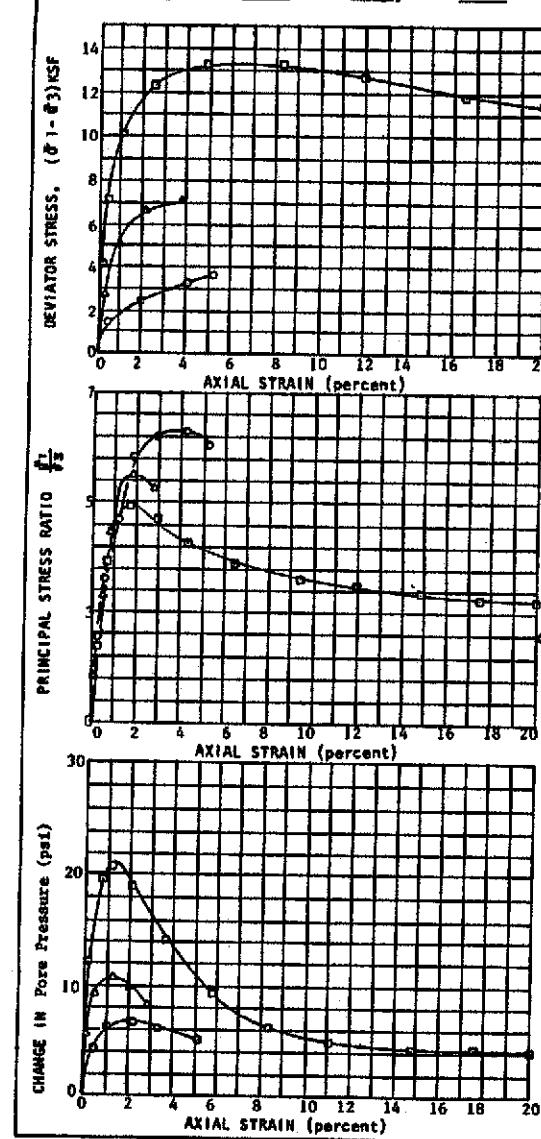
SHEET 2 OF 2
FIGURE C-14B

CU TRIAXIAL TEST - DIVERSION DAM FOUNDATION

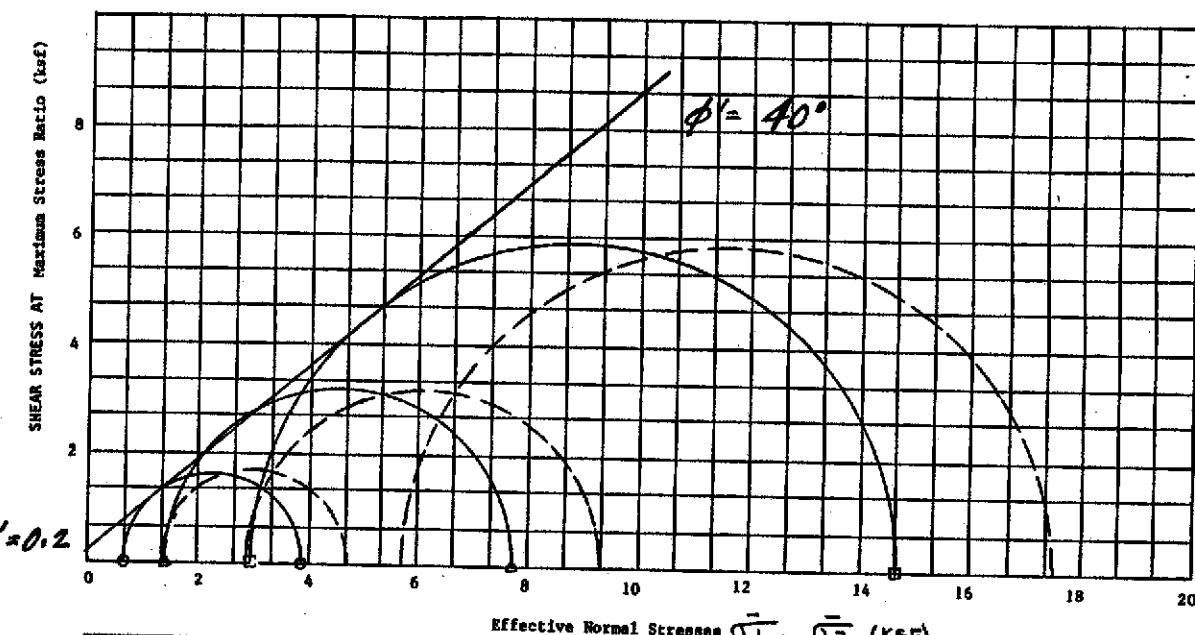
Consolidated Undrained Triaxial Shear Test - P-Q Stress Path Plot

Project: Montanore Project, Libby, MT
Drill Hole No. 49
Depth: 17.0'-19.0'
Lab No. 45984





MULTI-STAGED CONSOLIDATED UNDRAINED TRIAXIAL SHEAR TEST (UNDISTURBED)



TEST NO. OR SYMBOL	BORING NO. AND DEPTH	SAMPLE DATA			PORE PRESSURE RESPONSE (percent)	CONFINING PRESSURE σ_3 PSI	MAXIMUM DEVIATOR STRESS $\sigma_1 - \sigma_3$ KSF	MAXIMUM PRINCIPAL STRESS RATIO σ_1/σ_3	VALUES AT MOHR COULOMB FAILURE		HEIGHT TO DIAMETER RATIO	RATE OF STRAIN INCHES/MINUTE
		DRY DENSITY (pcf)	MOISTURE CONTENT (percent)	Initial Final					MINOR PRINCIPAL STRESS σ_3 KSF	MAJOR PRINCIPAL STRESS σ_1 KSF		
○ DH-49 17.0' to 19.0'		114.1	21.4	--	99	10	3.27	6.27	0.62	3.88	2.09	0.006
△		---	---	---	---	20	6.33	5.49	1.43	7.74	---	0.006
□		---	---	13.6	---	40	11.69	4.94	2.97	14.66	---	0.006

EFFECTIVE STRESS CIRCLES

TOTAL STRESS CIRCLE

Chen Northern, Inc.
328 Sackett Ave.
P.O. Box 949
Great Falls, MT 59403
Lab No. 45984

TRIAXIAL SHEAR TEST RESULTS

Montanore Project, Libby, MT

JOB NO.	DATE	PLATE NO.
90-207	November 1990	

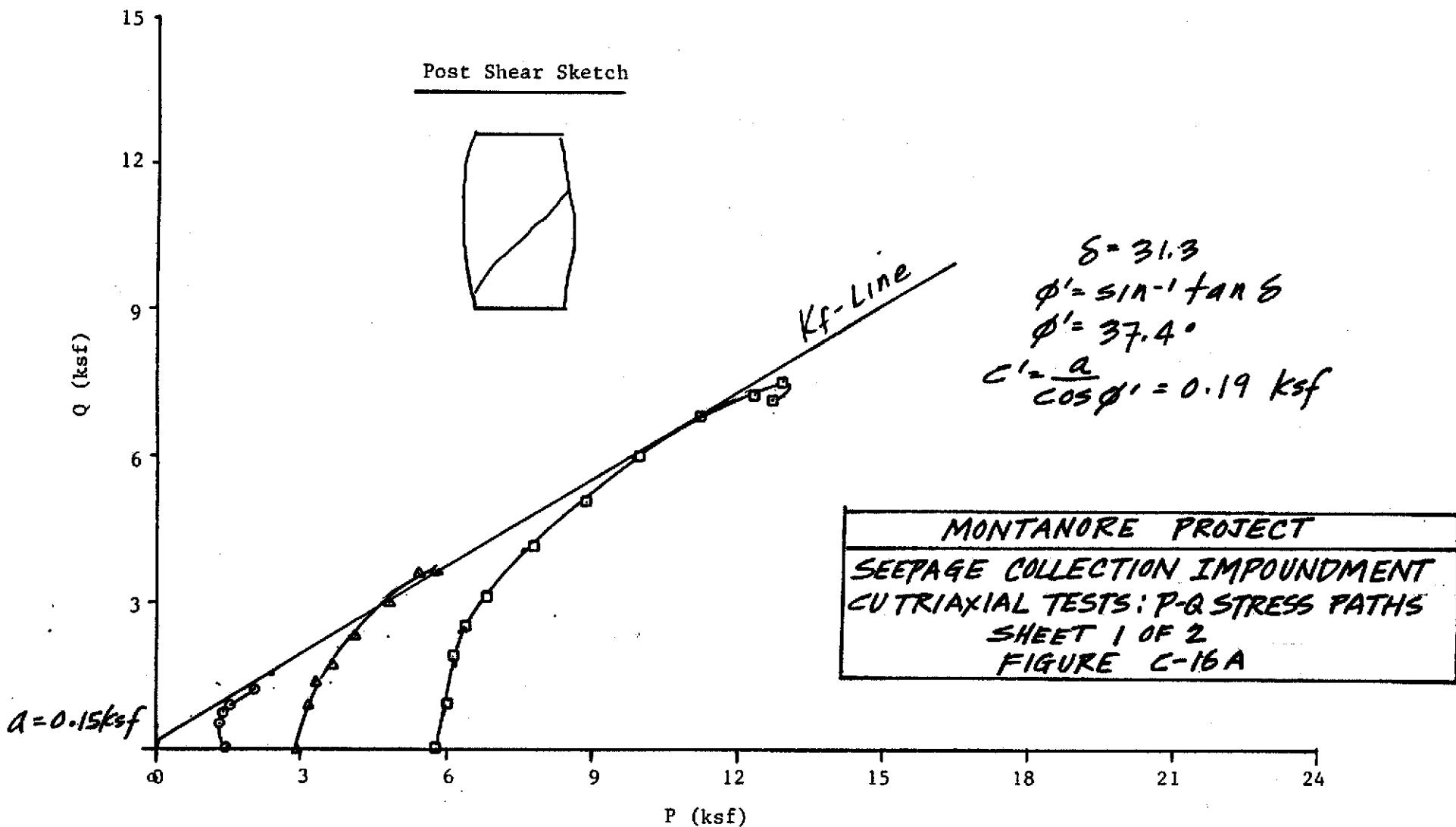
NET 157

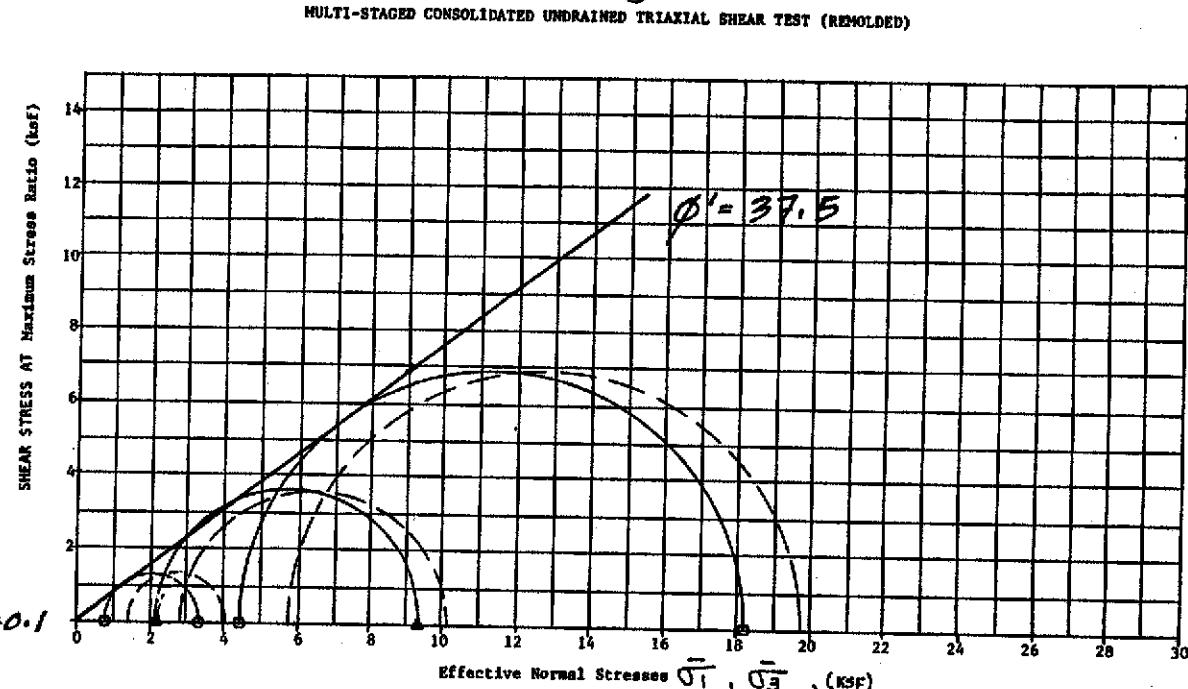
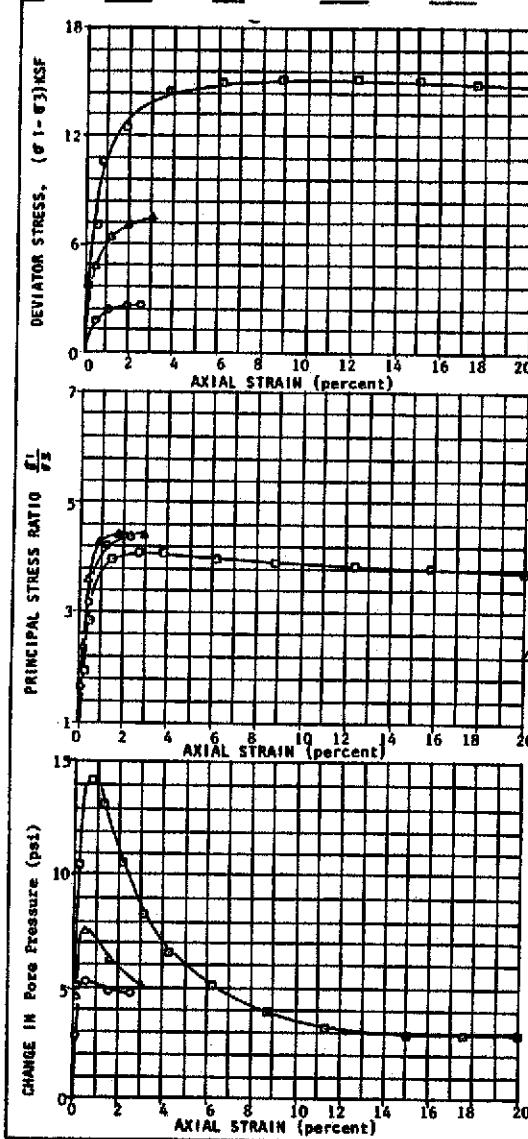
MONTANORE PROJECT		
DIVERSION DAM FOUNDATION		
CU TRIAXIAL TESTS: MOHR ENVELOPE		
SHEET 2 OF 2		
FIGURE C-15B		

CU TRIAXIAL TESTS --- COMPACTED EARTHFILL

Consolidated Undrained Triaxial Shear Test - P-Q Stress Path Plot

Project: Montanore Project, Libby, MT
Test Pit: TP-247
Depth: 2.0' - 12.0'
Lab No. 45983





TEST NO. OR SYMBOL	BORING NO. AND DEPTH	SAMPLE DATA				MAXIMUM DEVIATOR STRESS $\sigma_1 - \sigma_3$ KSF	MAXIMUM PRINCIPAL STRESS RATIO σ_1/σ_3	VALUES AT MOHR-COULOMB FAILURE		HEIGHT TO DIAMETER RATIO	RATE OF STRAIN INCHES/MINUTE	Coefficient of Permeability cm/sec	
		DRY DENSITY (pcf)	MOISTURE CONTENT (percent)		PORE PRESSURE RESPONSE (percent)	CONFINING PRESSURE σ_3 PSI		MINOR PRINCIPAL STRESS KSF	MAJOR PRINCIPAL STRESS KSF				
			Initial	Final				0.75	3.28				
○	TP-247 2.0' to 12.0'	116.7	11.3	—	99	10	2.53	4.37	0.75	3.28	2.14	0.006	2×10^{-5}
△	—	—	—	—	—	20	7.20	4.40	2.12	9.32	—	0.006	—
□	—	—	—	10.4	—	40	13.78	4.08	4.48	18.26	—	0.006	—

Moisture Content, % = 17.0

CheneNorthern, Inc.
528 Smelter Ave.
PO Box 569
Great Falls, MT 59403
Lab No. 45983

TRIAXIAL SHEAR TEST RESULTS
Montanore Project, Libby, MT
JOB NO. 90-207 DATE November 1990
PLATE NO.

NET 167

→ EFFECTIVE STRESS CIRCLES
--- TOTAL STRESS CIRCLES

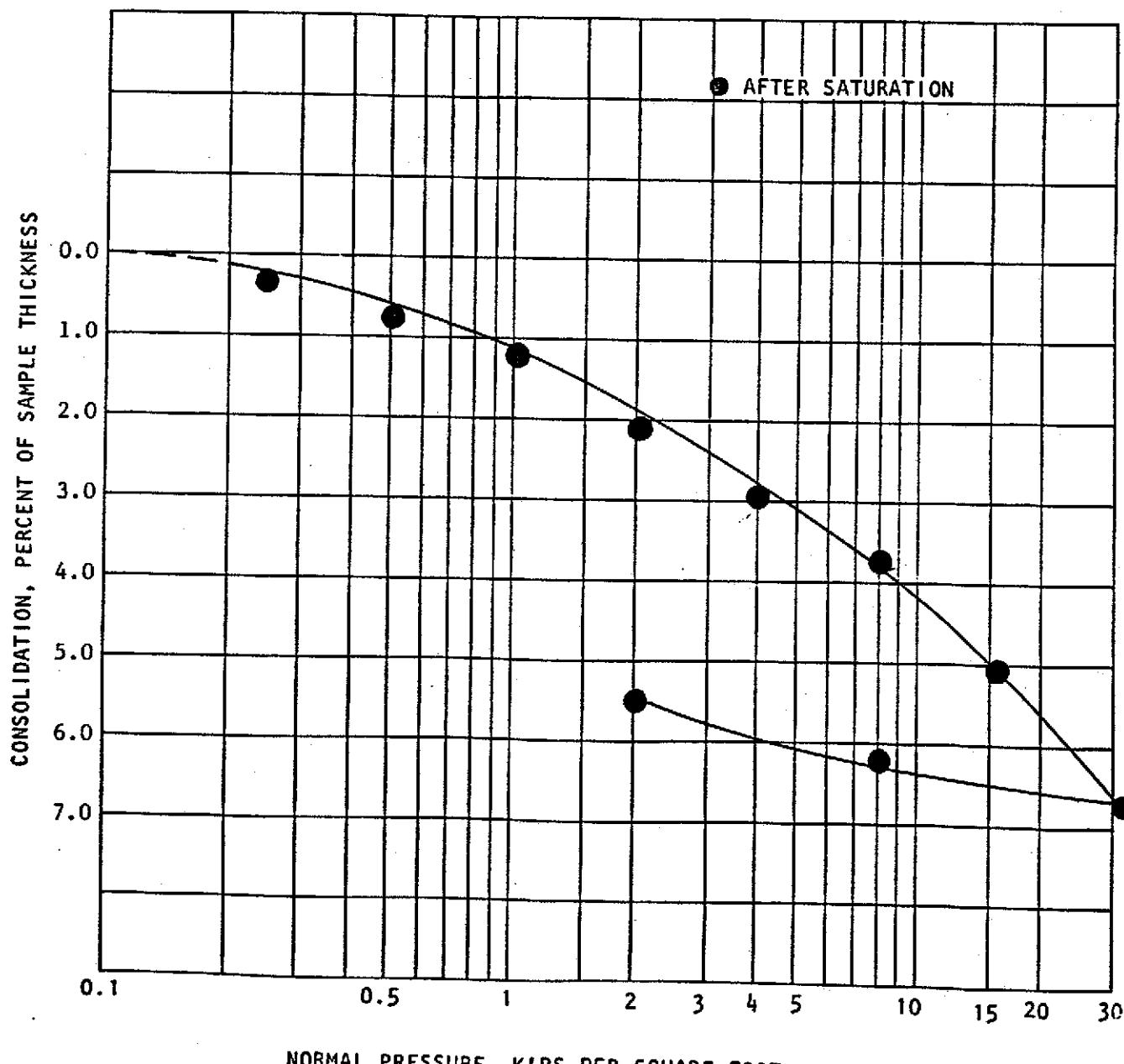
MONTANORE PROJECT
SEEPAGE COLLECTION IMPOUNDMENT
CU TRIAXIAL TESTS: MOHR ENVELOPE
SHEET 2 OF 2
FIGURE C-16B

**CONSOLIDATION TEST NO. 1
TAILINGS RETENTION DAM FOUNDATION
DRILL HOLE DH-23**

CONSOLIDATION TEST

DRILL HOLE DH-23
DEPTH 71.6'-72.2'
SAMPLE NO. 45419

MOIST UNIT WEIGHT : 121 pcf
DRY UNIT WEIGHT : 96 pcf
INITIAL MOISTURE CONTENT: 26%
FINAL MOISTURE CONTENT : 26%
CLASSIFICATION : Silty CLAY



NORMAL PRESSURE, KIPS PER SQUARE FOOT

SHEET 1 OF 6

TAILINGS RETENTION DAM FOUNDATION

Montanore Project
Libby, Montana

Noranda Minerals Corp.
Libby, Montana

Chen Northern, Inc.

528 Smelter Avenue
P.O. Box 949
Great Falls, Montana 59403

JOB NO. 90-207 PLATE NO.

CHEN-NORTHERN, INC.
CONSULTING GEOTECHNICAL ENGINEERS

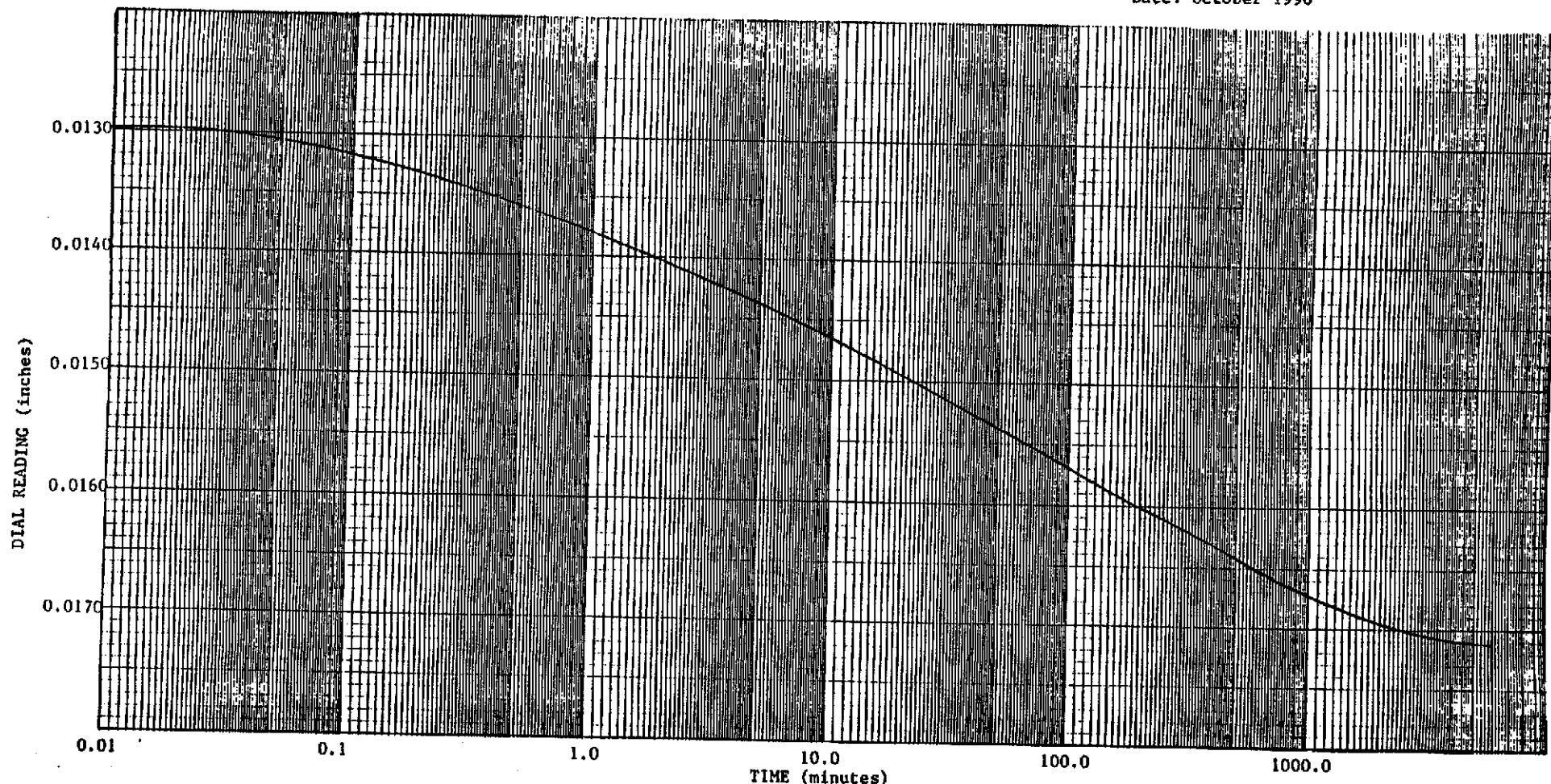
TIME RATE CONSOLIDATION

Sample No.: 45419

Location: DH-23, 71.6' - 72.2'

Confining Pressure Increment: 1000 to 2000 psf

Project: Montanore Project - Libby, MT
Job No.: 90-207
Date: October 1990



MONTANORE PROJECT
TAILINGS RETENTION DAM FOUNDATION
CONSOLIDATION TEST: TIME-RATE CURVE
SHEET 2 OF 6

CHEN-NORTHERN, INC.
CONSULTING GEOTECHNICAL ENGINEERS

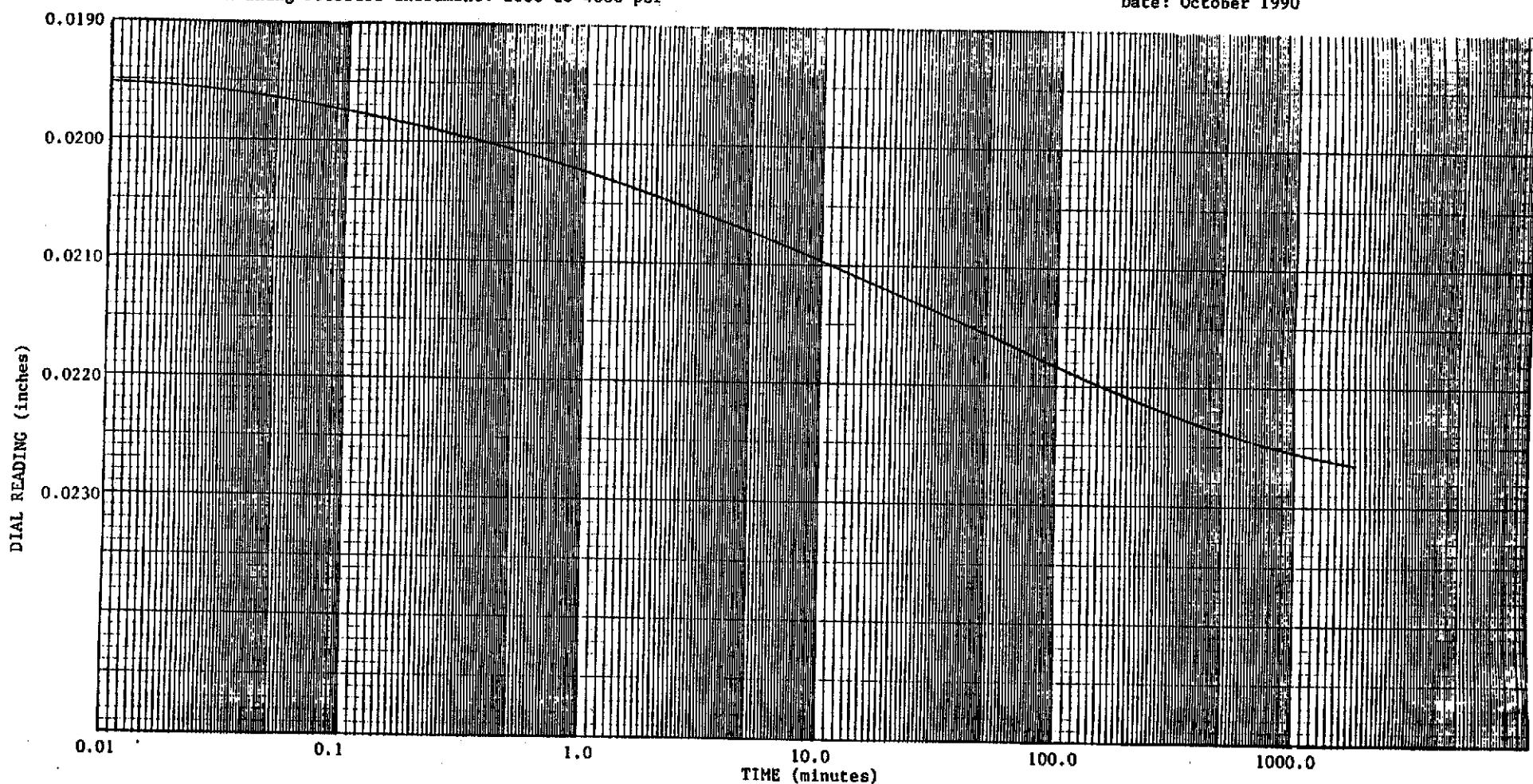
TIME RATE CONSOLIDATION

Sample No.: 45419

Location: DH-23, 71.6' - 72.2'

Confining Pressure Increment: 2000 to 4000 psf

Project: Montanore Project - Libby, MT
Job No.: 90-207
Date: October 1990



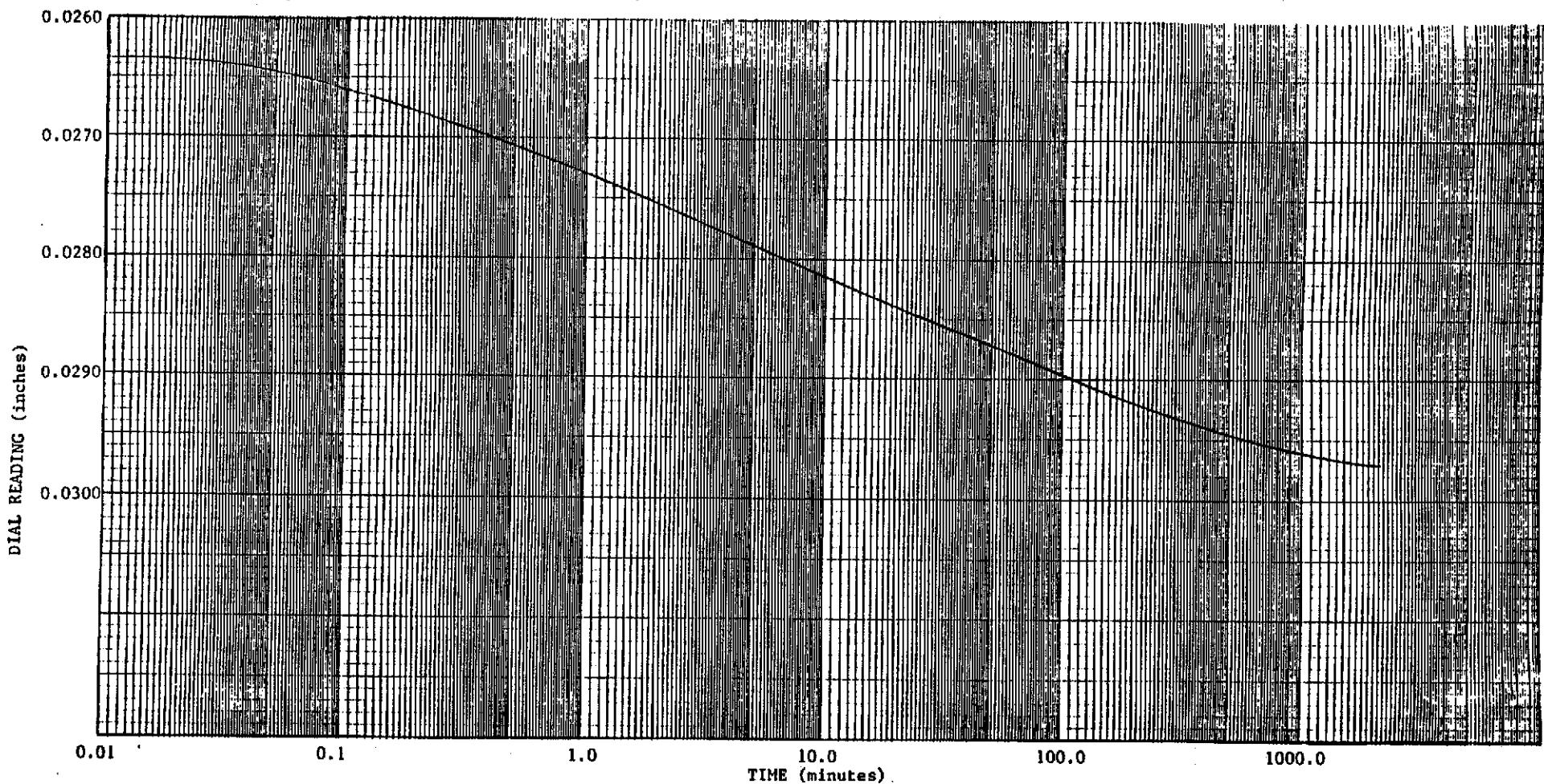
MONTANORE PROJECT
TAILINGS RETENTION DAM FOUNDATION
CONSOLIDATION TEST: TIME-RATE CURVE
SHEET 3 OF 6

CHEN-NORTHERN, INC.
CONSULTING GEOTECHNICAL ENGINEERS

TIME RATE CONSOLIDATION

Sample No.: 45419
Location: DH-23, 71.6' - 72.2'
Confining Pressure Increment: 4000 to 8000 psf

Project: Montanore Project - Libby, MT
Job No.: 90-207
Date: October 1990



MONTANORE PROJECT
TAILINGS RETENTION DAM FOUNDATION
CONSOLIDATION TEST: TIME-RATE CURVE
SHEET 4 OF 6

CHEN-NORTHERN, INC.
CONSULTING GEOTECHNICAL ENGINEERS

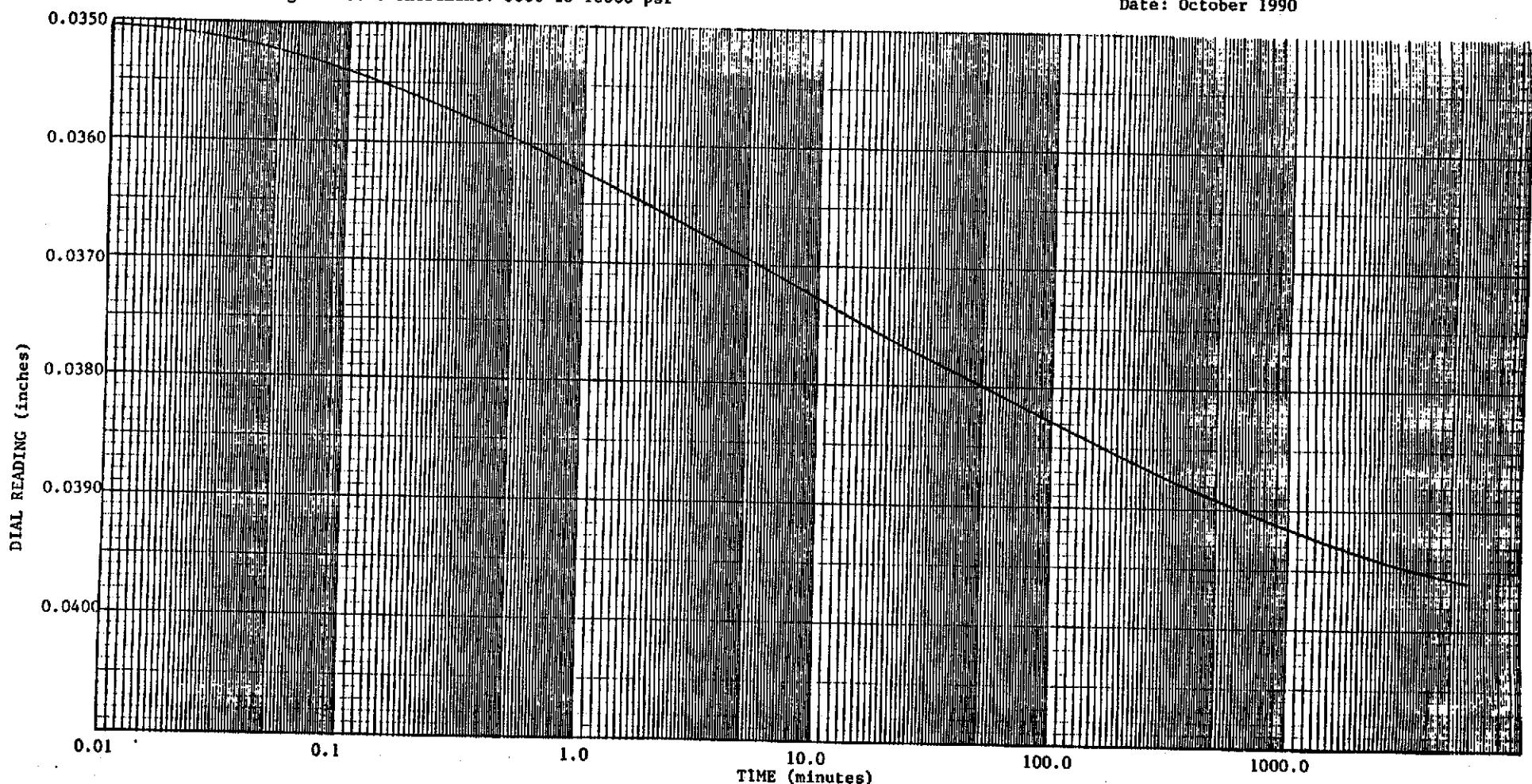
TIME RATE CONSOLIDATION

Sample No.: 45419

Location: DH-23, 71.6' - 72.2'

Confining Pressure Increment: 8000 to 16000 psf

Project: Montanore Project - Libby, MT
Job No.: 90-207
Date: October 1990



MONTANORE PROJECT
TAILINGS RETENTION DAM FOUNDATION
CONSOLIDATION TEST: TIME-RATE CURVE
SHEET 5 OF 6

CHEN-NORTHERN, INC.
CONSULTING GEOTECHNICAL ENGINEERS

TIME RATE CONSOLIDATION

Sample No.: 45419

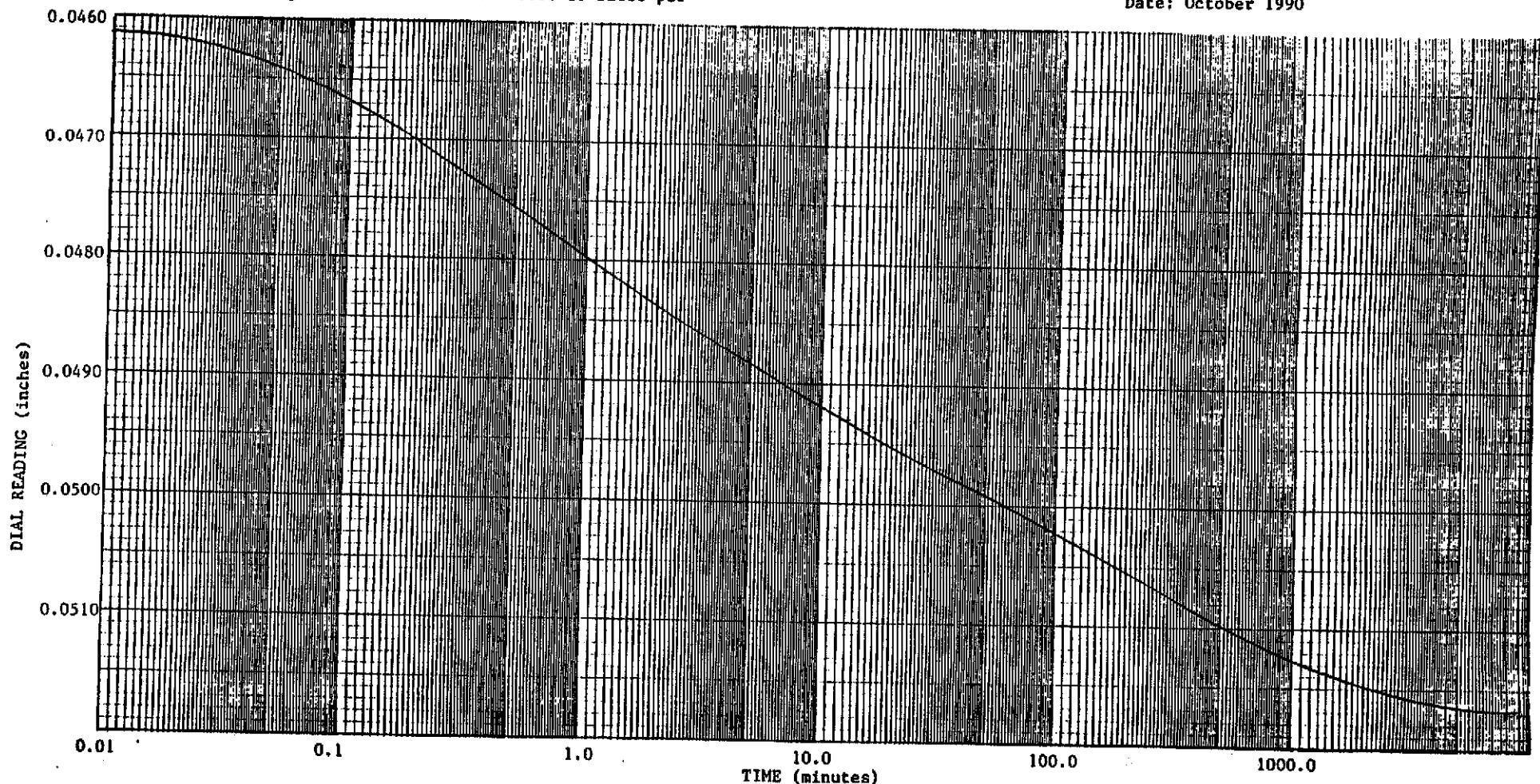
Location: DH-23, 71.6' - 72.2'

Confining Pressure Increment: 16000 to 32000 psf

Project: Montanore Project - Libby, MT

Job No.: 90-207

Date: October 1990



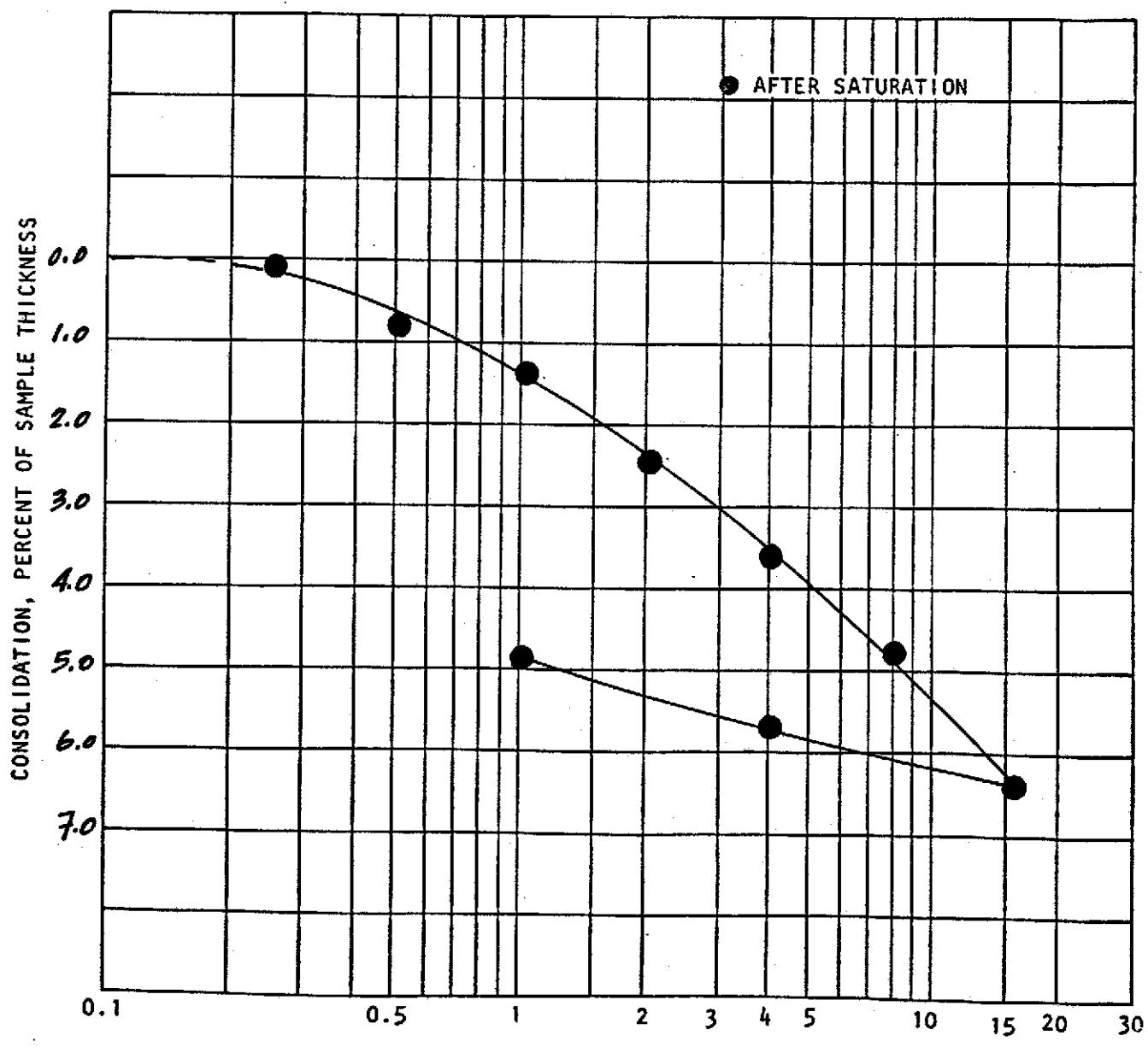
MONTANORE PROJECT
TAILINGS RETENTION DAM FOUNDATION
CONSOLIDATION TEST: TIME-RATE CURVE
SHEET 6 OF 6

**CONSOLIDATION TEST NO. 2
SEEPAGE COLLECTION DAM FOUNDATION
DRILL HOLE DH-38**

CONSOLIDATION TEST

DRILL HOLE DH-38
DEPTH 38.0' - 38.6'
SAMPLE NO. 45421

MOIST UNIT WEIGHT : 121pcf
DRY UNIT WEIGHT : 93pcf
INITIAL MOISTURE CONTENT: 29%
FINAL MOISTURE CONTENT : 29%
CLASSIFICATION : Silty CLAY



SEEPAGE COLLECTION DAM FOUNDATION

SHEET 1 OF 5

Montanore Project
Libby, Montana

Noranda Minerals Corp.
Libby, Montana

Chen Northern, Inc.

528 Smelter Avenue
P.O. Box 949
Great Falls, Montana 59403

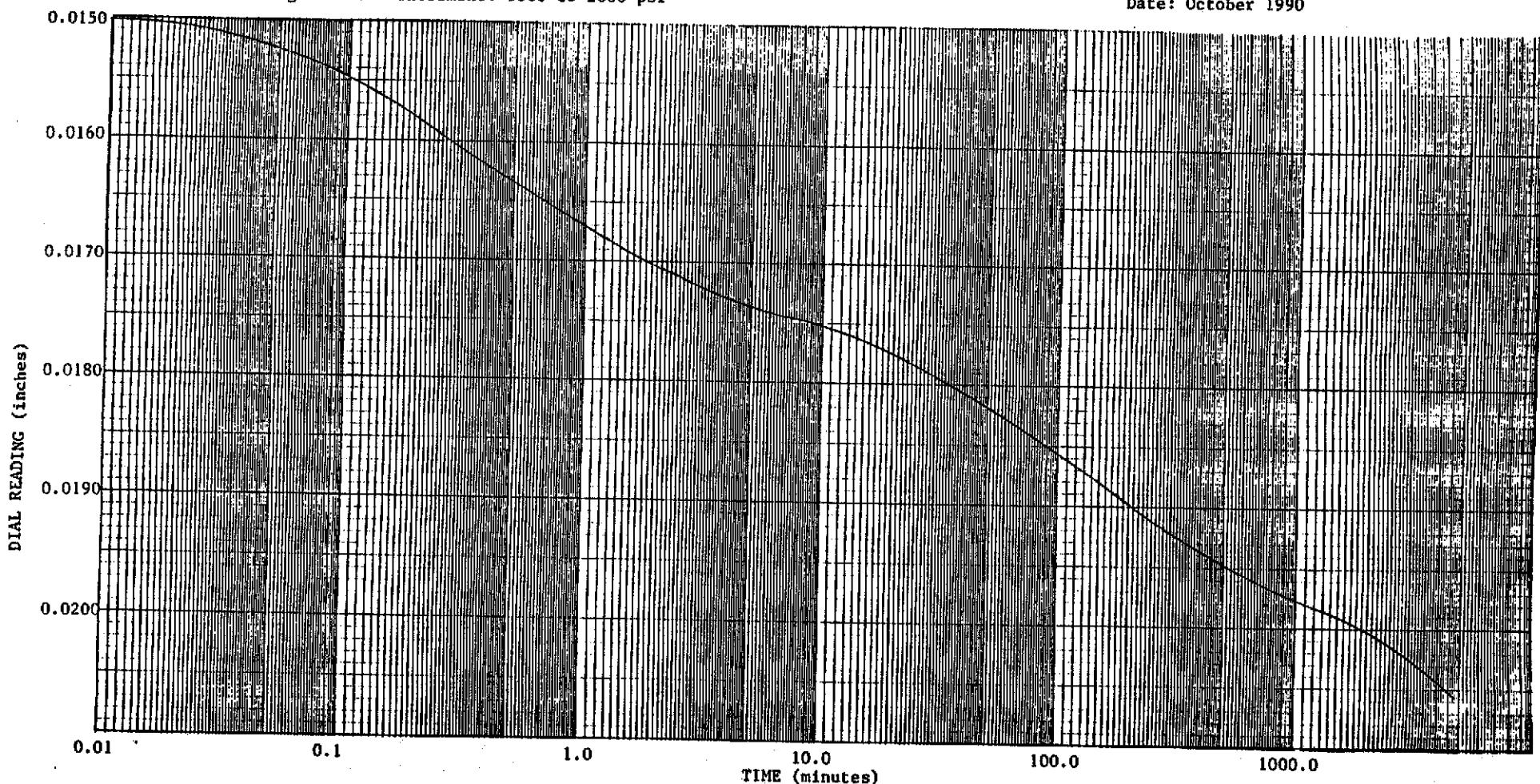
JOB NO. 90-207 PLATE NO.

CHEN-NORTHERN, INC.
CONSULTING GEOTECHNICAL ENGINEERS

TIME RATE CONSOLIDATION

Sample No.: 45421
Location: DH-38, 38.0' - 38.6'
Confining Pressure Increment: 1000 to 2000 psf

Project: Montanore Project - Libby, MT
Job No.: 90-207
Date: October 1990

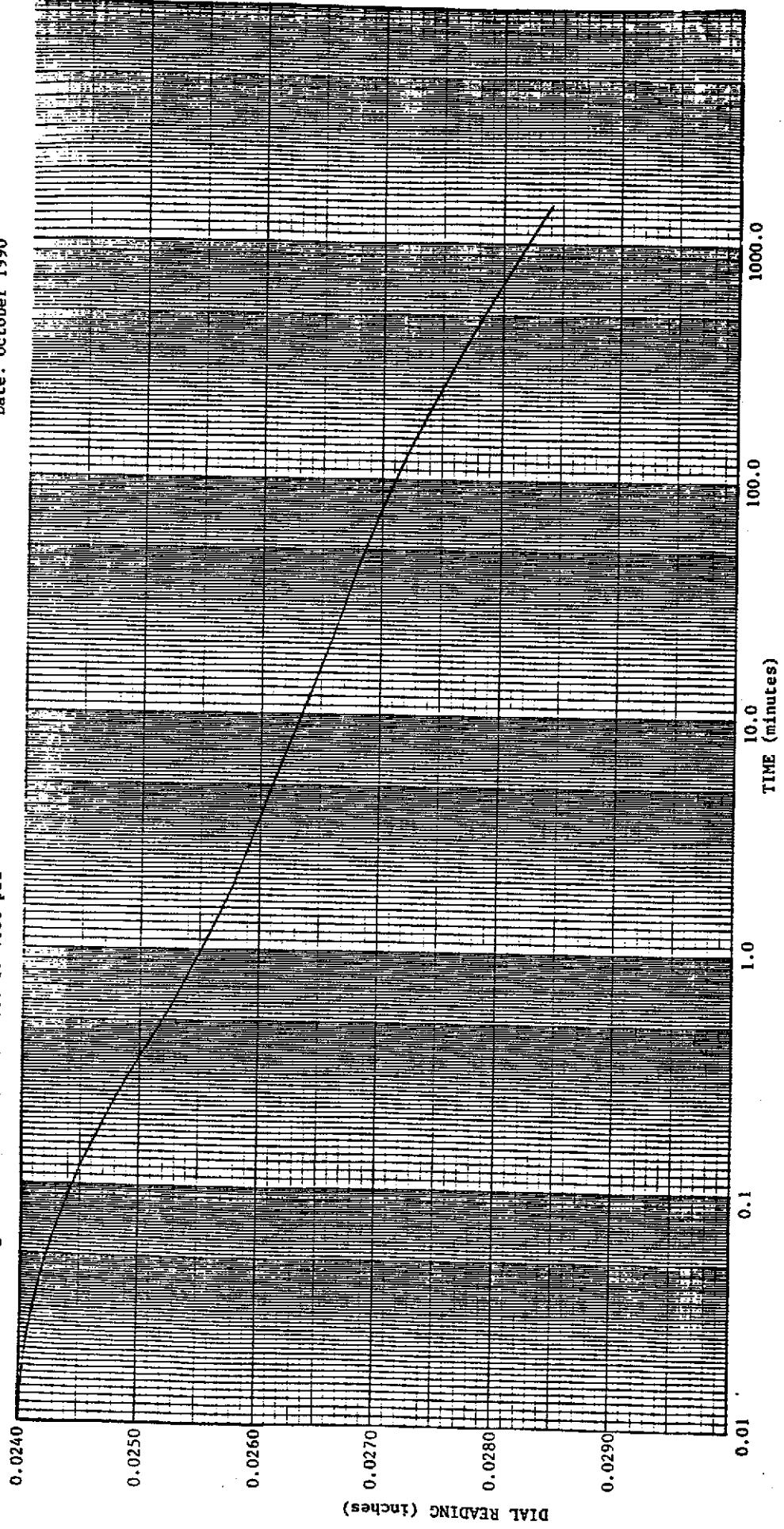


MONTANORE PROJECT
SEEPAGE COLLECTION DAM FOUNDATION
CONSOLIDATION TEST: TIME-RATE CURVE
SHEET 2 OF 5.

CHEN-NORTHERN, INC.
CONSULTING GEOTECHNICAL ENGINEERS

TIME RATE CONSOLIDATION

Sample No.: 45421
Location: DH-38, 38.0' - 38.6'
Confining Pressure Increment: 2000 to 4000 psf



MONTANORE PROJECT
SEEPAGE COLLECTION DAM FOUNDATION
CONSOLIDATION TEST : TIME-RATE CURVE
SHEET 3 OF 5

CHEN-NORTHERN, INC.
CONSULTING GEOTECHNICAL ENGINEERS

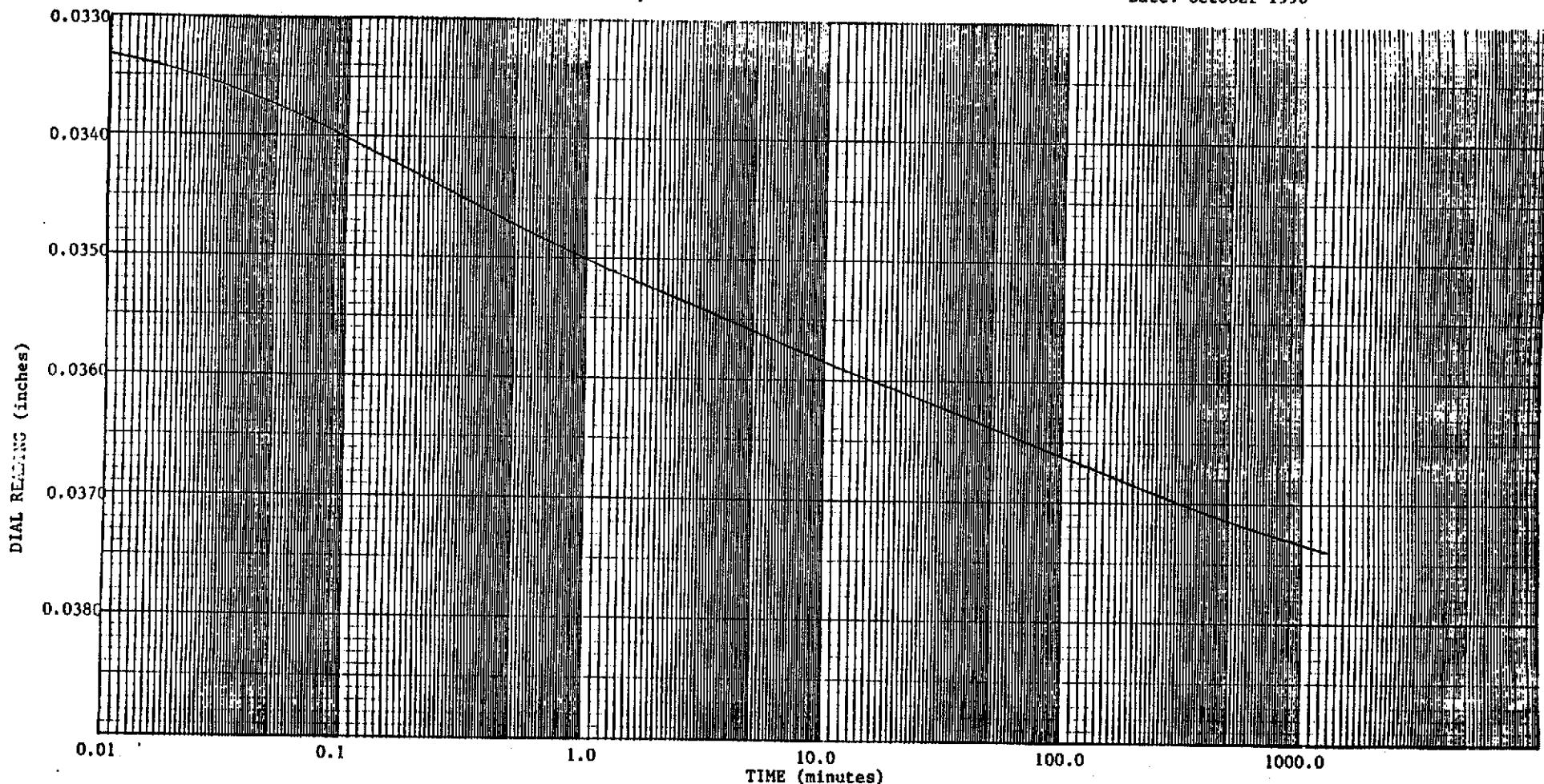
TIME RATE CONSOLIDATION

Sample No.: 45421

Location: DH-38, 38.0' ~ 38.6'

Confining Pressure Increment: 4000 to 8000 psf

Project: Montanore Project - Libby, MT
Job No.: 90-207
Date: October 1990



MONTANORE PROJECT
SEEPAGE COLLECTION DAM FOUNDATION
CONSOLIDATION TEST : TIME-RATE CURVE
SHEET 4 OF 5

CHEN-NORTHERN, INC.
CONSULTING GEOTECHNICAL ENGINEERS

TIME RATE CONSOLIDATION

Sample No.: 45421

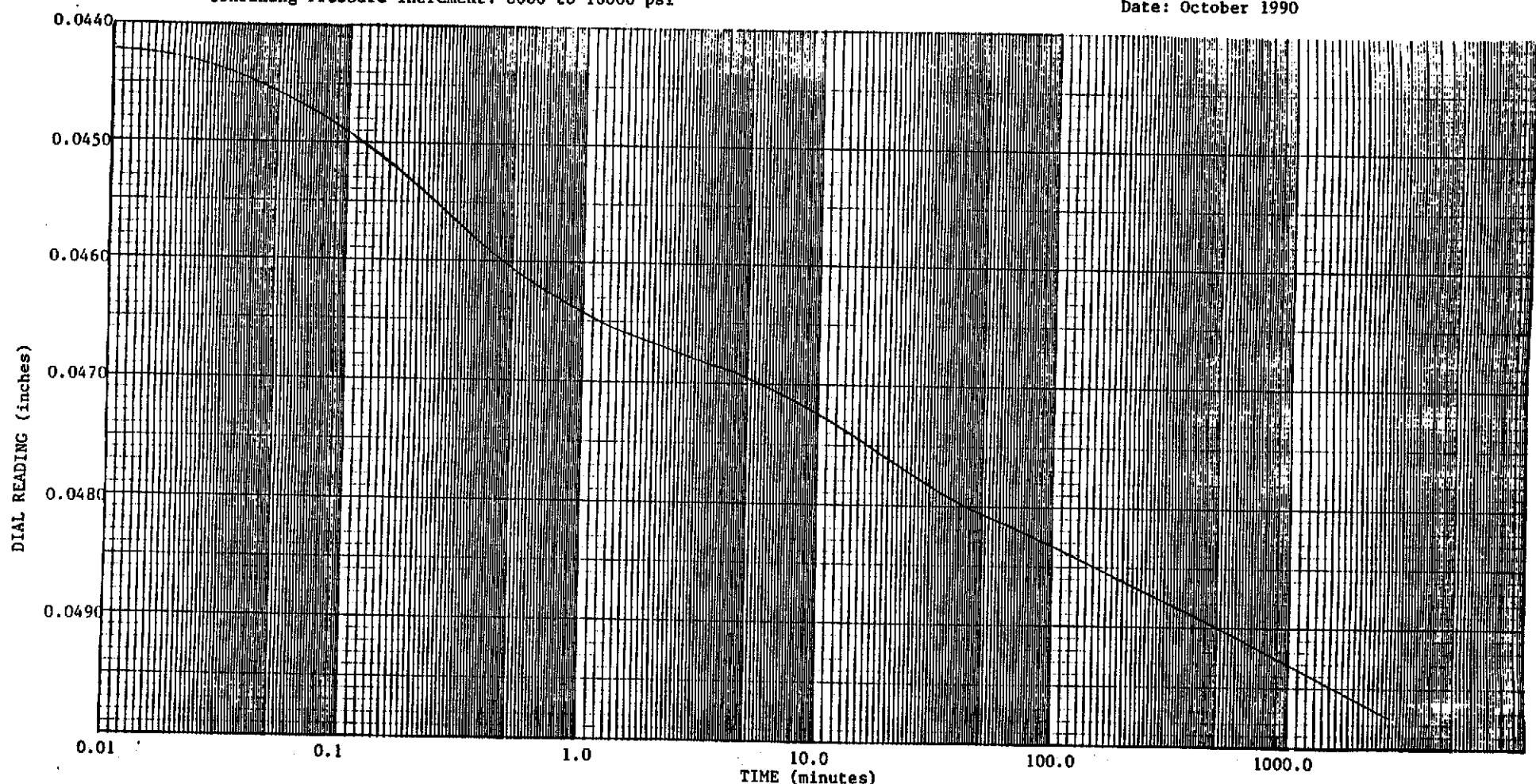
Location: DH-38, 38.0' - 38.6'

Confining Pressure Increment: 8000 to 16000 psf

Project: Montanore Project - Libby, MT

Job No.: 90-207

Date: October 1990



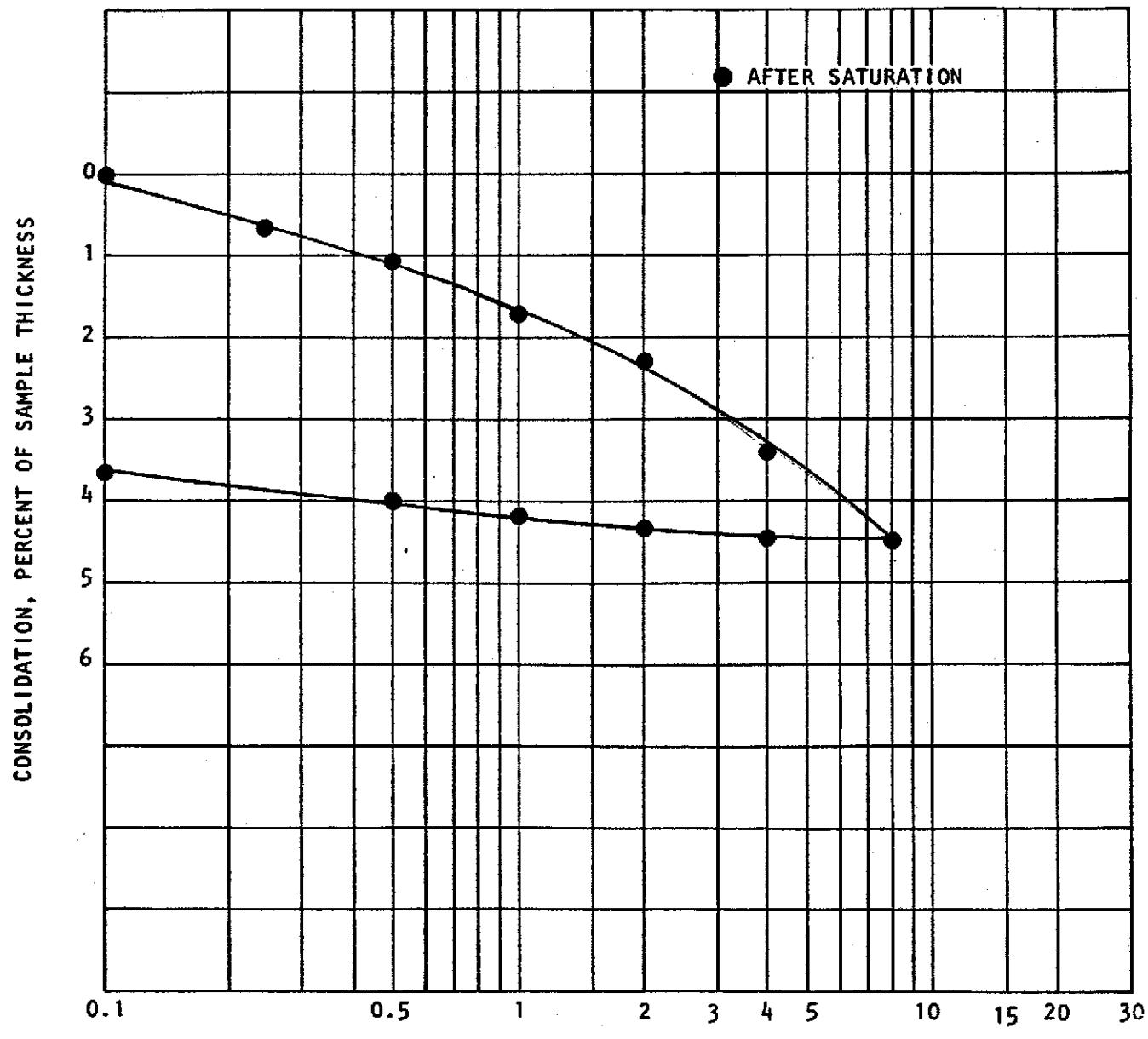
MONTANORE PROJECT
SEEPAGE COLLECTION DAM FOUNDATION
CONSOLIDATION TEST! TIME-RATE CURVE
SHEET 5 OF 5

**CONSOLIDATION TEST NO. 3
DIVERSION DAM FOUNDATION
DRILL HOLE DH-32**

CONSOLIDATION TEST

DRILL HOLE DH-32
DEPTH 23' - 25'
SAMPLE NO. 45423

MOIST UNIT WEIGHT : 146 pcf
DRY UNIT WEIGHT : 126 pcf
INITIAL MOISTURE CONTENT: 16%
FINAL MOISTURE CONTENT : 10%
CLASSIFICATION : Silty Clayey GRAVEL w/
Sand



NORMAL PRESSURE, KIPS PER SQUARE FOOT

SHEET 1 OF 5

DIVERSION DAM FOUNDATION

Montanore Project
Libby, Montana

Noranda Minerals Corp.
Libby, Montana

Chen Northern, Inc.

528 Smelter Ave.

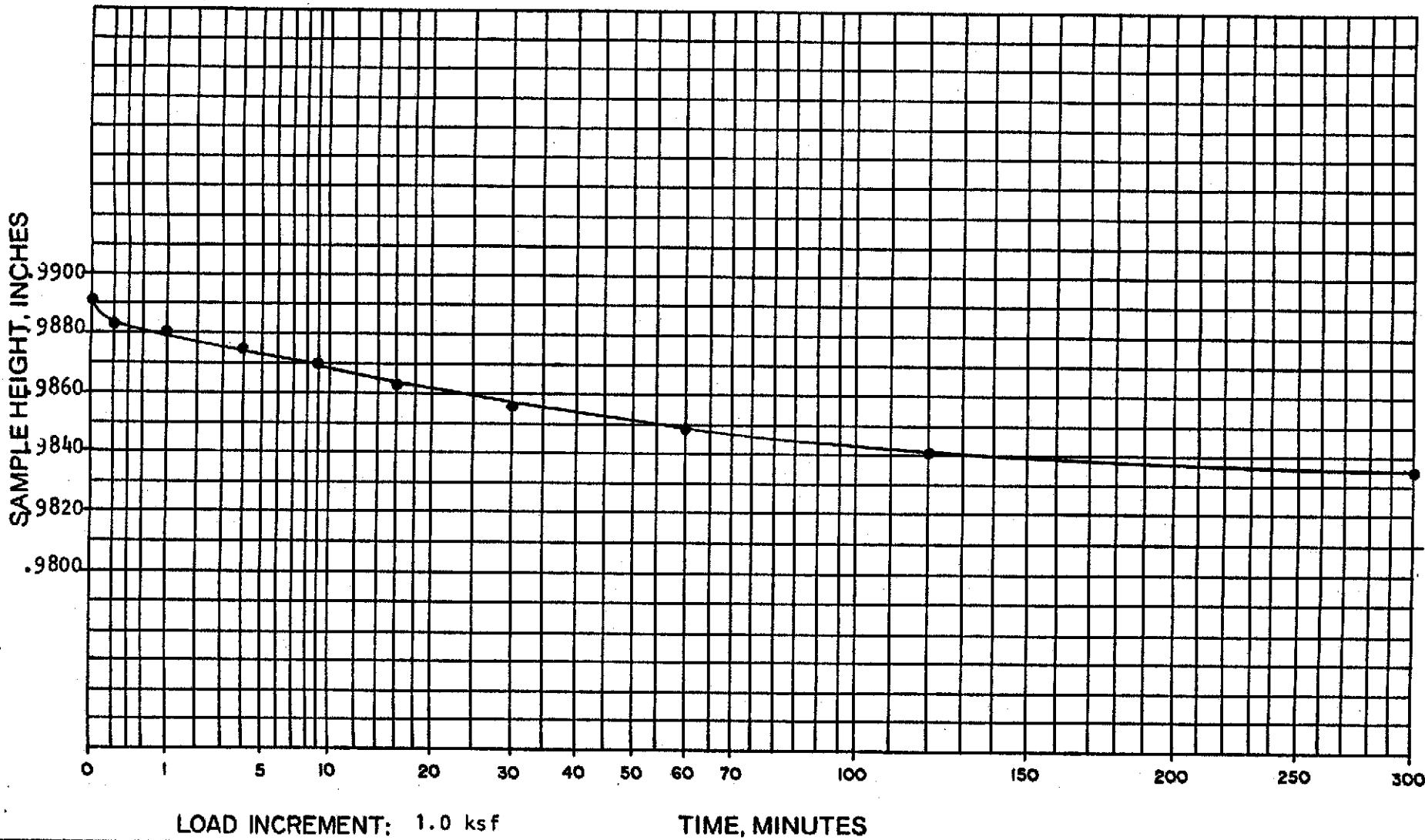
PO Box 949

Great Falls, MT 59403

JOB NO. 90-207

PLATE NO.

TIME RATE CONSOLIDATION TEST



LOAD INCREMENT: 1.0 ks f

TIME, MINUTES

Montanore Project Libby, Montana

Noranda Mineral Corp.
Libby, Montana

Lab. No. 45423

DRILL HOLE 32 MOIST UNIT WEIGHT 146 pcf

DEPTH 23.0'-25.0' DRY UNIT WEIGHT 126 pcf

CLASSIFICATION: INITIAL MOISTURE CONTENT 16%

FINAL MOISTURE CONTENT 10%

Chen Northern, Inc.

Consulting Engineers and Scientists

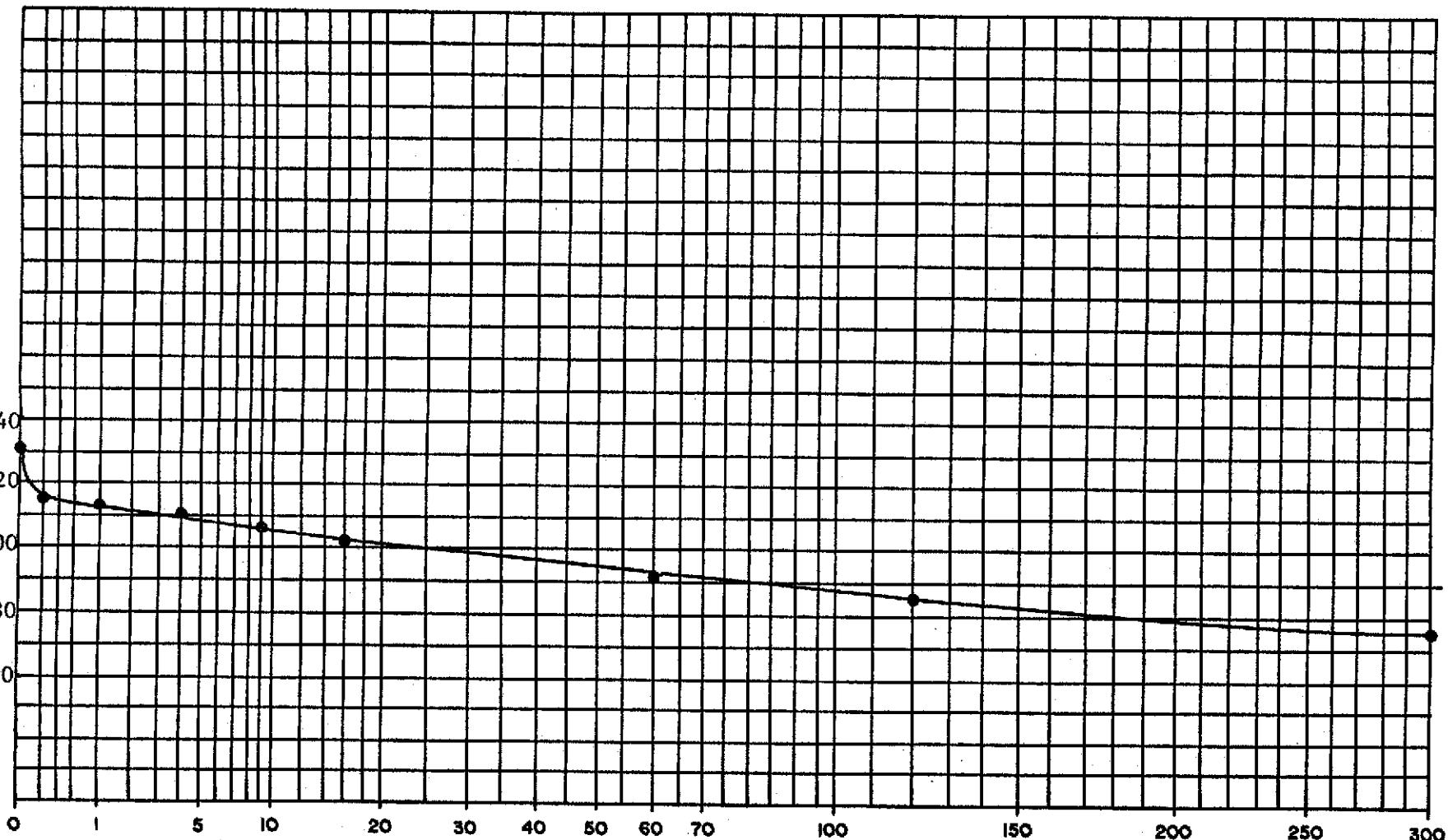
Job No. 90-207 **Plate No.**

(SHEET 2 OF 5)

NET 161

TIME RATE CONSOLIDATION TEST

SAMPLE HEIGHT, INCHES



LOAD INCREMENT: 2 ksf

TIME, MINUTES

Montanore Project
Libby, Montana

Lab. No. 45423

DRILL HOLE 32 MOIST UNIT WEIGHT 146 pcf
DEPTH 23.0'-25.0' DRY UNIT WEIGHT 126 pcf

Noranda Mineral Corp.
Libby, Montana

CLASSIFICATION: INITIAL MOISTURE CONTENT 16%
FINAL MOISTURE CONTENT 10%

Chen Northern, Inc.

Consulting Engineers and Scientists

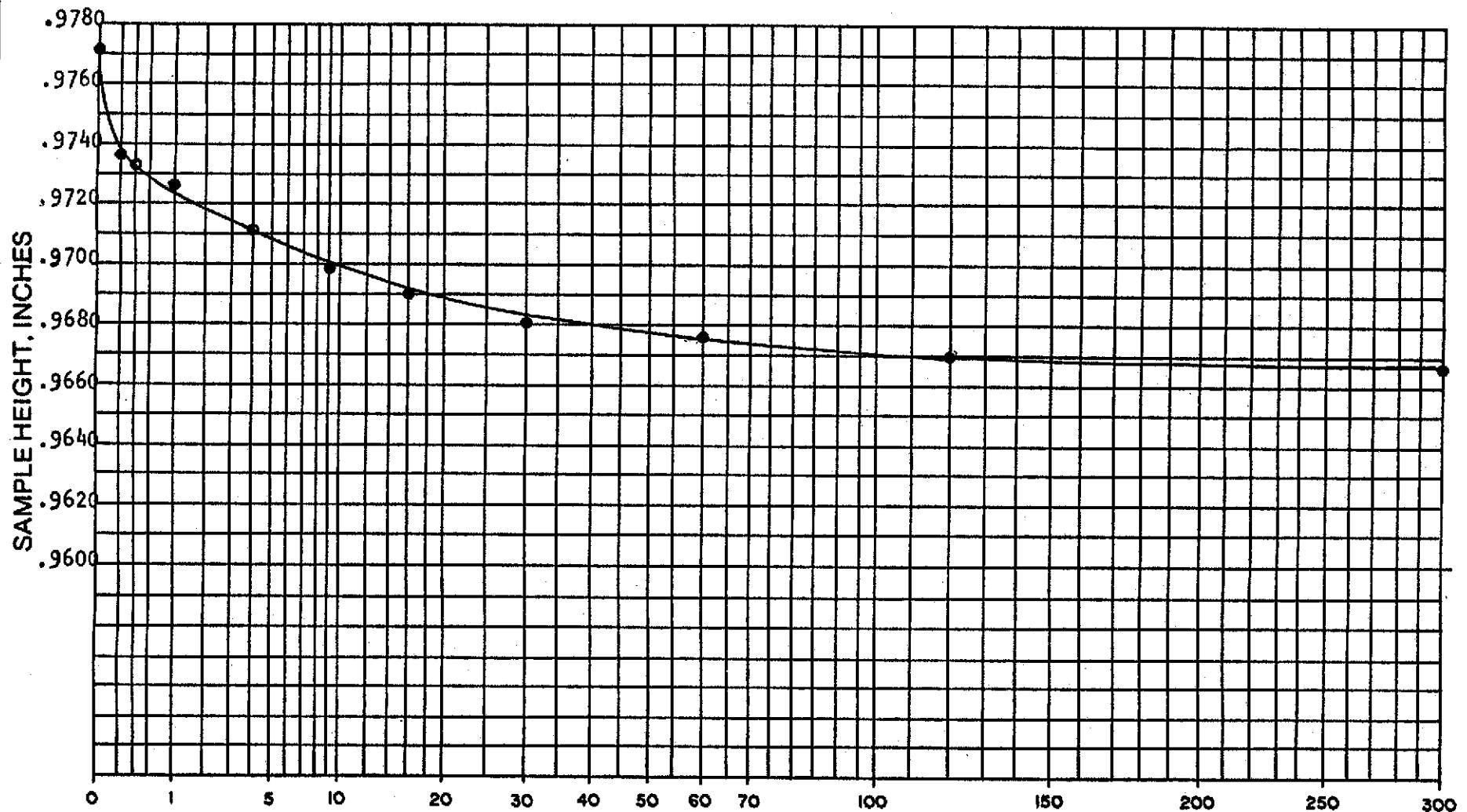
Job No. 90-207

Plate No.

(SHEET 3 OF 5)

NET 161

TIME RATE CONSOLIDATION TEST



LOAD INCREMENT: 4 ksf

TIME, MINUTES

Montanore Project
Libby, Montana

Lab No. 45423
DRILL HOLE 32 MOIST UNIT WEIGHT 146 pcf
DEPTH 23.0'-25.0' DRY UNIT WEIGHT 126 pcf

Noranda Mineral Corp.
Libby, Montana

CLASSIFICATION: INITIAL MOISTURE CONTENT 16%
FINAL MOISTURE CONTENT 10%

Chen Northern, Inc.

Consulting Engineers and Scientists

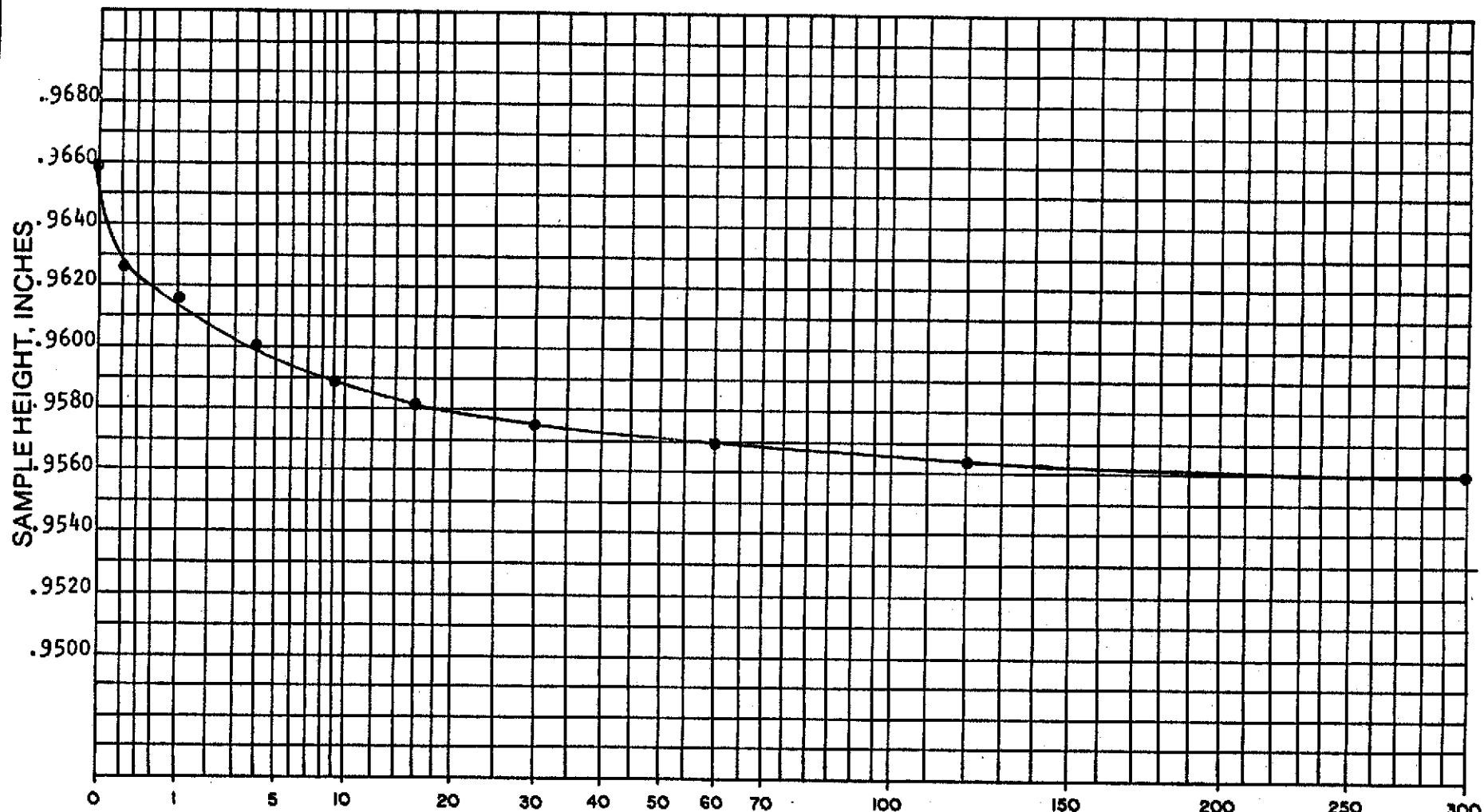
Job No. 90-207

Plate No.

(SHEET 4 OF 5)

NET 161

TIME RATE CONSOLIDATION TEST



LOAD INCREMENT: 8 ksf

TIME, MINUTES

Montanore Project
Libby, Montana

Lab No. 45423
DRILL HOLE 32
DEPTH 23.0'-25.0'

MOIST UNIT WEIGHT 146 pcf

Noranda Mineral Corp.
Libby, Montana

DRY UNIT WEIGHT 126 pcf

CLASSIFICATION: INITIAL MOISTURE CONTENT 16%

FINAL MOISTURE CONTENT 10%

Chen Northern, Inc.

Consulting Engineers and Scientists

Job No. 90-207 Plate No.

(SHEET 5 OF 5)

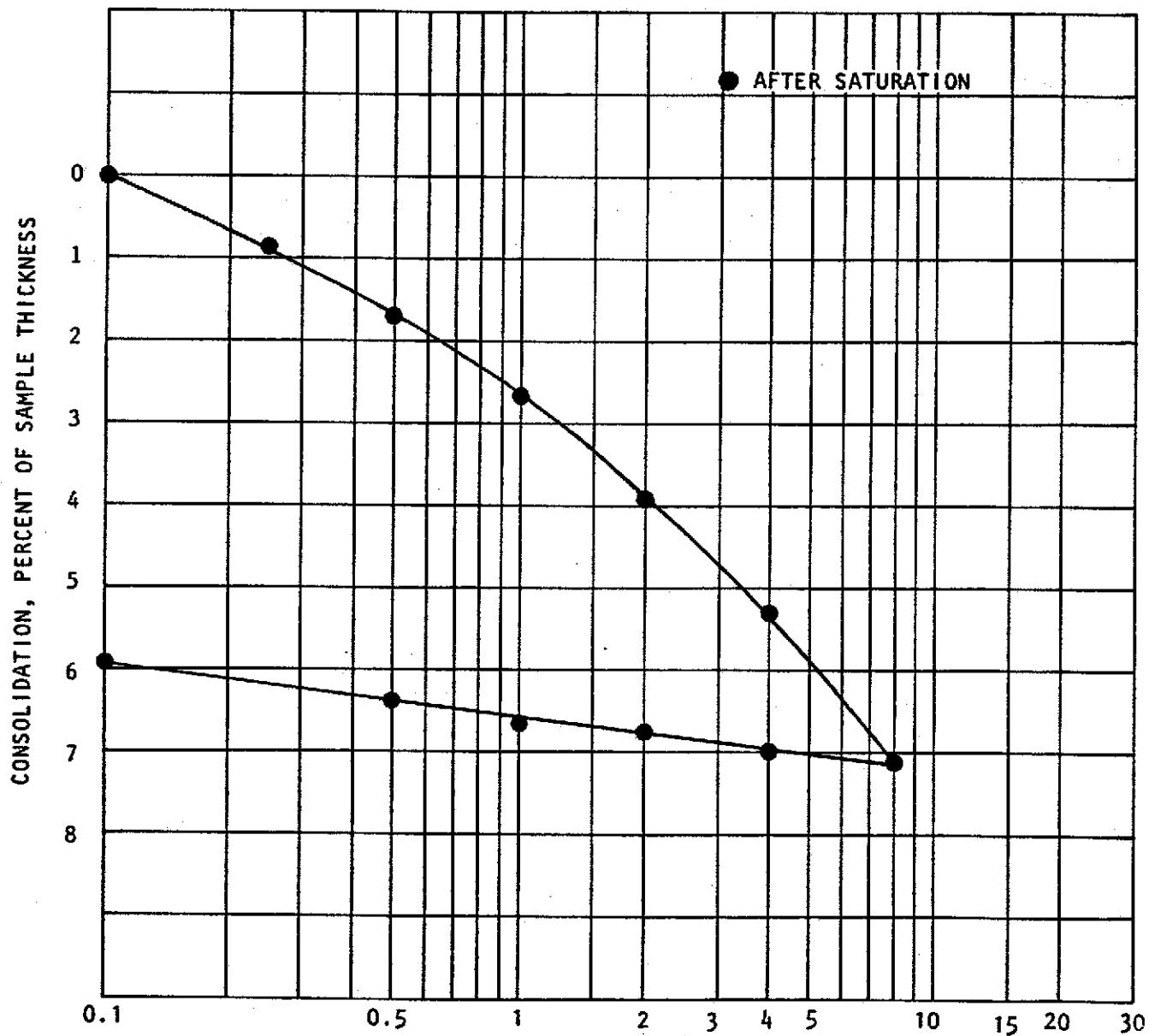
NET 161

**CONSOLIDATION TEST NO. 4
DIVERSION DAM FOUNDATION
DRILL HOLE DH-49**

CONSOLIDATION TEST

DRILL HOLE DH-49
DEPTH 17.0' - 19.0'
SAMPLE NO. 45984

MOIST UNIT WEIGHT : 134 pcf
DRY UNIT WEIGHT : 112 pcf
INITIAL MOISTURE CONTENT: 19%
FINAL MOISTURE CONTENT : 16%
CLASSIFICATION : Clayey SAND



NORMAL PRESSURE, KIPS PER SQUARE FOOT

SHEET 1 OF 5

DIVERSION DAM FOUNDATION

Montanore Project
Libby, Montana

Noranda Minerals Corp.
Libby, Montana

Chen Northern, Inc.

528 Smelter Ave.

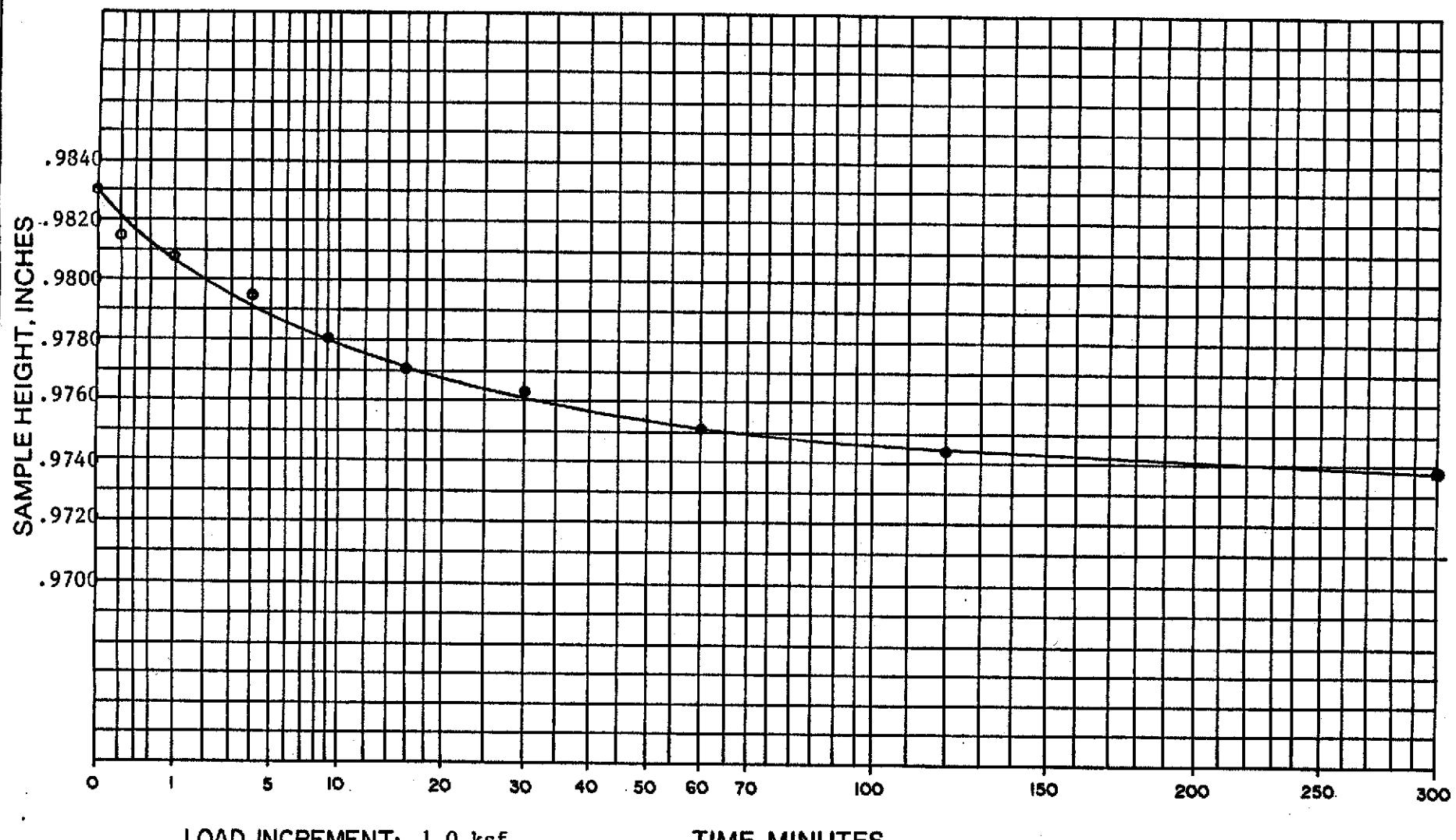
PO Box 949

Great Falls, MT 59403

JOB NO. 90-207

PLATE NO.

TIME RATE CONSOLIDATION TEST



LOAD INCREMENT: 1.0 ksf

TIME, MINUTES

Montanore Project
Libby, Montana

Lab No. 45984
DRILL HOLE 49
DEPTH 17.0-49.0'

MOIST UNIT WEIGHT 134 pcf

DRY UNIT WEIGHT 112 pcf

Noranda Minerals Corp.
Libby, Montana

CLASSIFICATION: INITIAL MOISTURE CONTENT 19%
FINAL MOISTURE CONTENT 16%

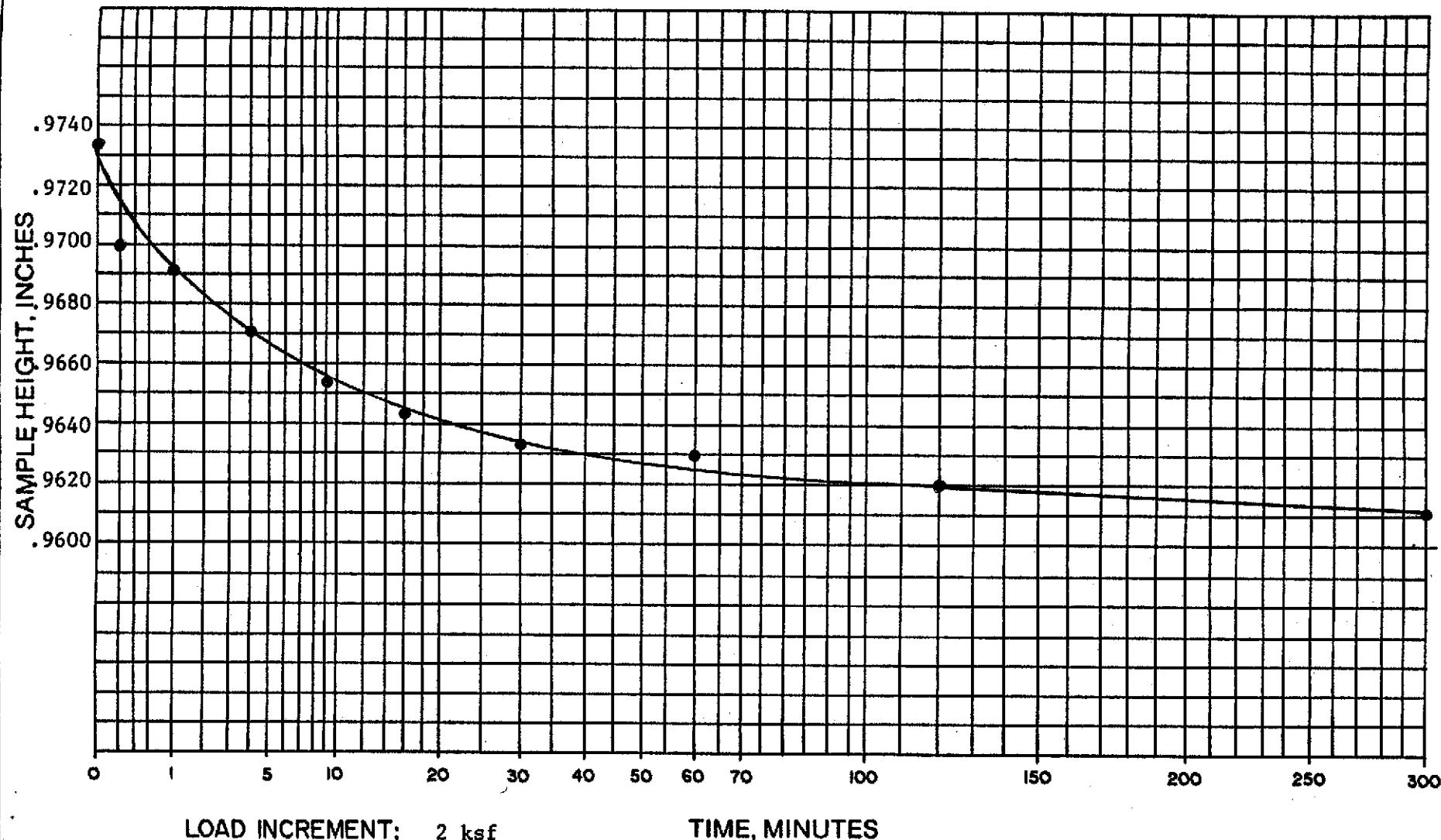
Chen Northern, Inc.

Consulting Engineers and Scientists

Job No. 90-207

Plate No.

TIME RATE CONSOLIDATION TEST



LOAD INCREMENT: 2 ksf

TIME, MINUTES

Montanore Project
Libby, Montana

Lab No. 45984

DRILL HOLE 49 MOIST UNIT WEIGHT 134 pcf

DEPTH 17.0'-19.0' DRY UNIT WEIGHT 112 pcf

Noranda Minerals Corp
Libby, Montana

CLASSIFICATION: INITIAL MOISTURE CONTENT 19%

FINAL MOISTURE CONTENT 16%

Chen Northern, Inc.

Consulting Engineers and Scientists

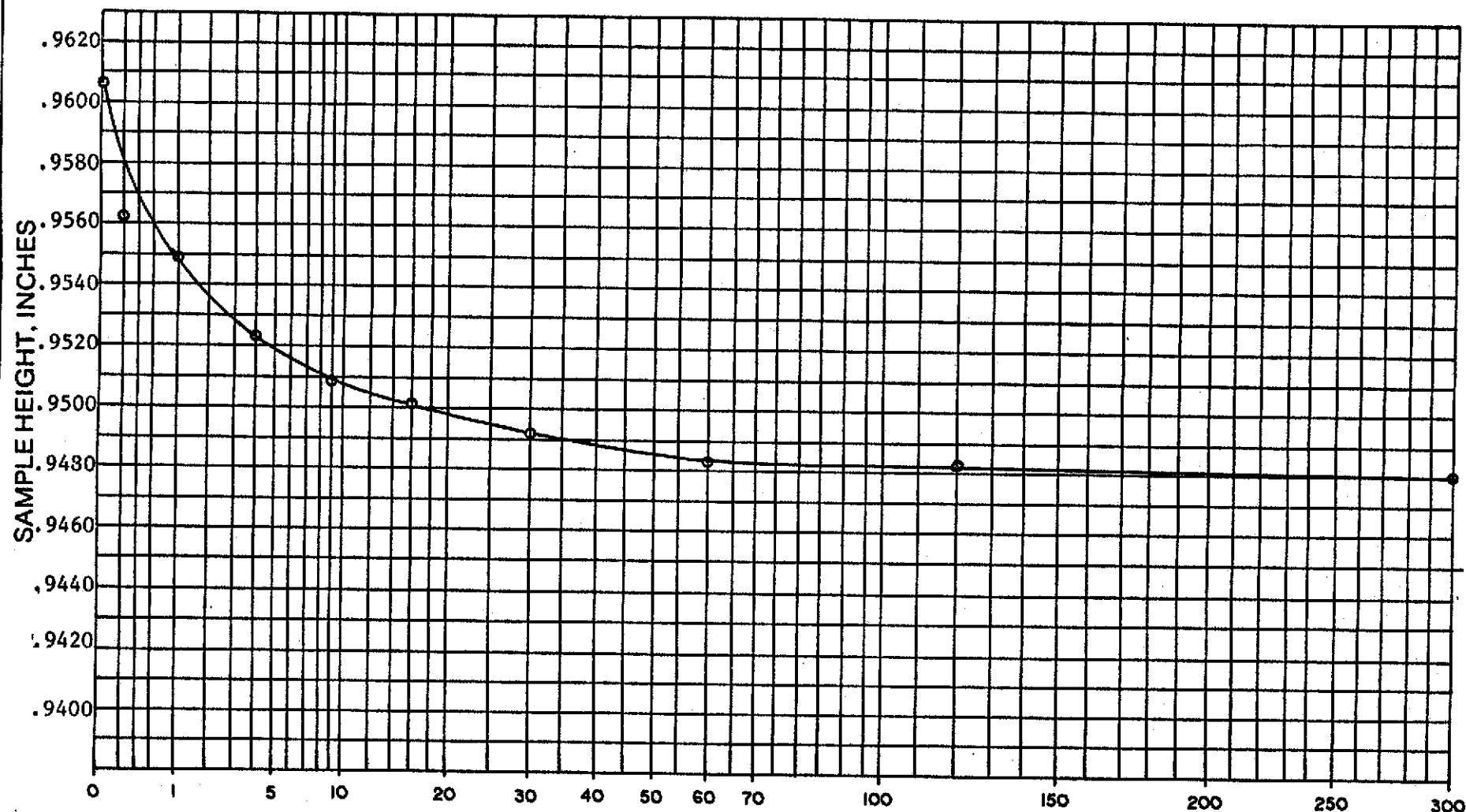
Job No. 90-207

Plate No.

(SHEET 3 OF 5)

NET 161

TIME RATE CONSOLIDATION TEST



LOAD INCREMENT: 4 ksf

TIME, MINUTES

Montanore Project
Libby, Montana

Lab No. 45984

DRILL HOLE 49 MOIST UNIT WEIGHT 134 pcf

DEPTH 17.0'-19.0' DRY UNIT WEIGHT 112 pcf

Noranda Minerals Corp
Libby, Montana

CLASSIFICATION: INITIAL MOISTURE CONTENT 19%

FINAL MOISTURE CONTENT 16%

Chen Northern, Inc.

Consulting Engineers and Scientists

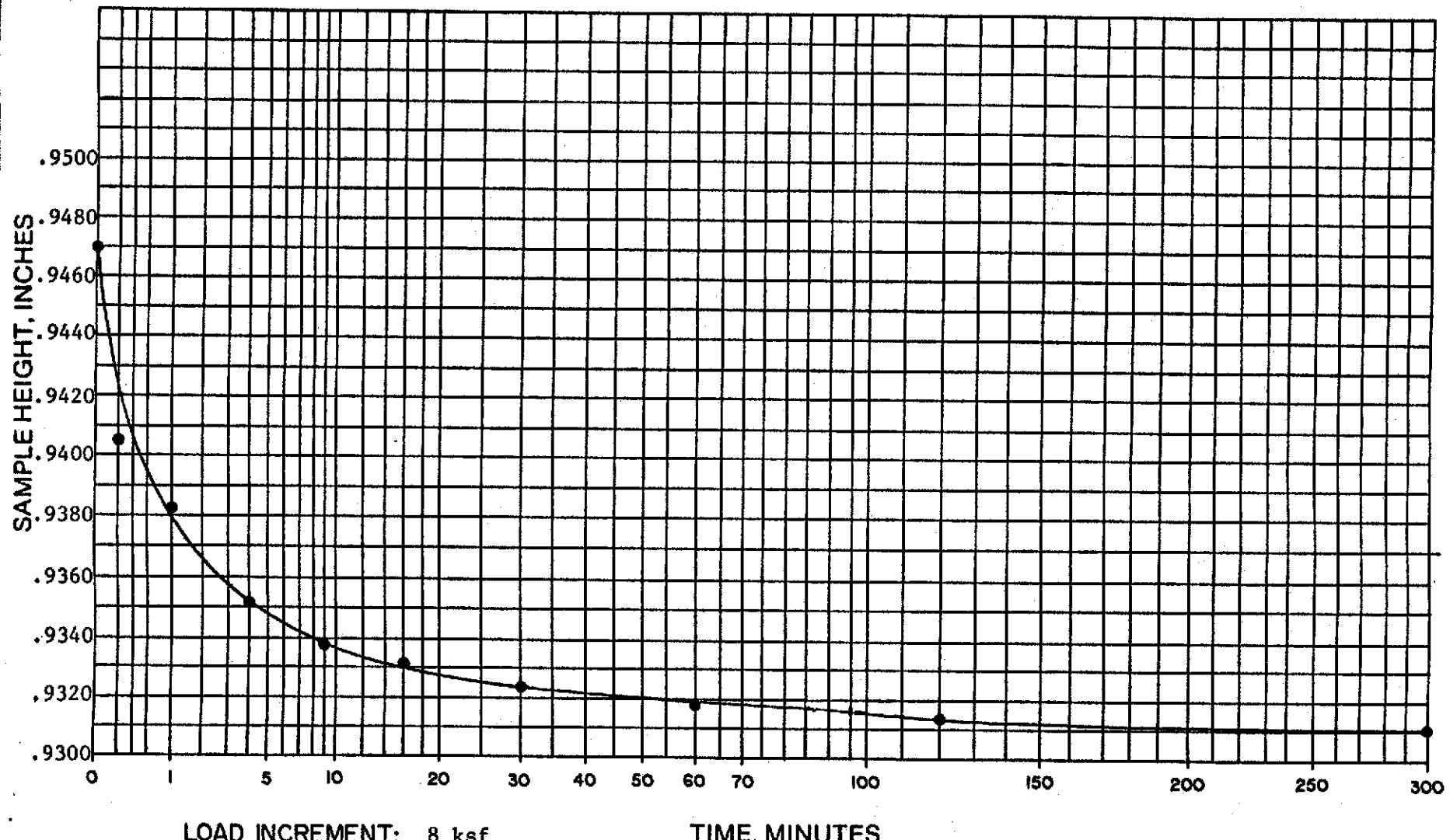
Job No. 90-207

Plate No.

(SHEET 4 OF 5)

NET 161

TIME RATE CONSOLIDATION TEST



LOAD INCREMENT: 8 ksf

TIME, MINUTES

Montanore Project
Libby, Montana

Noranda Minerals Corp
Libby, Montana

Lab No. 45984
DRILL HOLE 49 MOIST UNIT WEIGHT 134 pcf
DEPTH 17.0'-19.0' DRY UNIT WEIGHT 112 pcf
CLASSIFICATION: INITIAL MOISTURE CONTENT 19%
FINAL MOISTURE CONTENT 16%

Chen Northern, Inc.

Consulting Engineers and Scientists

Job No. 90-207 Plate No.

(SHEET 5 OF 5)

NET 161

MOISTURE - DENSITY RELATIONSHIP DATA

MOISTURE-DENSITY RELATIONSHIP DATA SHEET

GREAT FALLS
528 SMELTER AVENUE
P. O. BOX 951
GREAT FALLS, MT 59403
(406) 453-1641
FAX (406) 727-2070

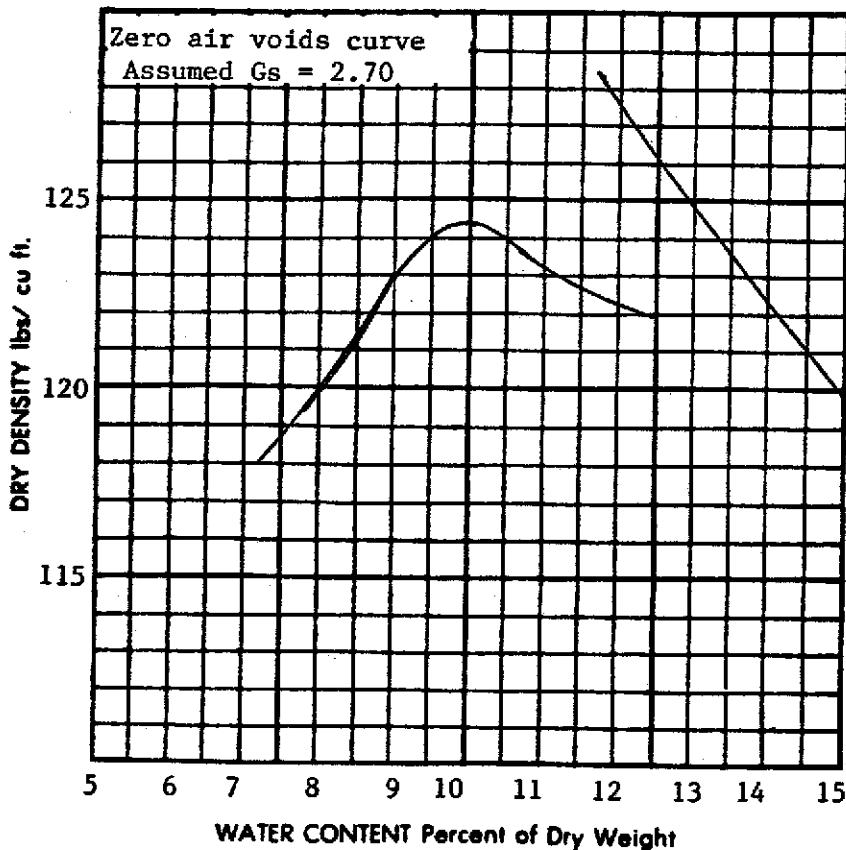
REPORT TO:

NORANDA MINERALS CORP/MONTANORE (2)
ATTN: MR. DAN MYERS
PO BOX 1486
LIBBY, MT 59923

PROJECT: Montanore Project, Libby, MT
CONTRACTOR: N/R
SAMPLE LOCATION: TP-201, 4.0' - 6.0'

MATERIAL USE: N/R

DATE: November, 1990
JOB NUMBER: 90-207
SHEET: 1 OF 1
INVOICE NO.: 100931
LAB NO.: 45347
DATE SAMPLED: N/R
DATE RECEIVED: October 1990
SAMPLED BY: Morrison-Knudsen

MOISTURE-DENSITY RELATIONSHIP**REMARKS:**

Reviewed By: Kenneth A. B. Munn

DISTRIBUTION: Morrison-Knudsen Engineers, Inc.

MOISTURE-DENSITY RELATIONSHIP DATA SHEET

GREAT FALLS
528 SMELTER AVENUE
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GREAT FALLS, MT 59403
(406) 453-1641
FAX (406) 727-2070

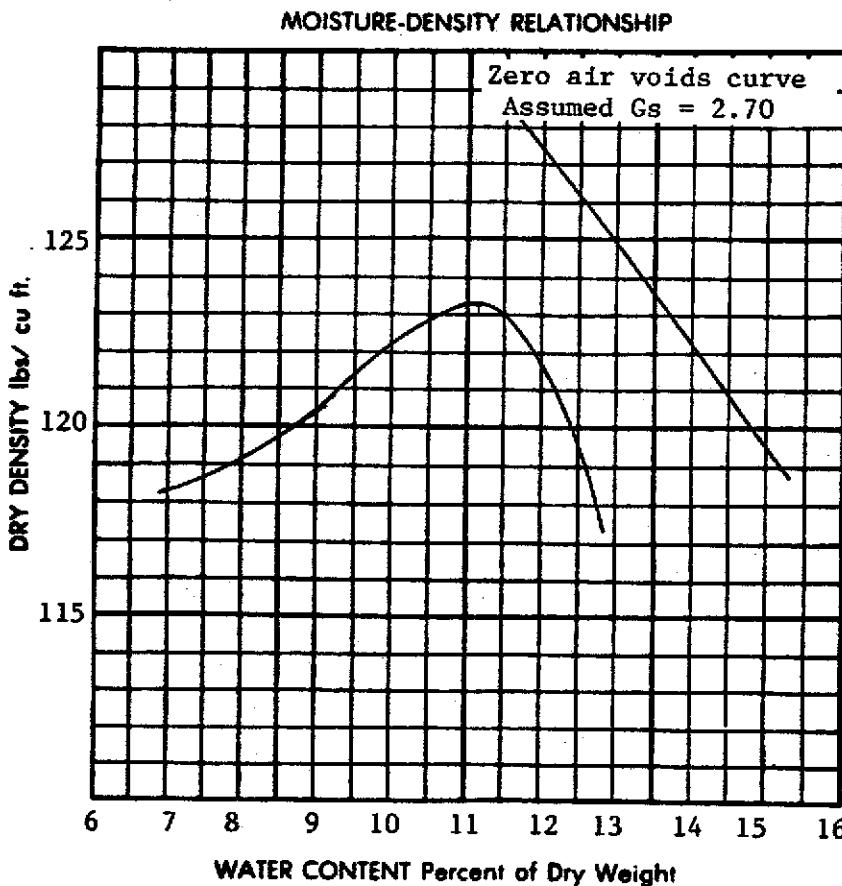
REPORT TO:

NORANDA MINERALS CORP/MONTANORE (2)
ATTN: MR. DAN MYERS
PO BOX 1486
LIBBY, MT 59923

PROJECT: Montanore Project, Libby, MT
CONTRACTOR: N/R
SAMPLE LOCATION: TP 205, 2.0' - 5.0'

MATERIAL USE: N/R

DATE: November 1990
JOB NUMBER: 90-207
SHEET: 1 OF 1
INVOICE NO.: 100885
LAB NO.: 45352
DATE SAMPLED: N/R
DATE RECEIVED: October 1990
SAMPLED BY: Morrison-Knudsen

**MECHANICAL ANALYSIS**

SIZE	% PASS	SPEC'S.
4"	100	
3"	90	
2"	87	
1-1/2"	85	
1"	82	
3/4"	79	
1/2"	75	
3/8"	73	
No. 4	70	
No. 10	62	
No. 20	57	
No. 40	53	
No. 80	49	
No. 100	—	
No. 200 (wash)	44	

VISUAL CLASSIFICATION

Clayey GRAVEL with Sand
SPECIFIC GRAVITY: 2.70 Assumed
LIQUID LIMIT: N/R
PLASTICITY INDEX: N/R

TEST PROCEDURE ASTM D698, Method D
MAX. DENSITY: 123.3 .

OPT. MOIST.: 11.3

RAMMER TYPE: 5.5 pound manual

PREPARATION PROCEDURE: Moist
PENETRATION RESIS.:

REMARKS:

DISTRIBUTION: Morrison-Knudsen Engineers, Inc.

MOISTURE-DENSITY RELATIONSHIP DATA SHEET

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528 SMELTER AVENUE
P. O. BOX 951
GREAT FALLS, MT 59403
(406) 453-1641
FAX (406) 727-2070

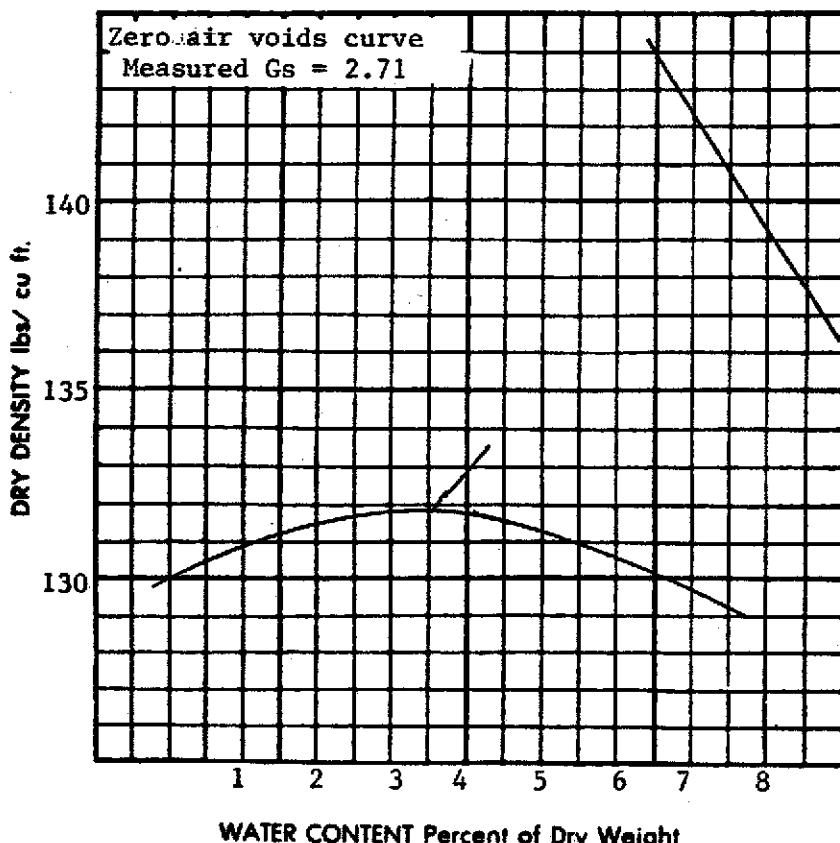
REPORT TO:

NORANDA MINERALS CORP/MONTANORE (2)
ATTN: MR. DAN MYERS
PO BOX 1486
LIBBY, MT 59923

PROJECT: Montanore Project, Libby, MT
CONTRACTOR: N/R
SAMPLE LOCATION: TP-207, 3.0' - 6.0'

MATERIAL USE: N/R

DATE: November 1990
JOB NUMBER: 90-207
SHEET: 1 OF 1
INVOICE NO.: 100885
LAB NO.: 45355
DATE SAMPLED: N/R
DATE RECEIVED: October 1990
SAMPLED BY: Morrison-Knudsen

MOISTURE-DENSITY RELATIONSHIP

DISTRIBUTION: Morrison-Knudsen Engineers, Inc.

MECHANICAL ANALYSIS

SIZE	% PASS	SPECS.
5"	100	
4"	84	
3"	69	
2"	63	
1-1/2"	60	
1"	55	
3/4"	51	
1/2"	46	
3/8"	44	
No. 4	38	
No. 10	31	
No. 20	26	
No. 40	23	
No. 80	20	
No. 100	20	
No. 200 (wash)	17	

VISUAL CLASSIFICATION

Clayey GRAVEL with Sand
SPECIFIC GRAVITY: 2.71

LIQUID LIMIT: N/R

PLASTICITY INDEX: N/R

TEST PROCEDURE: ASTM D698, Method D
MAX. DENSITY: 131.9

OPT. MOIST.: 3.5

RAMMER TYPE: 5.5 pound manual

PREPARATION PROCEDURE: Moist

PENETRATION RESIS.: N/R

REMARKS:

MOISTURE-DENSITY RELATIONSHIP DATA SHEET

GREAT FALLS
528 SMELTER AVENUE
P. O. BOX 951
GREAT FALLS, MT 59403
(406) 453-1641
FAX (406) 727-2070

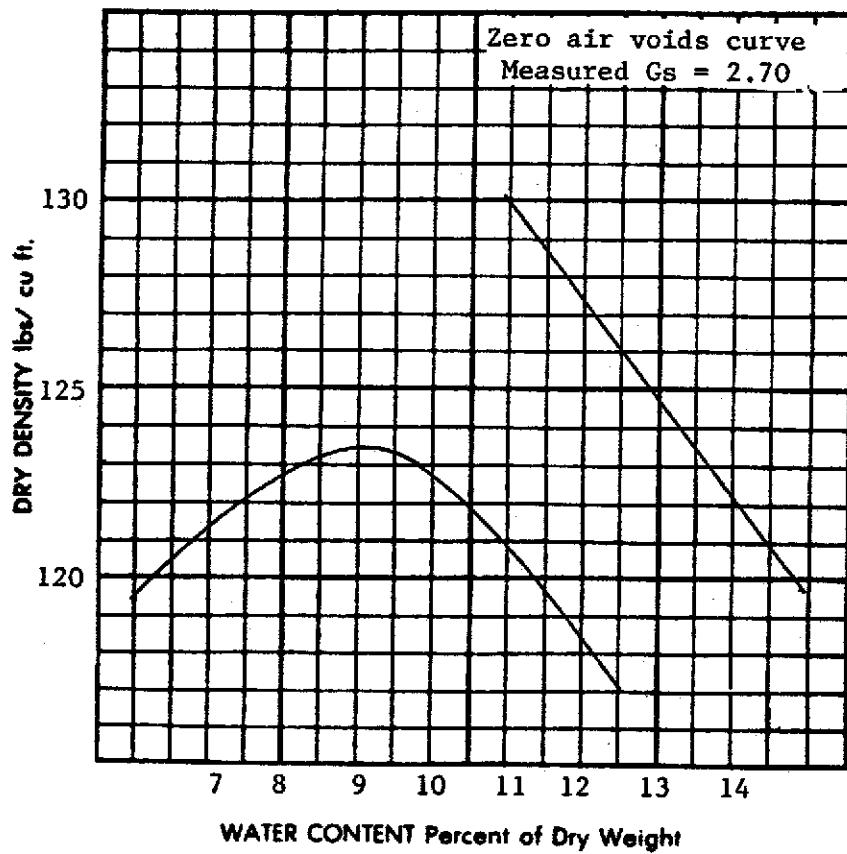
REPORT TO:
 NORANDA MINERALS CORP/MONTANORE (2)
 ATTN: MR. DAN MYERS
 PO BOX 1486
 LIBBY, MT 59923

PROJECT: Montanore Project, Libby, MT
CONTRACTOR: N/R
SAMPLE LOCATION: TP-208, 1.0' - 3.0'

MATERIAL USE: N/R

DATE: November 1990
JOB NUMBER: 90-207
SHEET: 1 OF 1
INVOICE NO.: 100885
LAB NO.: 45357
DATE SAMPLED: N/R
DATE RECEIVED: October 1990
SAMPLED BY: Morrison-Knudsen

MOISTURE-DENSITY RELATIONSHIP



REMARKS:

VISUAL CLASSIFICATION

Clayey GRAVEL with Sand
SPECIFIC GRAVITY: 2.70

LIQUID LIMIT: N/R

PLASTICITY INDEX: N/R

TEST PROCEDURE ASTM D698, Method D
MAX. DENSITY: 123.4

OPT. MOIST.: 9.1

RAMMER TYPE: 5.5 pound manual

PREPARATION PROCEDURE: Moist

PENETRATION RESIS.: N/A

DISTRIBUTION: Morrison-Knudsen Engineers, Inc.

MOISTURE-DENSITY RELATIONSHIP DATA SHEET

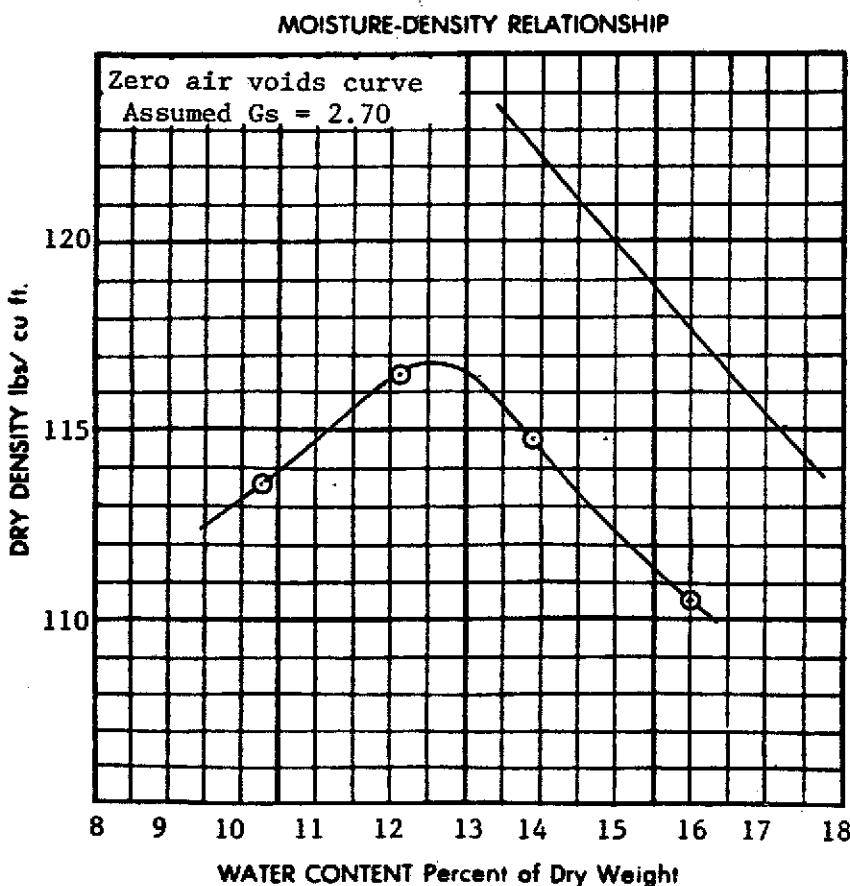
BILLINGS
600 SOUTH 25TH STREET
P. O. BOX 30615
BILLINGS, MT 59107
(406) 248-9161
FAX (406) 248-9282

REPORT TO:
 NORANDA MINERALS CORP/MONTANORE (2)
 ATTN: MR. DAN MYERS
 PO BOX 1486
 LIBBY, MT 59923

PROJECT: Montanore Project, Libby, MT
CONTRACTOR: N/R
SAMPLE LOCATION: TP-209, 4.0' - 9.5'

MATERIAL USE: N/R

DATE: November 1990
JOB NUMBER: 90-207
SHEET: 1 OF 1
INVOICE NO.: 100885
LAB NO.: 45359
DATE SAMPLED: N/R
DATE RECEIVED: October 1990
SAMPLED BY: Morrison-Knudsen



MECHANICAL ANALYSIS		
SIZE	% PASS	SPECS.
3"	100	
2"	85	
1-1/2"	84	
1"	83	
3/4"	82	
1/2"	80	
3/8"	79	
No. 4	68	
No. 10	55	
No. 20	52	
No. 40	49	
No. 80	47	
No. 100	46	
No. 200	41	
0.005mm	12	

VISUAL CLASSIFICATION
 Silty Clayey Gravel with Sand
 SPECIFIC GRAVITY: 2.70 (Assumed)
 LIQUID LIMIT: N/R
 PLASTICITY INDEX: N/R

TEST PROCEDURE ASTM D698, Method D
 MAX. DENSITY: 11.6.8
 OPT. MOIST.: 12.6
 RAMMER TYPE: Manual
 PREPARATION PROCEDURE: Moist
 PENETRATION RESIS.: N/R

REMARKS:

DISTRIBUTION: Morrison-Knudsen Engineers, Inc.

MOISTURE-DENSITY RELATIONSHIP DATA SHEET

GREAT FALLS
528 SMELTER AVENUE
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GREAT FALLS, MT 59403
(406) 453-1641
FAX (406) 727-2070

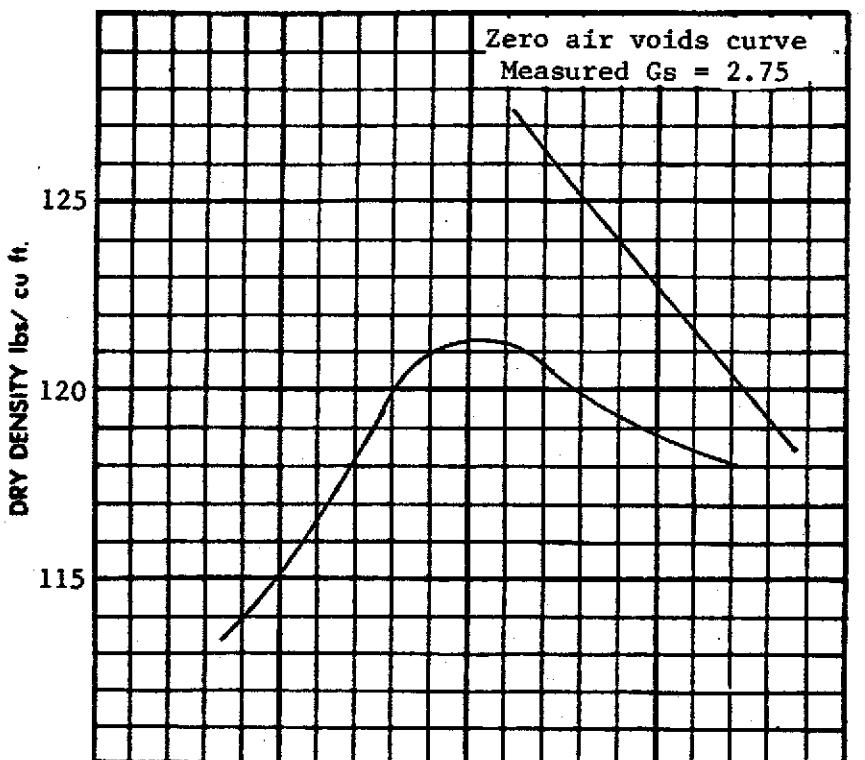
REPORT TO:

NORANDA MINERALS CORP/MONTANORE (2)
ATTN: MR. DAN MYERS
PO BOX 1486
LIBBY, MT 59923

PROJECT: Montanore Project, Libby, MT
CONTRACTOR: N/R
SAMPLE LOCATION: TP-211, 4.0' - 9.0'

MATERIAL USE:

DATE: November 1990
JOB NUMBER: 90-207
SHEET: 1 OF 1
INVOICE NO.: 100885
LAB NO.: 45361
DATE SAMPLED: N/R
DATE RECEIVED: October 1990
SAMPLED BY: Morrison-Knudsen

MOISTURE-DENSITY RELATIONSHIP**REMARKS:**

VISUAL CLASSIFICATION
Sandy Silty CLAY
SPECIFIC GRAVITY: 2.75
LIQUID LIMIT: N/R
PLASTICITY INDEX: N/R

TEST PROCEDURE ASTM D698, Method D
MAX. DENSITY: 121.3
OPT. MOIST.: 12.0
RAMMER TYPE: 5.5 pound manual
PREPARATION PROCEDURE: Moist
PENETRATION RESIS.: N/R

WATER CONTENT Percent of Dry Weight

DISTRIBUTION: Morrison-Knudsen Engineers, Inc.

MOISTURE-DENSITY RELATIONSHIP DATA SHEET

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FAX (406) 727-2070

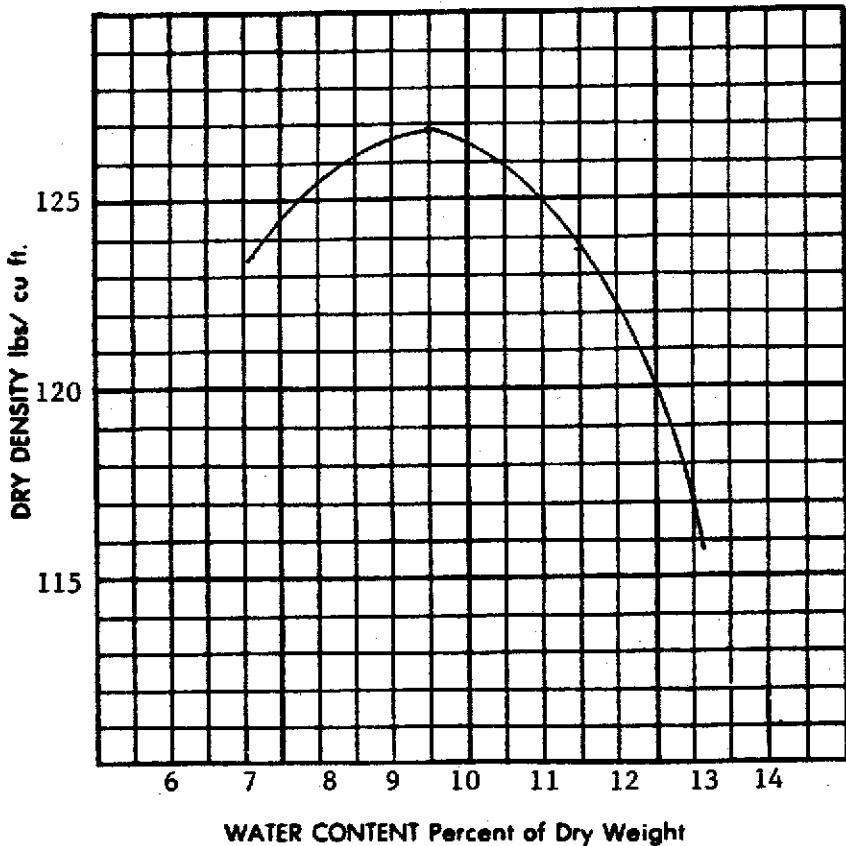
REPORT TO:
 NORANDA MINERALS CORP/MONTANORE (2)
 ATTN: MR. DAN MYERS
 PO BOX 1486
 LIBBY, MT 59923

PROJECT: Montanore Project, Libby, MT
CONTRACTOR: N/R
SAMPLE LOCATION: TP-214, 3.0' - 10.0'

MATERIAL USE: N/R

DATE: November 1990
JOB NUMBER: 90-207
SHEET: 1 OF 1
INVOICE NO.: 100885
LAB NO.: 45365
DATE SAMPLED: N/R
DATE RECEIVED: October 1990
SAMPLED BY: Morrison-Knudsen

MOISTURE-DENSITY RELATIONSHIP



DISTRIBUTION: Morrison-Knudsen Engineers, Inc.

MECHANICAL ANALYSIS

SIZE	% PASS	SPECS.
4"	100	
3"	89	
2"	80	
1-1/2"	76	
1"	70	
3/4"	67	
1/2"	63	
3/8"	60	
No. 4	57	
No. 10	55	
No. 20	48	
No. 40	45	
No. 100	40	
No. 200	39	

UNIFIED CLASSIFICATION (ASTM D2487)

N/R
SPECIFIC GRAVITY: N/R
LIQUID LIMIT: N/R
PLASTICITY INDEX: N/R

TEST PROCEDURE: ASTM D698, Method D
MAX. DENSITY: 127.0
OPT. MOIST.: 9.5
RAMMER TYPE: 5.5 pound manual
PREPARATION PROCEDURE: Moist
PENETRATION RESIS.: N/R

REMARKS:

MOISTURE-DENSITY RELATIONSHIP DATA SHEET

GREAT FALLS
528 SMELTER AVENUE
P. O. BOX 951
GREAT FALLS, MT 59403
(406) 453-1641
FAX (406) 727-2070

REPORT TO:
 NORANDA MINERALS CORP/MONTANORE (2)
 ATTN: MR. DAN MYERS
 PO BOX 1486
 LIBBY, MT 59923

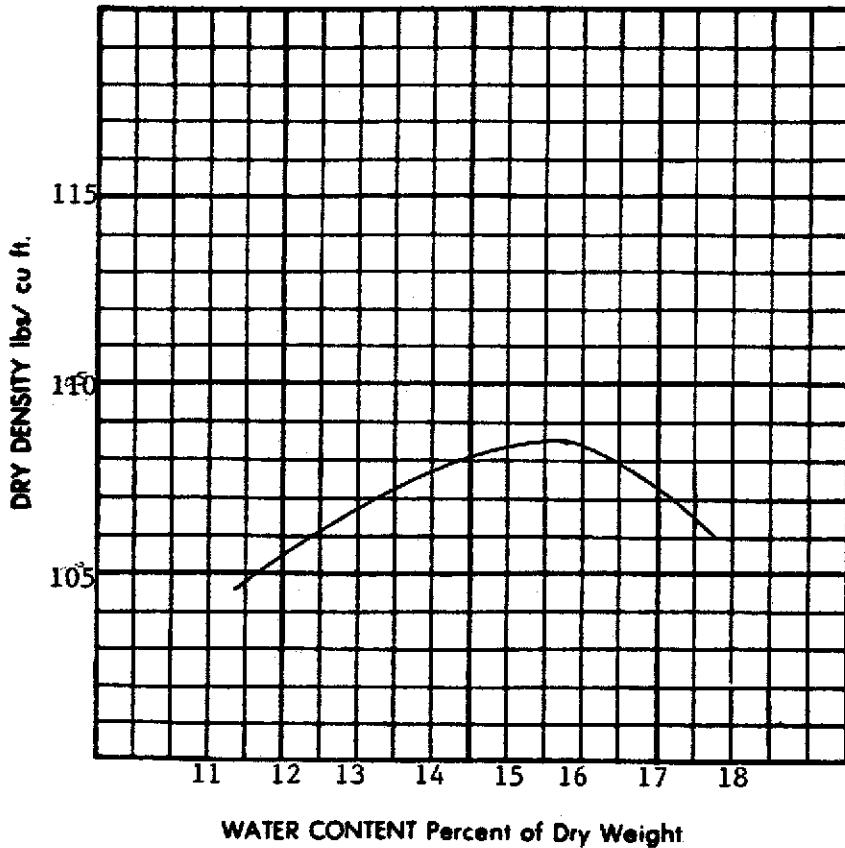
PROJECT: Montanore Project, Libby, MT
CONTRACTOR: N/R
SAMPLE LOCATION: TP-226, 3.0' - 16.5'

MATERIAL USE: N/R

DATE: November 1990
JOB NUMBER: 90-207
 SHEET: 1 OF 1
INVOICE NO.: 100885
LAB NO.: 45379
DATE SAMPLED: N/R
DATE RECEIVED: October 1990
SAMPLED BY: Morrison-Knudsen

MECHANICAL ANALYSIS		
SIZE	% PASS	SPEC'S.
3"	100	
2"	99	
1-1/2"	96	
1"	92	
3/4"	88	
1/2"	84	
3/8"	82	
No. 4	71	
No. 10	60	
No. 20	53	
No. 40	50	
No. 100	44	
No. 200	37	

MOISTURE-DENSITY RELATIONSHIP



REMARKS:

UNIFIED CLASSIFICATION (ASTM D2487)
 N/R
SPECIFIC GRAVITY: N/R
LIQUID LIMIT: 31
PLASTICITY INDEX: 14

TEST PROCEDURE ASTM D698, Method D
MAX. DENSITY: 108.5
OPT. MOIST.: 15.7
RAMMER TYPE: 5.5 pound manual
PREPARATION PROCEDURE: Moist
PENETRATION RESIS.: N/R

DISTRIBUTION: Morrison-Knudsen Engineers, Inc.

MOISTURE-DENSITY RELATIONSHIP DATA SHEET

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(406) 453-1841
FAX (406) 727-2070

REPORT TO:

NORANDA MINERALS CORP/MONTANORE (2)
ATTN: MR. DAN MYERS
PO BOX 1486
LIBBY, MT 59923

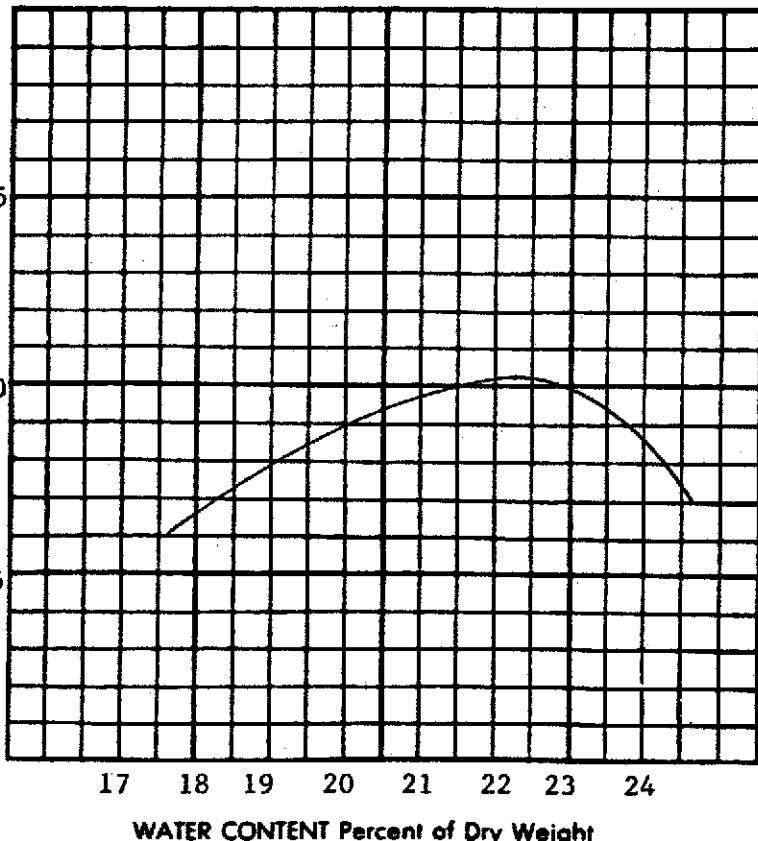
PROJECT: Montanore Project, Libby, MT
CONTRACTOR: N/R
SAMPLE LOCATION: TP-235, 4.0' - 12.0'

MATERIAL USE: N/R

DATE: November 1990
JOB NUMBER: 90-207
SHEET: 1 OF 1
INVOICE NO.: 100885
LAB NO.: 45389
DATE SAMPLED: N/R
DATE RECEIVED: October 1990
SAMPLED BY: Morrison-Knudsen

MOISTURE-DENSITY RELATIONSHIP

DRY DENSITY lbs/ cu ft.

**MECHANICAL ANALYSIS**

SIZE	% PASS	SPECS.
1-1/2"	100	
1"	99	
3/4"	98	
1/2"	97	
3/8"	96	
No. 4	87	
No. 10	75	
No. 20	65	
No. 40	58	
No. 100	52	
No. 200	48	

UNIFIED CLASSIFICATION (ASTM D2487)

N/R
SPECIFIC GRAVITY: N/R
LIQUID LIMIT: N/R
PLASTICITY INDEX: N/R

TEST PROCEDURE ASTM D698, Method D
MAX. DENSITY: 100.2
OPT. MOIST.: 22.4
RAMMER TYPE: 5.5 pound manual
PREPARATION PROCEDURE: Moist
PENETRATION RESIS.: N/R

REMARKS:

DISTRIBUTION: Morrison-Knudsen Engineers, Inc.

MOISTURE-DENSITY RELATIONSHIP DATA SHEET

BILLINGS
600 SOUTH 25TH STREET
P. O. BOX 30615
BILLINGS, MT 59107
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FAX (406) 248-9282

REPORT TO:

NORANDA MINERALS CORP/MONTANORE (2)
ATTN: MR. DAN MYERS
PO BOX 1486
LIBBY, MT 59923

PROJECT: Montanore Project, Libby, MT
CONTRACTOR: N/R
SAMPLE LOCATION: TP-247, 2.0' - 12.0'

MATERIAL USE: N/R

DATE: November 1990
JOB NUMBER: 90-207
SHEET: 1 OF 1
INVOICE NO.: 100885
LAB NO.: 45983
DATE SAMPLED: N/R
DATE RECEIVED: October 1990
SAMPLED BY: Morrison-Knudsen

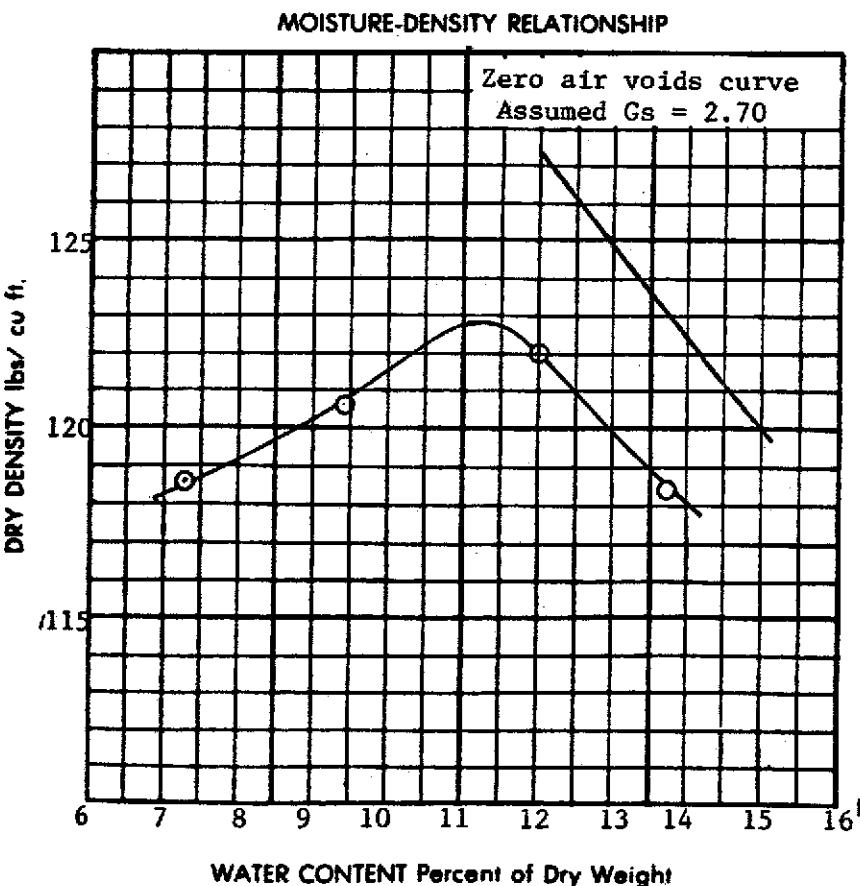
MECHANICAL ANALYSIS

SIZE	% PASS	SPEC.
3"	100	
2"	97	
1-1/2"	95	
1"	93	
3/4"	90	
1/2"	85	
3/8"	82	
No. 4	72	
No. 10	64	
No. 20	59	
No. 40	57	
No. 80	53	
No. 100	52	
No. 200	47	
0.005mm	19	

UNIFIED CLASSIFICATION (ASTM D2487)

Silty Clayey GRAVEL with Sand
SPECIFIC GRAVITY: 2.70 (Assumed)
LIQUID LIMIT: Granular
PLASTICITY INDEX: Non-Plastic

TEST PROCEDURE ASTM D698, Method D
MAX. DENSITY: 122.8
OPT. MOIST.: 11.3
RAMMER TYPE: 5.5 pound manual
PREPARATION PROCEDURE: Moist
PENETRATION RESIS.: N/R



WATER CONTENT Percent of Dry Weight

DISTRIBUTION: Morrison-Knudsen Engineers, Inc.

MOISTURE-DENSITY RELATIONSHIP DATA SHEET

GREAT FALLS
528 SMELTER AVENUE
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GREAT FALLS, MT 59403
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FAX (406) 727-2070

REPORT TO:

NORANDA MINERALS CORP/MONTANORE (2)
ATTN: MR. DAN MYERS
PO BOX 1486
LIBBY, MT 59923

PROJECT: Montanore Project, Libby, MT
CONTRACTOR: N/R
SAMPLE LOCATION: TP-250, 2.0' - 11.5'

MATERIAL USE: N/R

DATE: November 1990
JOB NUMBER: 90-207
SHEET: 1 OF 1
INVOICE NO.: 100885
LAB NO.: 45811
DATE SAMPLED: N/R
DATE RECEIVED: October 1990
SAMPLED BY: Morrison-Knudsen

MECHANICAL ANALYSIS

SIZE	% PASS	SPECS.
3"	100	
2"	99	
1-1/2"	96	
1"	93	
3/4"	90	
1/2"	85	
3/8"	82	
No. 4	71	
No. 10	66	
No. 20	62	
No. 40	59	
No. 80	55	
No. 100	53	
No. 200	47	
0.005mm	12	

UNIFIED CLASSIFICATION (ASTM D2487)
Silty GRAVEL with Sand

SPECIFIC GRAVITY: 2.70 (Assumed)

LIQUID LIMIT: Granular

PLASTICITY INDEX: Non-Plastic

TEST PROCEDURE ASTM D698, Method D
MAX. DENSITY: 123.3

OPT. MOIST.: 11.8

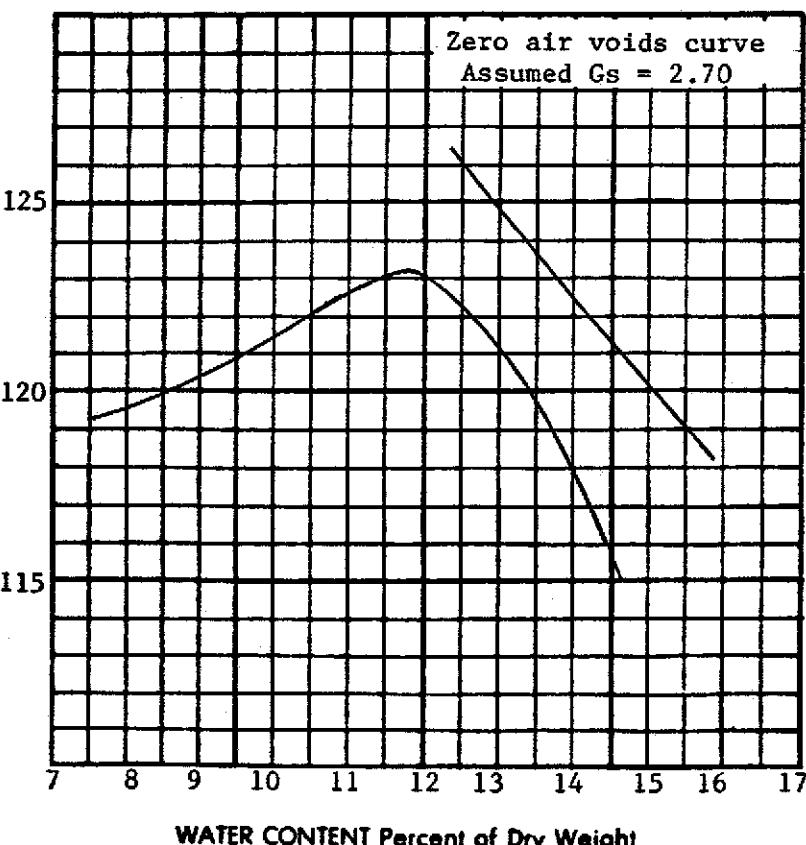
RAMMER TYPE: 5.5 pound manual

PREPARATION PROCEDURE: Moist

PENETRATION RESIS.: N/A

REMARKS:

DRY DENSITY lbs/cu ft.



WATER CONTENT Percent of Dry Weight

DISTRIBUTION: Morrison-Knudsen Engineers, Inc.

1990 BORING GRAIN SIZE CURVES

Chen-Northern, Inc.

GRAIN SIZE DISTRIBUTION CURVE

Project: Montanore Project - Libby, MT

Location: DH-23, 60.0' - 61.5'

Classification SILT

Moisture Content 23 %

Sample No. 45117

Job No. 90-207

Date October 1990

Plasticity Index Non-Plastic %

$$\text{Coefficient of Uniformity} = C_U = \frac{D_{60}}{D_{10}} =$$

U.S. Standard Sieve Opening in inches

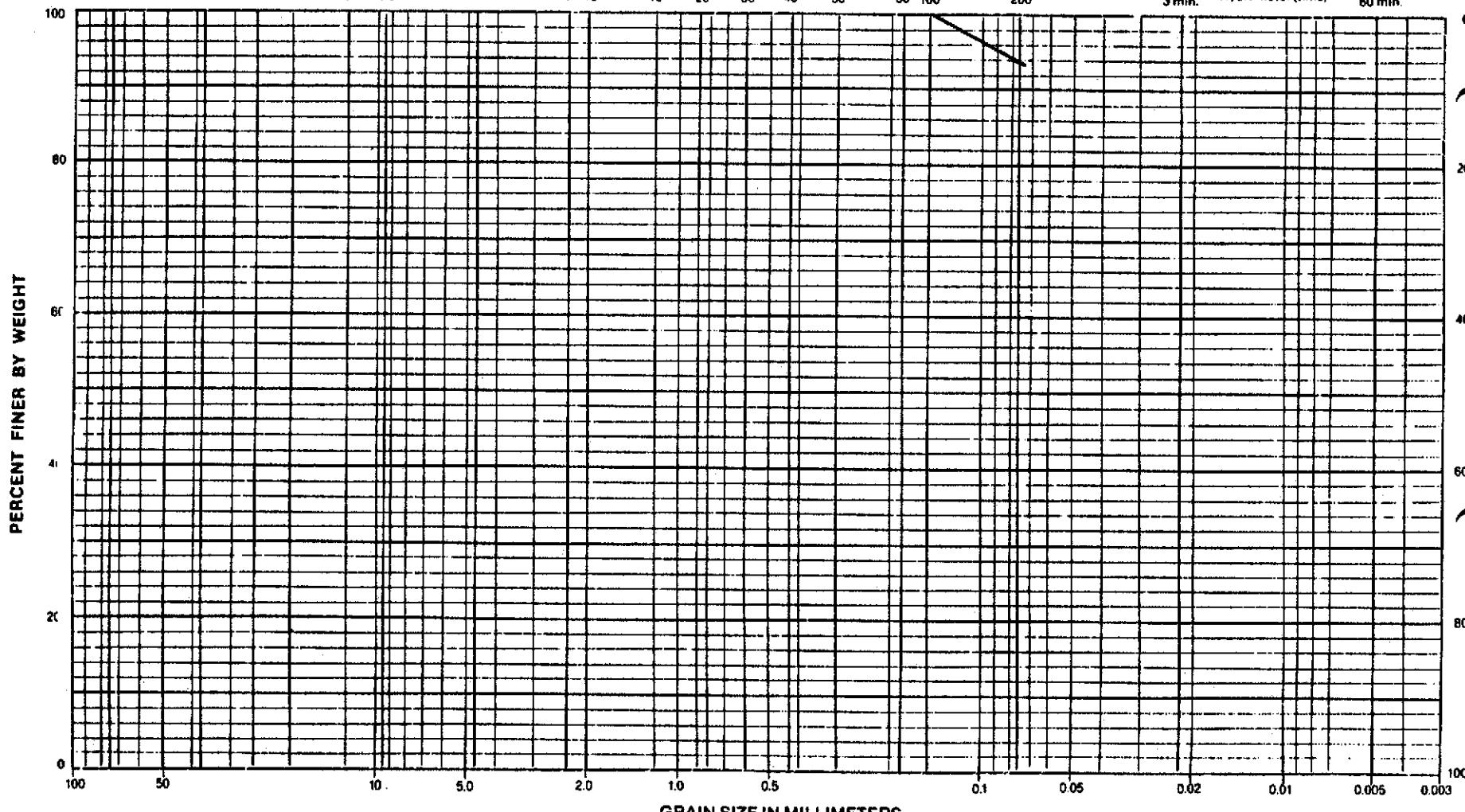
3" 2" 1½" 1" ¾" ½" 3/8" 4

$$\text{Coefficient of Curvature} = C_Z = \frac{(D_{30})^2}{D_{10} \times D_{60}} =$$

U.S. Standard Sieve Numbers

8 10 15 20 30 40 50 80 100 200

3 min. Hydrometer (time) 60 min.



Gravel		Sand			Fines		
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay	

Chen-Northern, Inc.

GRAIN SIZE DISTRIBUTION CURVE

Project: Montanore Project - Libby, MT

Location: DH-28, 10.0' - 29.5'

Classification Silty Clayey GRAVEL with Sand

Moisture Content -- %

Liquid Limit 24 %

Sample No. 45407A

Job No. 90-207

Date October 1990

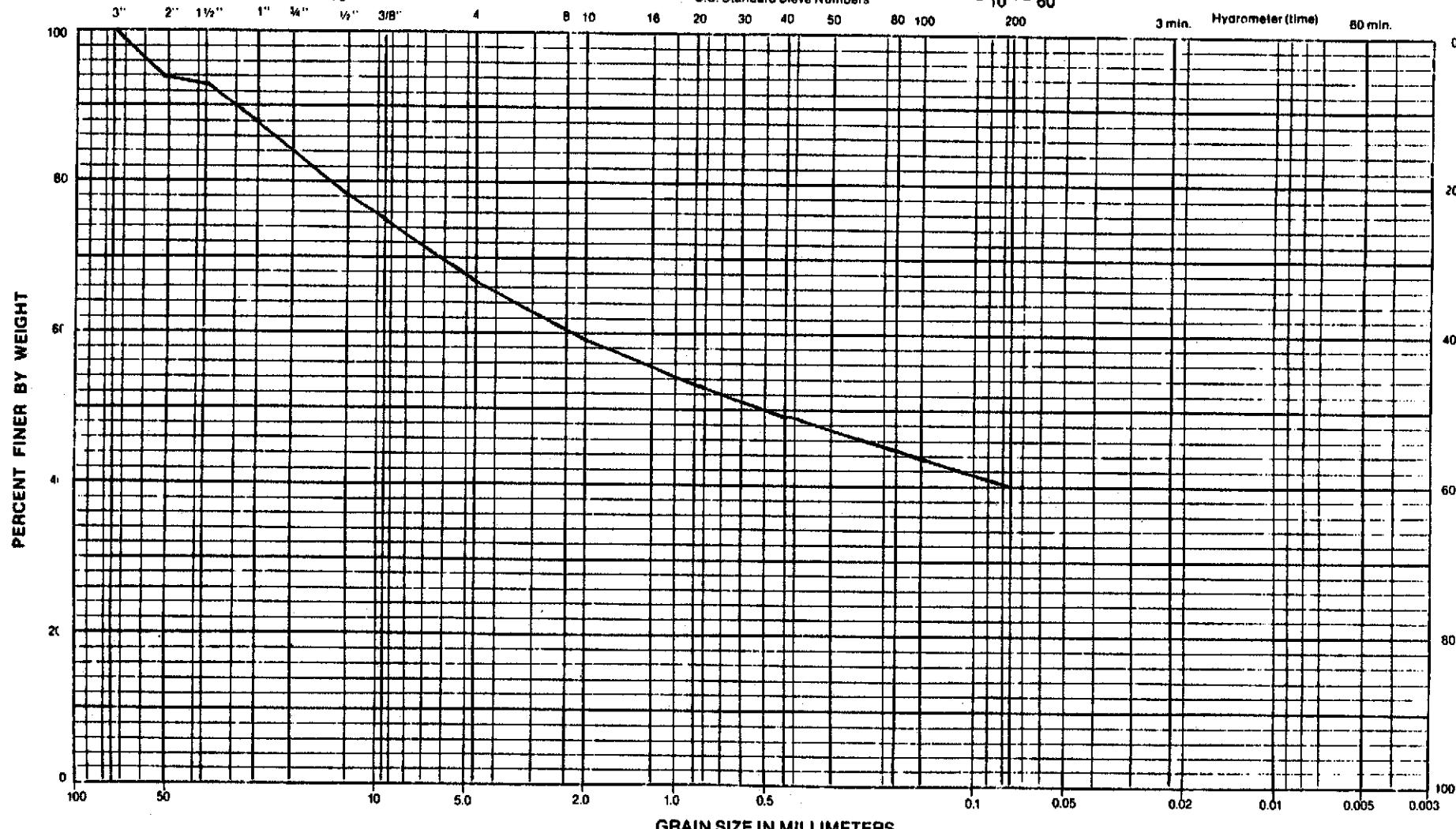
Plasticity Index 6 %

$$\text{Coefficient of Uniformity} = C_U = \frac{D_{60}}{D_{10}} =$$

U.S. Standard Sieve Opening in Inches

$$\text{Coefficient of Curvature} = C_Z = \frac{(D_{30})^2}{D_{10} \times D_{60}} =$$

U.S. Standard Sieve Numbers



Gravel		Sand			Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

Chen-Northern, Inc.

Project: Montanore Project - Libby, MT

Location: DH-29, 29.5' - 45.0'

Classification Clayey SAND with Gravel

Moisture Content _____ %

Liquid Limit -- %

Sample No. 45407B

Job No. 90-207

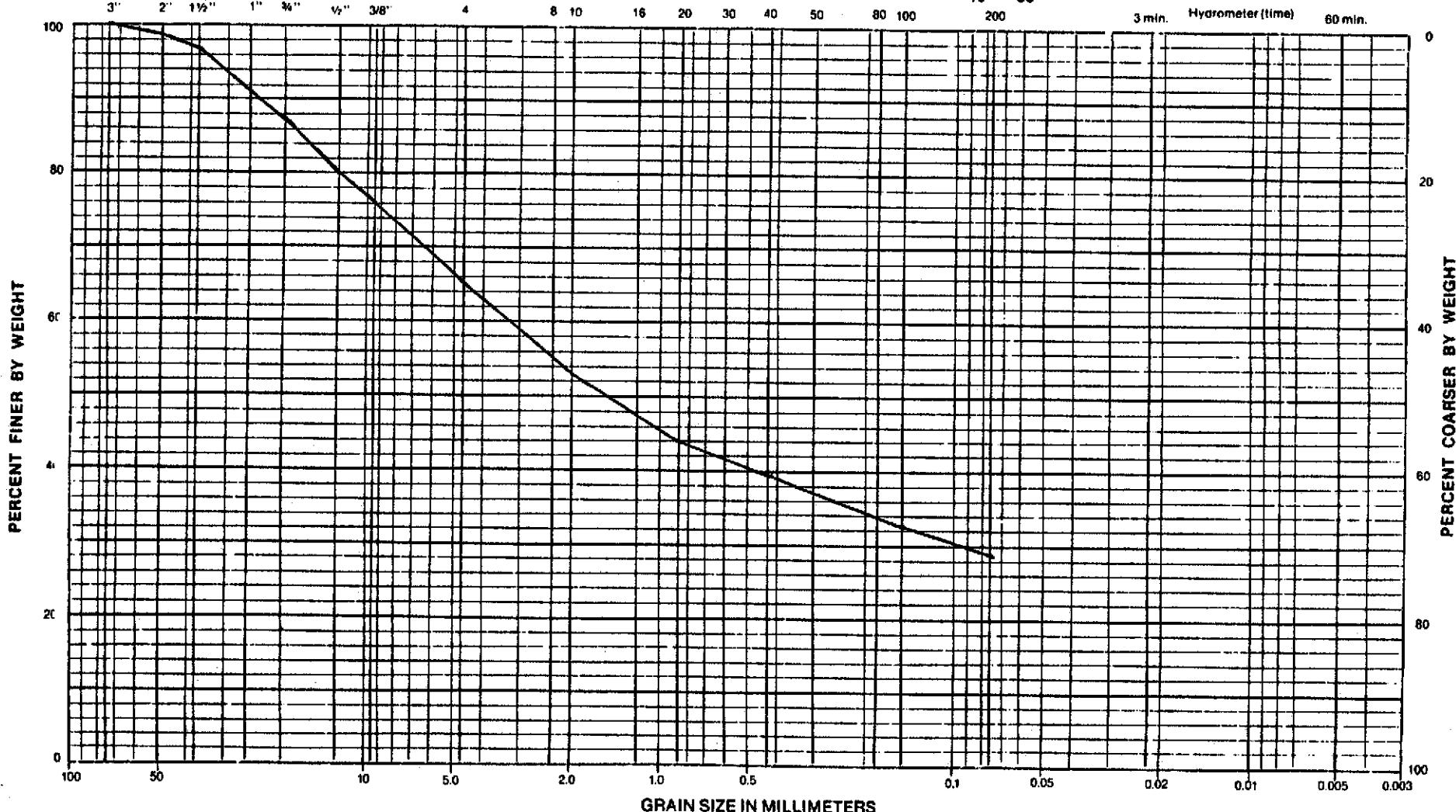
Date October 1990

$$\text{Coefficient of Uniformity} = C_U = \frac{D_{60}}{D_{10}} = \underline{\hspace{2cm}}$$

U.S. Standard Sieve Opening in Inches

U.S. Standard Sieve Opening in Inches

U.S. Standard Sieve Opening in Inches



Gravel		Sand			Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

Chen-Northern, Inc.

GRAIN SIZE DISTRIBUTION CURVE

Project: Montanore Project - Libby, MT

Location: DH-30, 5.0' - 13.5'

Classification Clayey GRAVEL with Sand

Moisture Content -- %

$$\text{Coefficient of Uniformity} = C_U = \frac{D_{60}}{D_{10}} =$$

U.S. Standard Sieve Opening in Inches

3"	2"	1 1/2"	1"	5/8"	1/2"	3/8"
----	----	--------	----	------	------	------

Liquid Limit 30 %

Sample No. 45408

Job No. 90-207

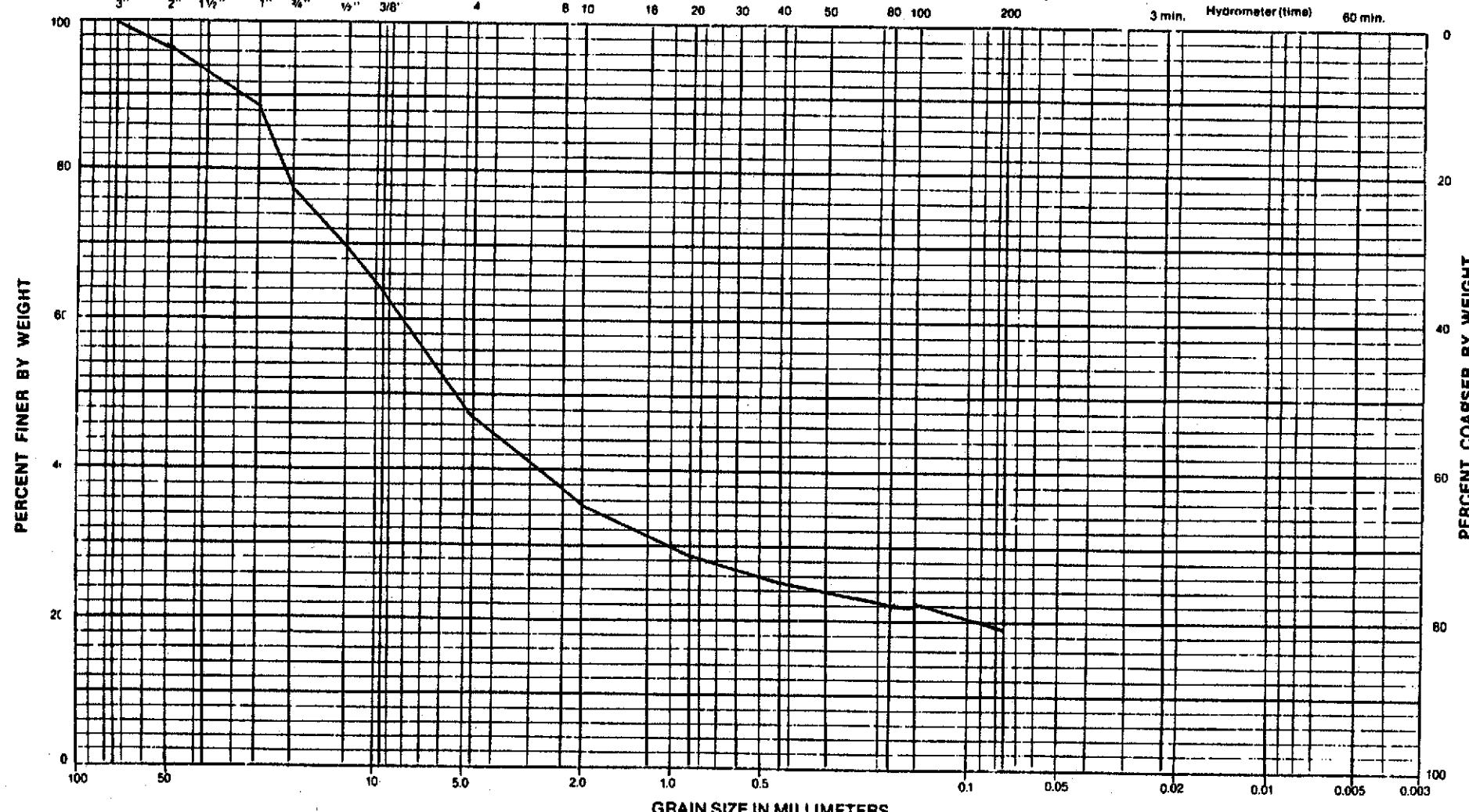
Date October 1990

Plasticity Index 8 %

$$\text{Coefficient of Curvature} = C_Z = \frac{(D_{30})^2}{D_{10} \times D_{60}} =$$

U.S. Standard Sieve Numbers

8	10	16	20	30	40	50	80	100	200
---	----	----	----	----	----	----	----	-----	-----



Gravel		Sand			Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

Chen-Northern, Inc.

GRAIN SIZE DISTRIBUTION CURVE

Project: Montanore Project, Libby, MT

Location: DH-32 23' - 25'

Classification Silty Clayey GRAVEL w/Sand

Moisture Content 16 %

Liquid Limit 22 %

Sample No. 45423

Job No. 90-207

Date Nov. 1990

Plasticity Index 5 %

$$\text{Coefficient of Uniformity} = C_U = \frac{D_{60}}{D_{10}} =$$

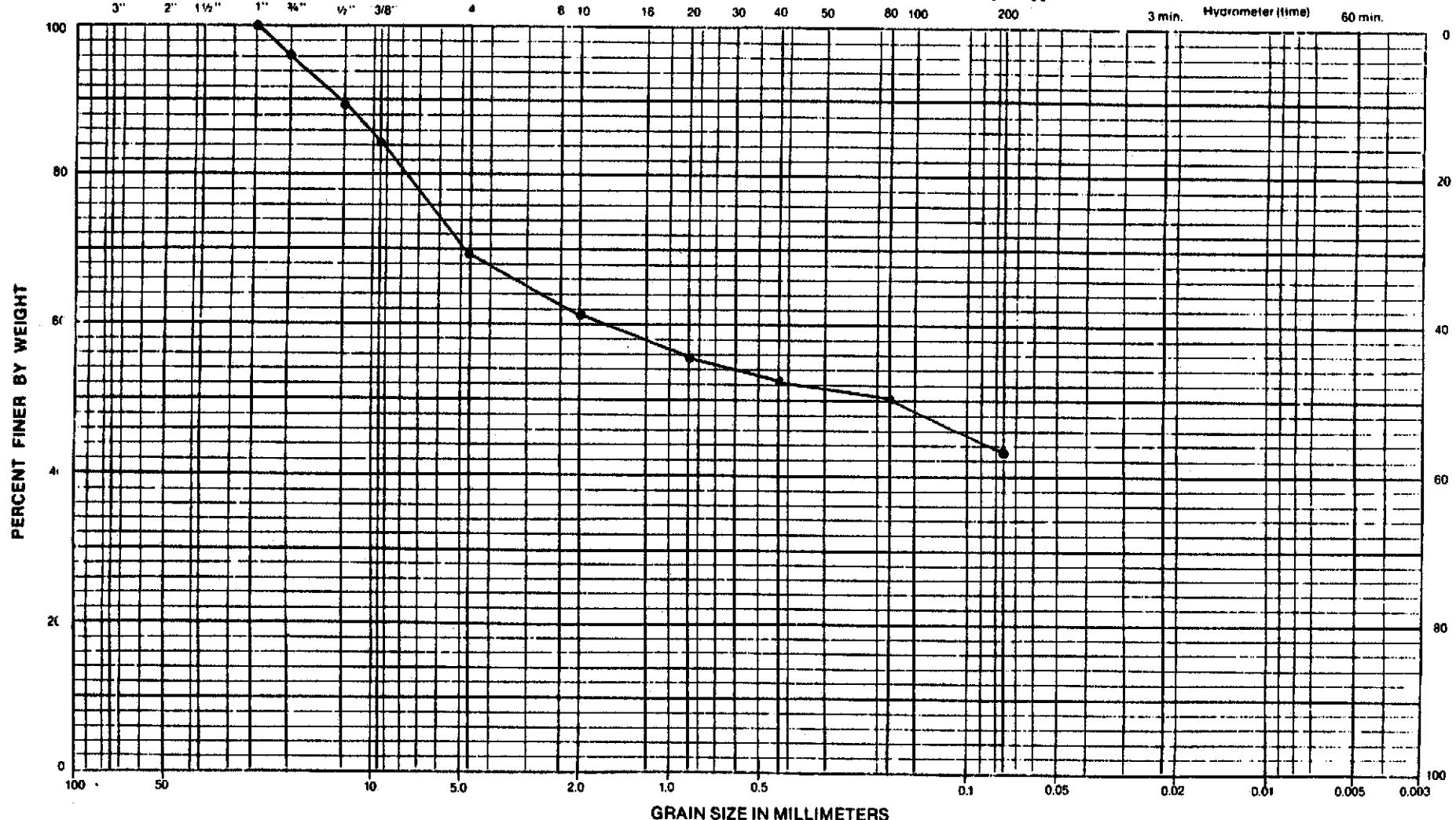
U.S. Standard Sieve Opening in Inches

3"	2"	1 1/2"	1"	5/8"	3/8"	4
----	----	--------	----	------	------	---

$$\text{Coefficient of Curvature} = C_Z = \frac{(D_{30})^2}{D_{10} \times D_{60}} =$$

U.S. Standard Sieve Numbers

6	10	16	20	30	40	50	80	100	200
---	----	----	----	----	----	----	----	-----	-----



Gravel		Sand			Fines	
Coarse	Fine	Coarse	Medium	Fine	Slit	Clay

Chen-Northern, Inc.

GRAIN SIZE DISTRIBUTION CURVE

Project: Montanore Project - Libby, MT

Location: DH-38, 33.5' - 34.2'

Classification Silty CLAY

Moisture Content 30 %

Sample No. 45118

Job No. 90-207

Date October 1990

Plasticity Index 4 %

$$\text{Coefficient of Uniformity} = C_U = \frac{D_{60}}{D_{10}} =$$

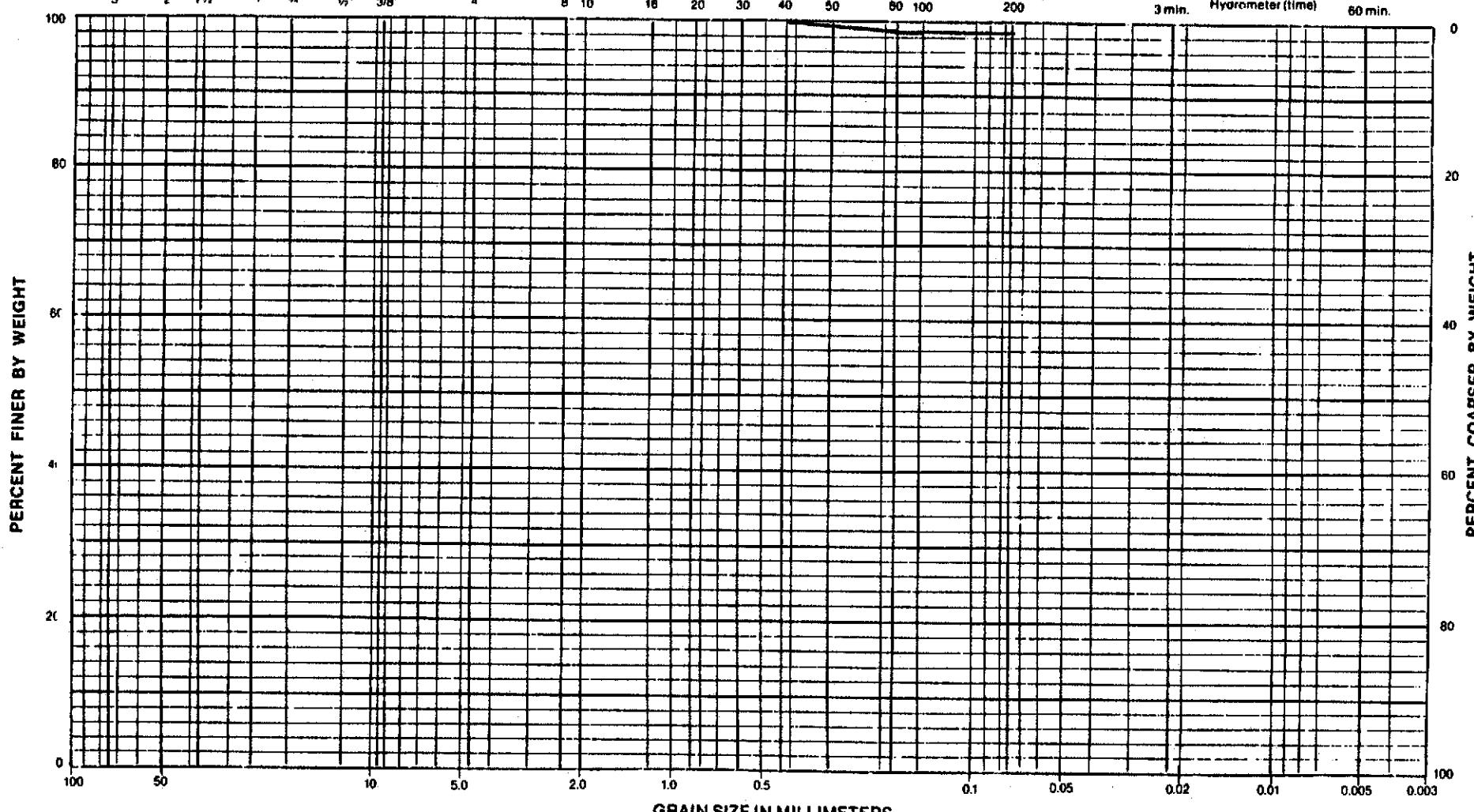
U.S. Standard Sieve Opening in Inches

3"	2"	1 1/2"	1"	3/4"	1/2"	3/8"
----	----	--------	----	------	------	------

$$\text{Coefficient of Curvature} = C_Z = \frac{(D_{30})^2}{D_{10} \times D_{60}} =$$

U.S. Standard Sieve Numbers

4	8	10	16	20	30	40	50	80	100	200
---	---	----	----	----	----	----	----	----	-----	-----



Gravel		Sand			Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

Chen-Northern, Inc.

GRAIN SIZE DISTRIBUTION CURVE

Project: Montanore Project - Libby, MT

Location: DH-44, HS-1, 14.3' - 15.0'

Classification Sandy Lean CLAY

Moisture Content 17 %

Sample No. 45341

Job No. 90-207

Date October 1990

Plasticity Index 6 %

$$\text{Coefficient of Uniformity} = C_U = \frac{D_{60}}{D_{10}} =$$

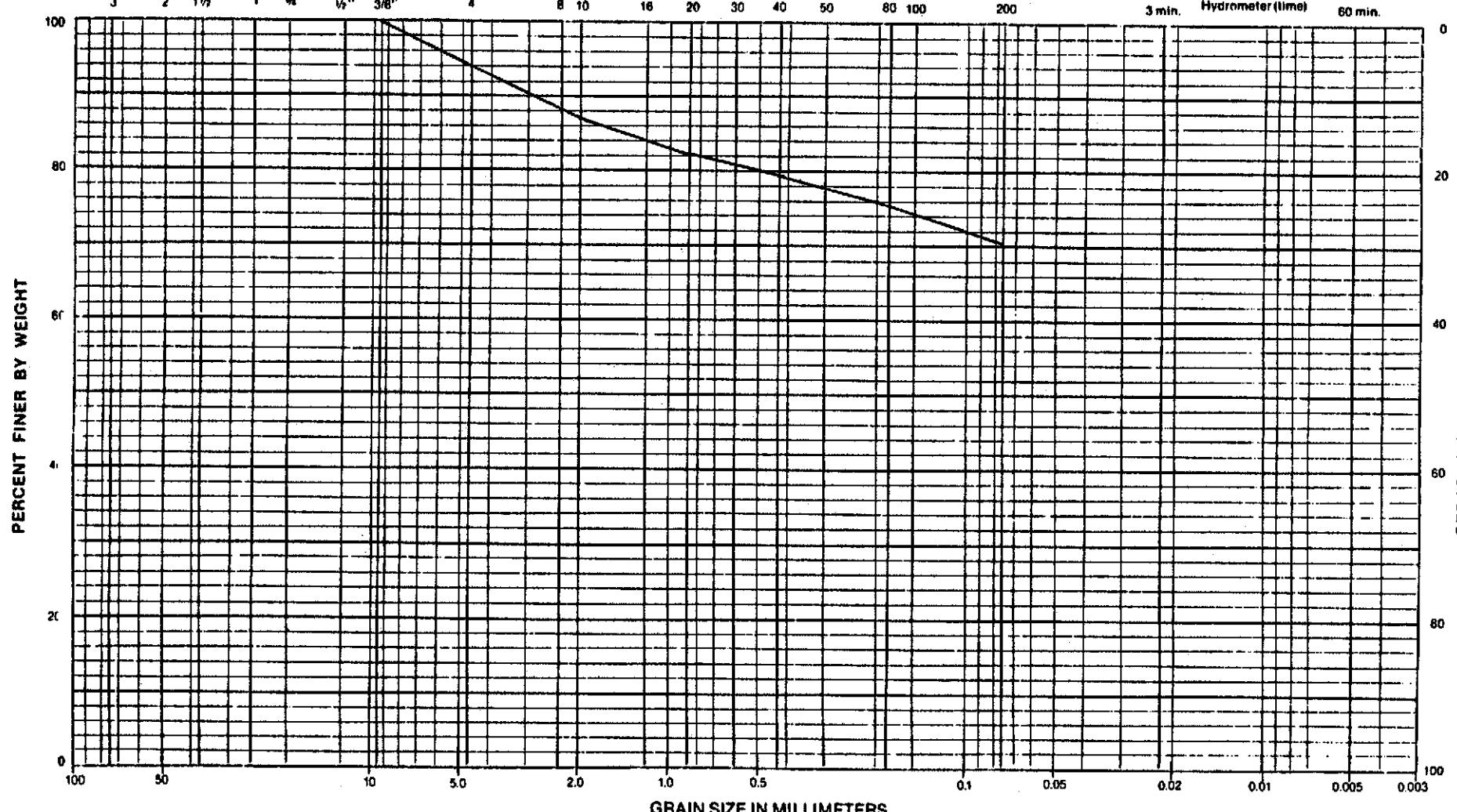
U.S. Standard Sieve Opening in Inches

3"	2"	1 1/2"	1"	5/8"	1/2"	3/8"
----	----	--------	----	------	------	------

$$\text{Coefficient of Curvature} = C_Z = \frac{(D_{30})^2}{D_{10} \times D_{60}} =$$

U.S. Standard Sieve Numbers

8	10	16	20	30	40	50	80	100	200
---	----	----	----	----	----	----	----	-----	-----



Gravel		Sand				Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay	

Chen-Northern, Inc.

Project: Montanore Project - Libby, MT

Location: DH-44, 26.5' - 27.0'

Classification Lean CLAY

Moisture Content 21 %

GRAIN SIZE DISTRIBUTION CURVE

Sample No. 45119

Job No. 90-207

Date October 1990

Liquid Limit -- %

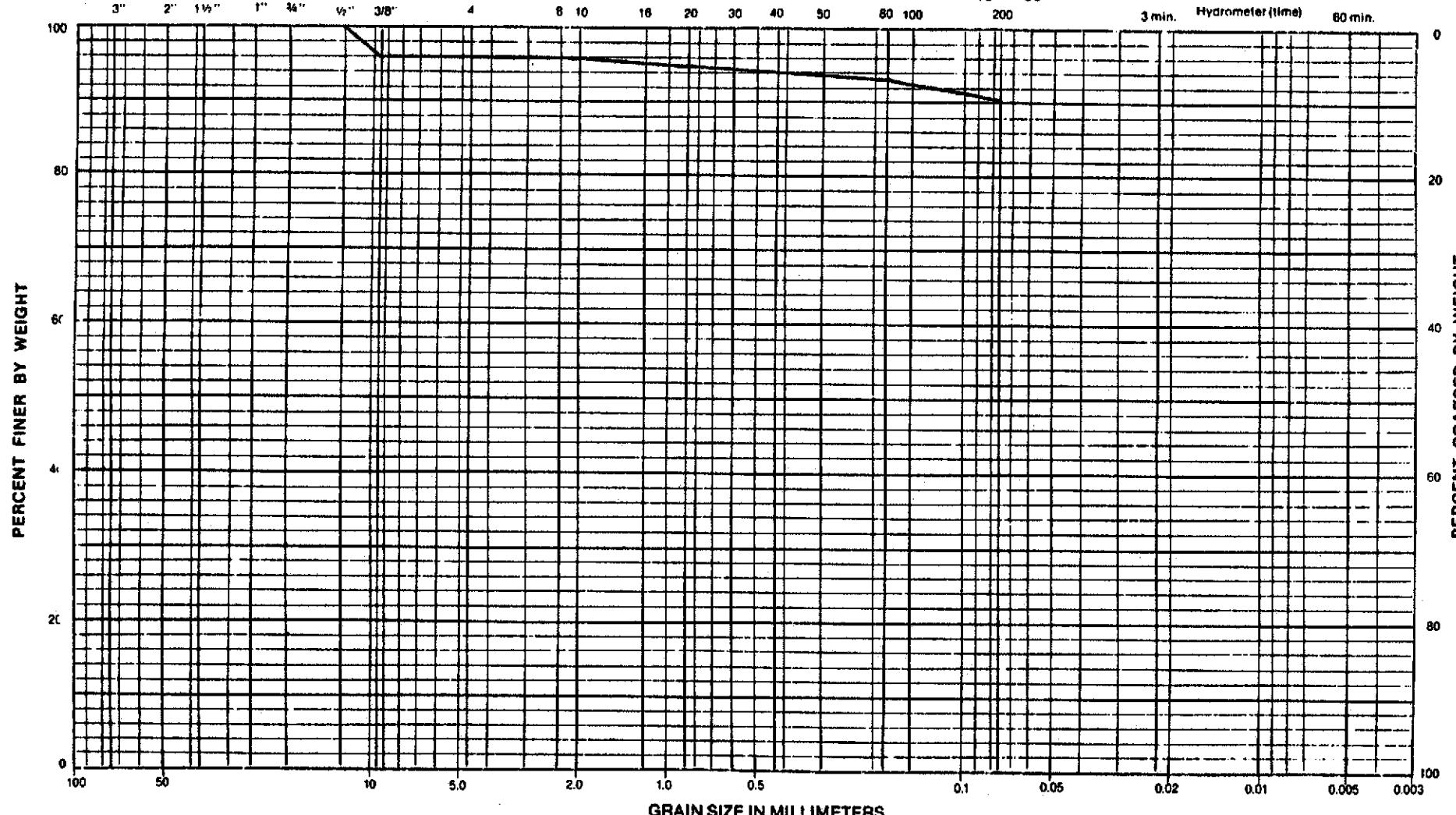
Plasticity Index -- %

$$\text{Coefficient of Uniformity} = C_U = \frac{D_{60}}{D_{10}} = \text{_____}$$

U.S. Standard Sieve Opening in Inches

$$\text{Coefficient of Curvature} = C_Z = \frac{(D_{30})^2}{D_{10} \times D_{60}} = \text{_____}$$

U.S. Standard Sieve Numbers



Gravel		Sand			Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

Chen-Northern, Inc.

GRAIN SIZE DISTRIBUTION CURVE

Project: Montanore Project - Libby, MT

Location: DH-45, 22.6' - 23.2'

Classification Lean CLAY

Moisture Content -- %

Sample No. 45120

Job No. 90-207

Date October 1990

Liquid Limit -- %

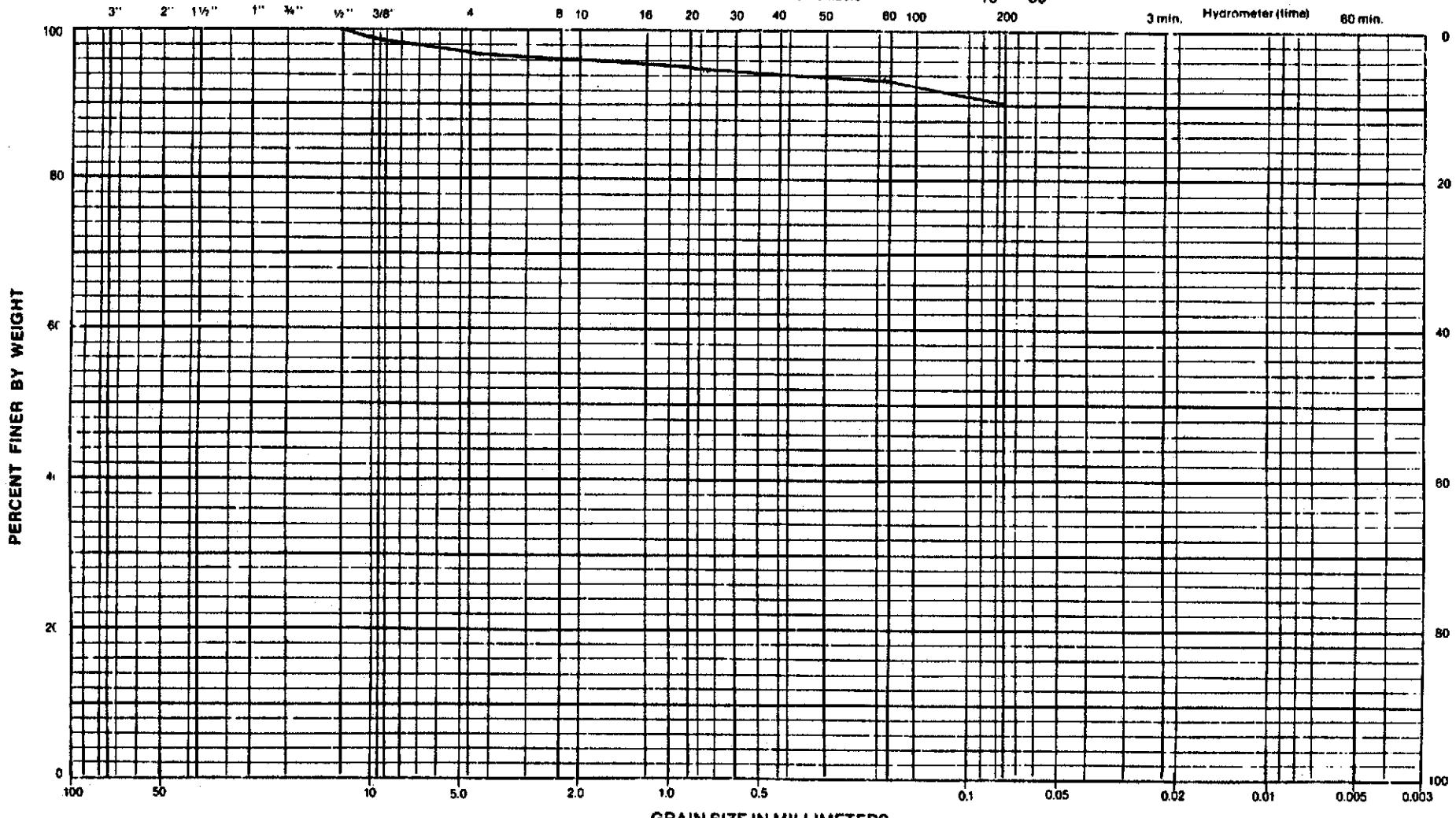
Plasticity Index -- %

$$\text{Coefficient of Uniformity} = C_U = \frac{D_{60}}{D_{10}} =$$

U.S. Standard Sieve Opening in Inches

$$\text{Coefficient of Curvature} = C_Z = \frac{(D_{30})^2}{D_{10} \times D_{60}} =$$

U.S. Standard Sieve Numbers



Gravel		Sand			Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

Chen-Northern, Inc.

GRAIN SIZE DISTRIBUTION CURVE

Project: Montanore Project, Libby, MT

Location: DH-49, 17.0' - 19.0'

Classification Clayey SAND

Moisture Content 19 %

Sample No. 45984

Job No. 90-207

Date November 1990

Plasticity Index 8 %

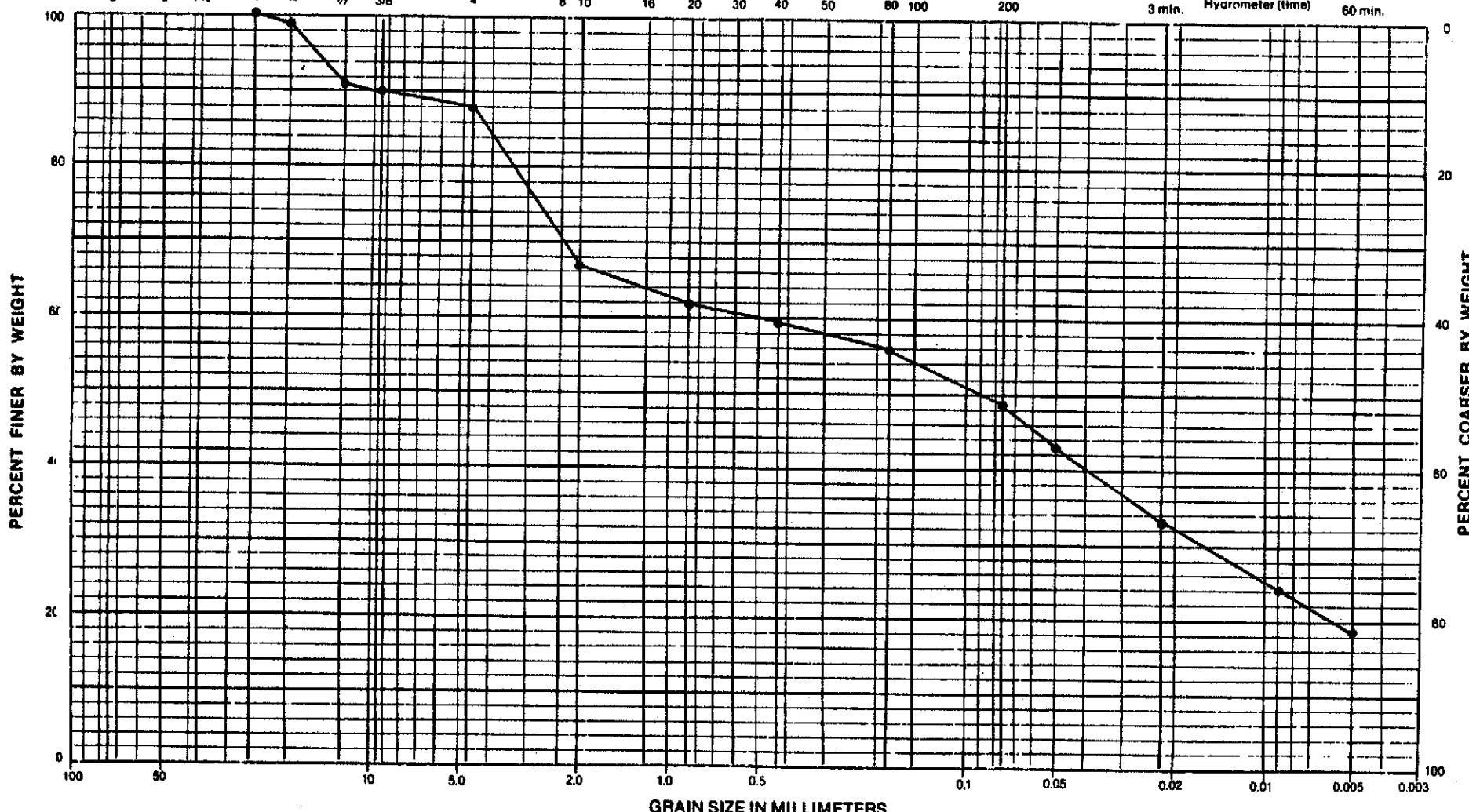
Liquid Limit 26 %

$$\text{Coefficient of Uniformity} = C_U = \frac{D_{60}}{D_{10}} =$$

U.S. Standard Sieve Opening in Inches
3" 2" 1½" 1" ¼" ½" 3/8"

$$\text{Coefficient of Curvature} = C_Z = \frac{(D_{30})^2}{D_{10} \times D_{60}} =$$

U.S. Standard Sieve Numbers
100 80 60 50 40 30 20 16 10 8 4 2



Gravel		Sand			Fines		
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay	

Chen-Northern, Inc.

GRAIN SIZE DISTRIBUTION CURVE

Project: Montanore Project, Libby, MT

Location: DH-51 7.0' - 9.0'

Classification Gravelly Silty CLAY w/Sand

Moisture Content 23 %

Sample No. 45985

Job No. 90-207

Date Nov. 1990

Plasticity Index --- %

$$\text{Coefficient of Uniformity} = C_U = \frac{D_{60}}{D_{10}} =$$

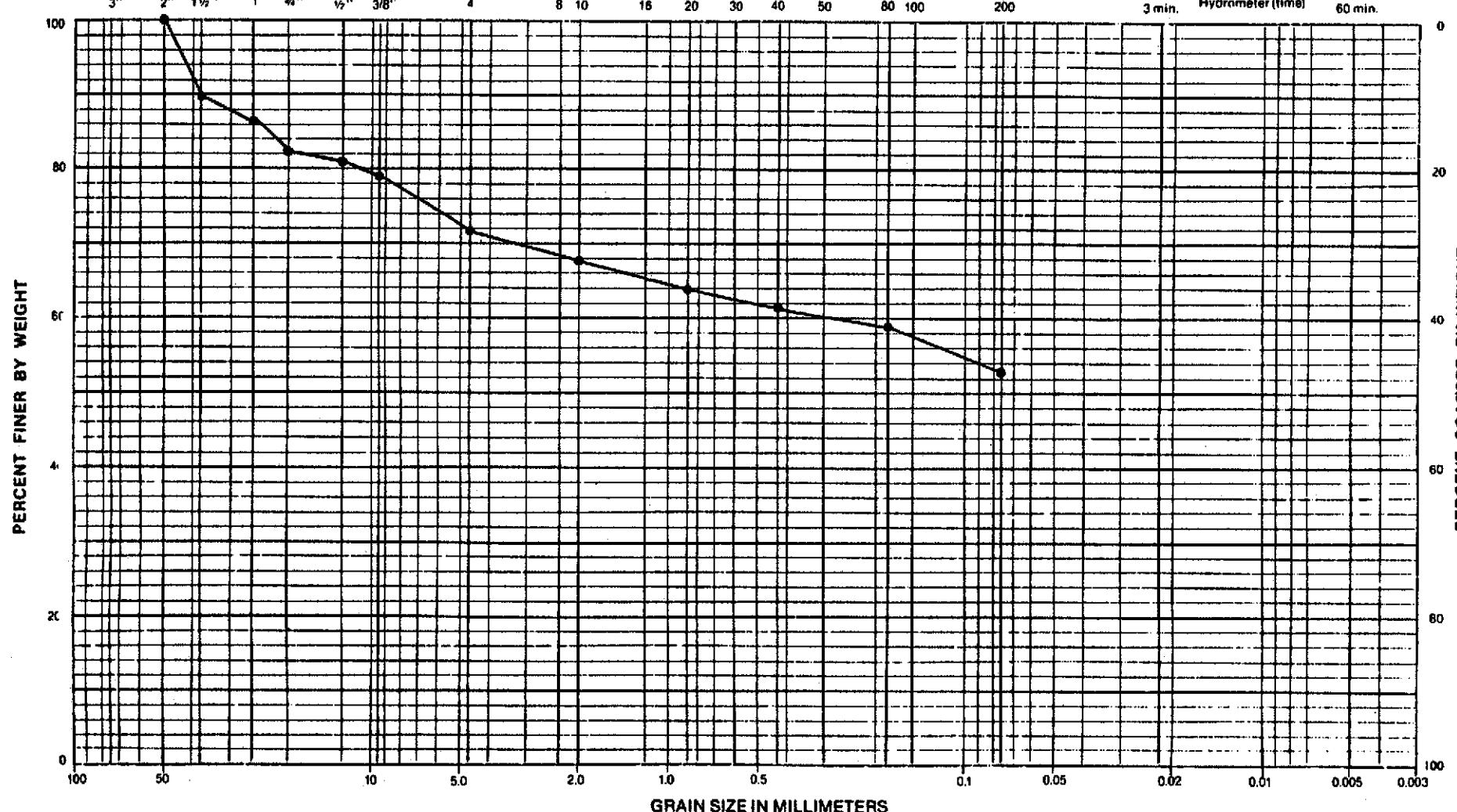
U.S. Standard Sieve Opening in Inches

3"	2"	1 1/2"	1"	5/8"	1/2"	3/8"
----	----	--------	----	------	------	------

$$\text{Coefficient of Curvature} = C_Z = \frac{(D_{30})^2}{D_{10} \times D_{60}} =$$

U.S. Standard Sieve Numbers

8	10	15	20	30	40	50	80	100	200
---	----	----	----	----	----	----	----	-----	-----



Gravel		Sand			Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

1990 TEST PIT GRAIN SIZE CURVES

Chen-Northern, Inc.

GRAIN SIZE DISTRIBUTION CURVE

Project: Montanore Project - Libby, MT

Location: TP-201, 4.0' - 6.0'

Classification Silty Clayey GRAVEL with Sand

Moisture Content 12 %

Liquid Limit 22 %

Sample No. 45347

Job No. 90-207

Date October 1990

Plasticity Index 5 %

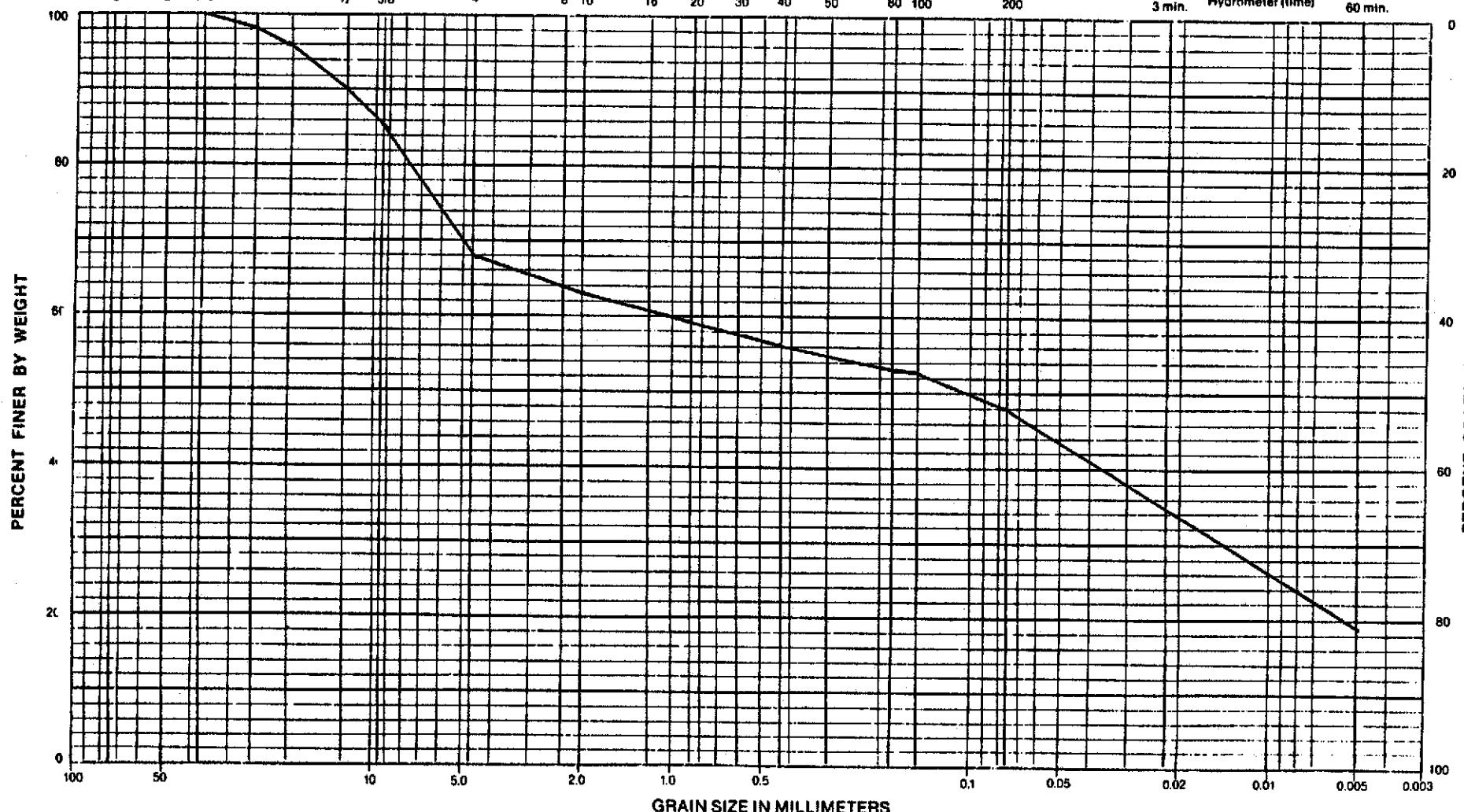
$$\text{Coefficient of Uniformity} = C_U = \frac{D_{60}}{D_{10}} =$$

U.S. Standard Sieve Opening in Inches

$$3'' \quad 2'' \quad 1\frac{1}{2}'' \quad 1'' \quad \frac{3}{4}'' \quad \frac{1}{2}'' \quad \frac{3}{8}'' \quad 4 \quad 8 \quad 10 \quad 16 \quad 20 \quad 30 \quad 40 \quad 50 \quad 80 \quad 100 \quad 200 \quad 3 \text{ min.} \quad \text{Hydrometer (time)} \quad 60 \text{ min.}$$

$$\text{Coefficient of Curvature} = C_Z = \frac{(D_{30})^2}{D_{10} \times D_{60}} =$$

U.S. Standard Sieve Numbers



Gravel		Sand			Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

Chen-Northern, Inc.

GRAIN SIZE DISTRIBUTION CURVE

Project: Montanore Project - Libby, MT

Location: TP-203, 10.0' - 14.0'

Classification Clayey GRAVEL with Sand

Moisture Content 12 %

Sample No. 45350

Job No. 90-207

Date October 1990

$$\text{Coefficient of Uniformity} = C_U = \frac{D_{60}}{D_{10}} =$$

U.S. Standard Sieve Opening in Inches

3"	2"	1 1/2"	1"	3/4"	1/2"	3/8"	4
----	----	--------	----	------	------	------	---

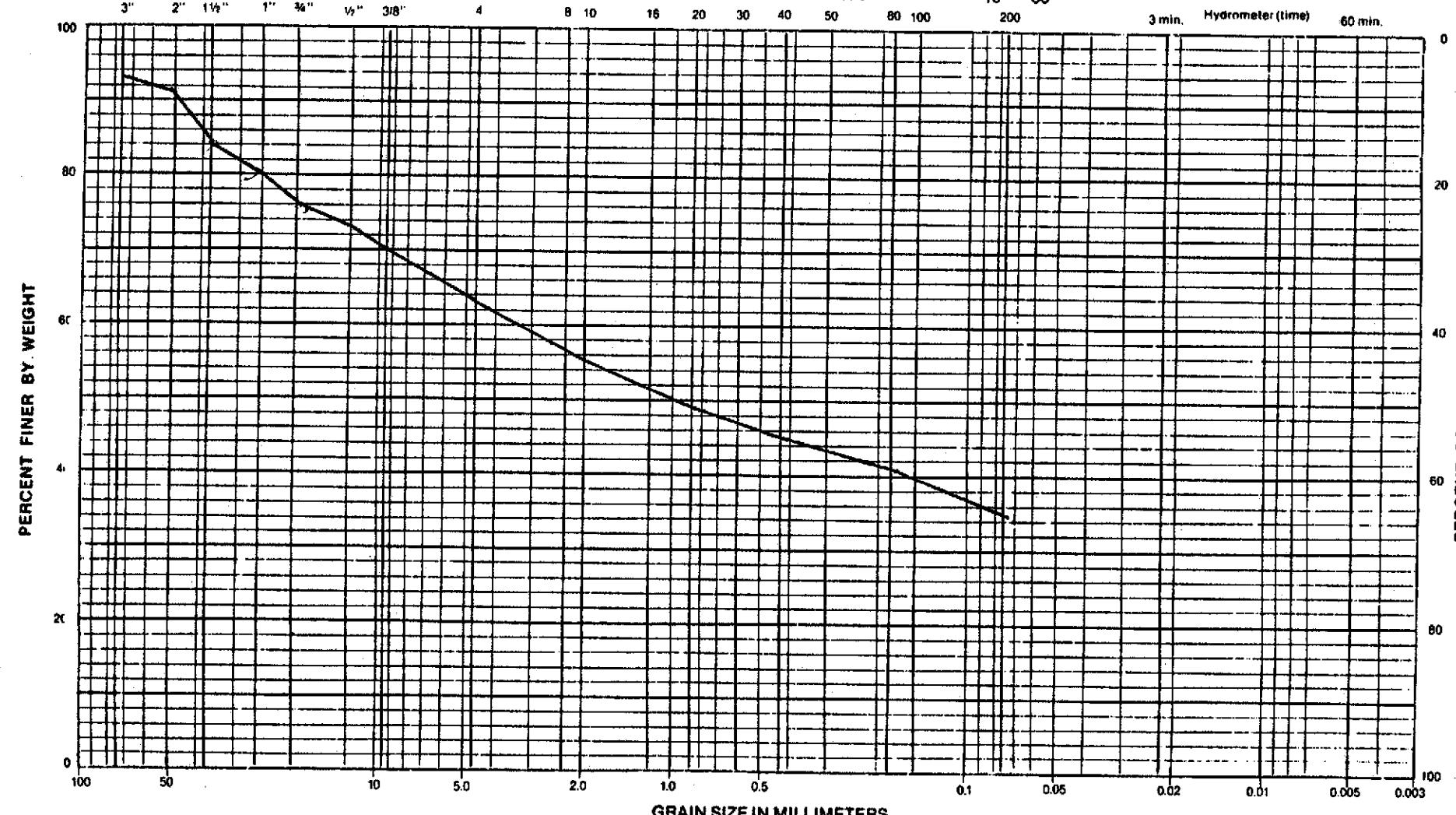
Liquid Limit -- %

Plasticity Index -- %

$$\text{Coefficient of Curvature} = C_Z = \frac{(D_{30})^2}{D_{10} \times D_{60}} =$$

U.S. Standard Sieve Numbers

8	10	16	20	30	40	50	80	100	200
---	----	----	----	----	----	----	----	-----	-----



Gravel		Sand			Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

Chen-Northern, Inc.

GRAIN SIZE DISTRIBUTION CURVE

Project: Montanore Project - Libby, MT

Location: TP-204, 2.0' - 10.0'

Classification Clayey GRAVEL with Sand

Moisture Content 11 %

Sample No. 45351

Job No. 90-207

Date October 1990

Liquid Limit -- %

Plasticity Index -- %

$$\text{Coefficient of Uniformity} = C_U = \frac{D_{60}}{D_{10}} = \text{_____}$$

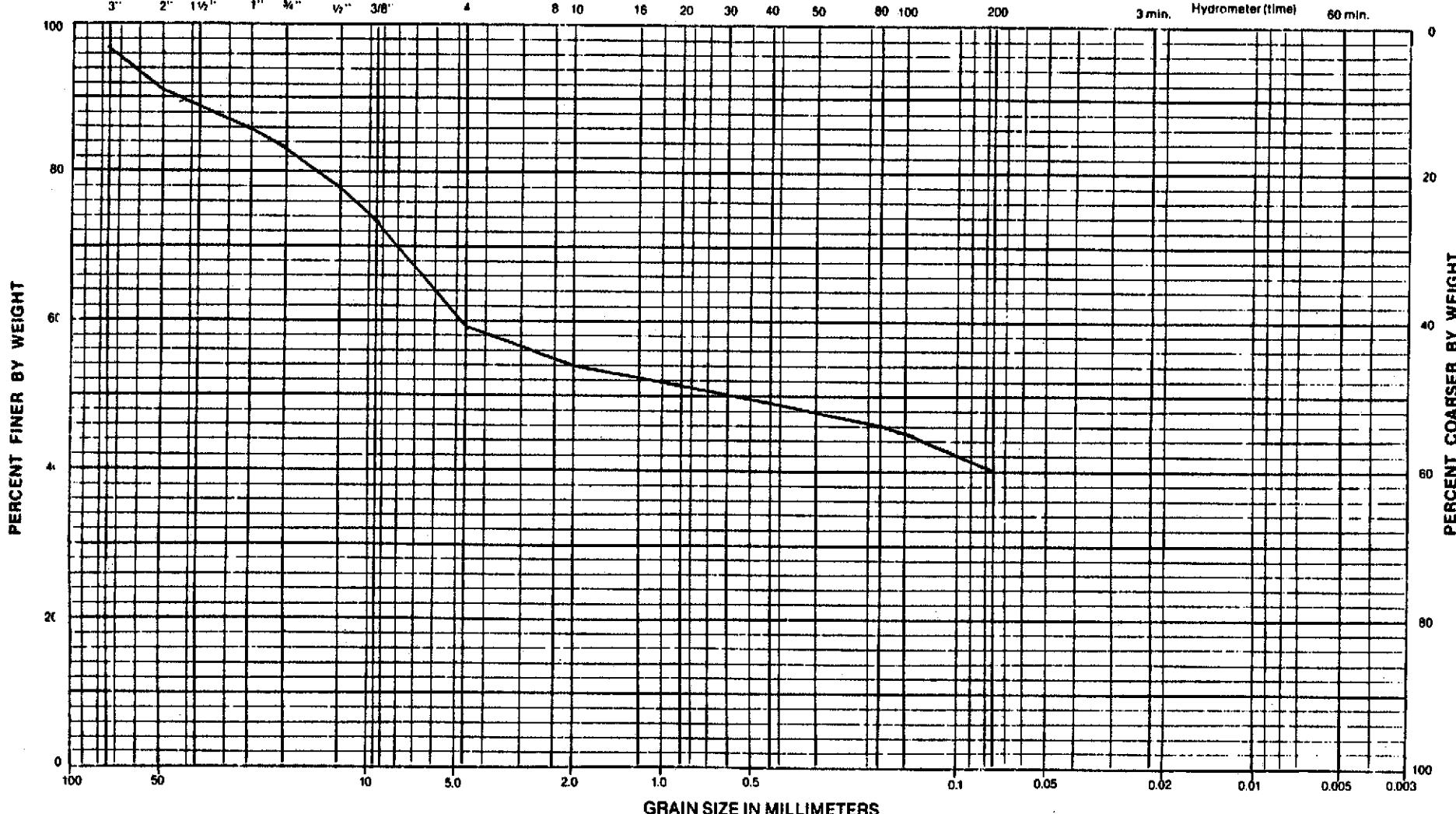
U.S. Standard Sieve Opening in Inches

3"	2"	1 1/2"	1"	3/4"	5/8"	3/8"	4
----	----	--------	----	------	------	------	---

$$\text{Coefficient of Curvature} = C_Z = \frac{(D_{30})^2}{D_{10} \times D_{60}} = \text{_____}$$

U.S. Standard Sieve Numbers

8	10	16	20	30	40	50	80	100	200
---	----	----	----	----	----	----	----	-----	-----



Gravel		Sand			Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

Chen-Northern, Inc.

Project: Montanore Project - Libby, MT

Location: TP-205, 2.0' - 5.0'

Classification Clayey GRAVEL with Sand

Moisture Content 11 %

Sample No. 45352

Job No. 90-207

Date October 1990

GRAIN SIZE DISTRIBUTION CURVE

Liquid Limit -- %

Plasticity Index -- %

$$\text{Coefficient of Uniformity} = C_U = \frac{D_{60}}{D_{10}} =$$

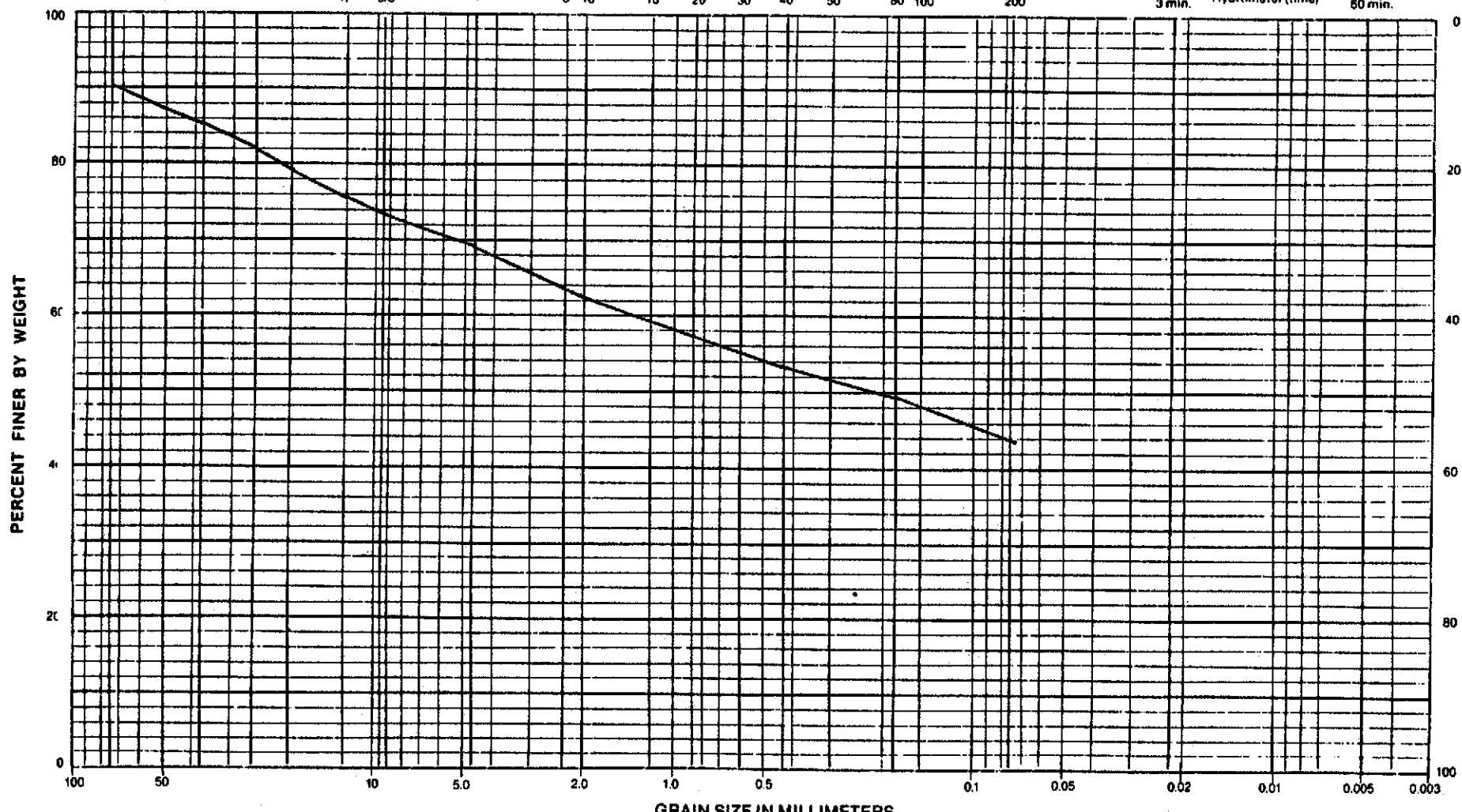
U.S. Standard Sieve Opening in Inches

3"	2"	1 1/2"	1"	3/4"	1/2"	3/8"	4
----	----	--------	----	------	------	------	---

$$\text{Coefficient of Curvature} = C_Z = \frac{(D_{30})^2}{D_{10} \times D_{60}} =$$

U.S. Standard Sieve Numbers

8	10	15	20	30	40	50	80	100	200
---	----	----	----	----	----	----	----	-----	-----



Gravel		Sand			Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

Chen-Northern, Inc.

GRAIN SIZE DISTRIBUTION CURVE

Project: Montanore Project - Libby, MT

Location: TP-207, 3.0' - 6.0'

Classification Clayey GRAVEL with Sand

Moisture Content 6 %

Liquid Limit 21 %

Sample No. 45355

Job No. 90-207

Date October 1990

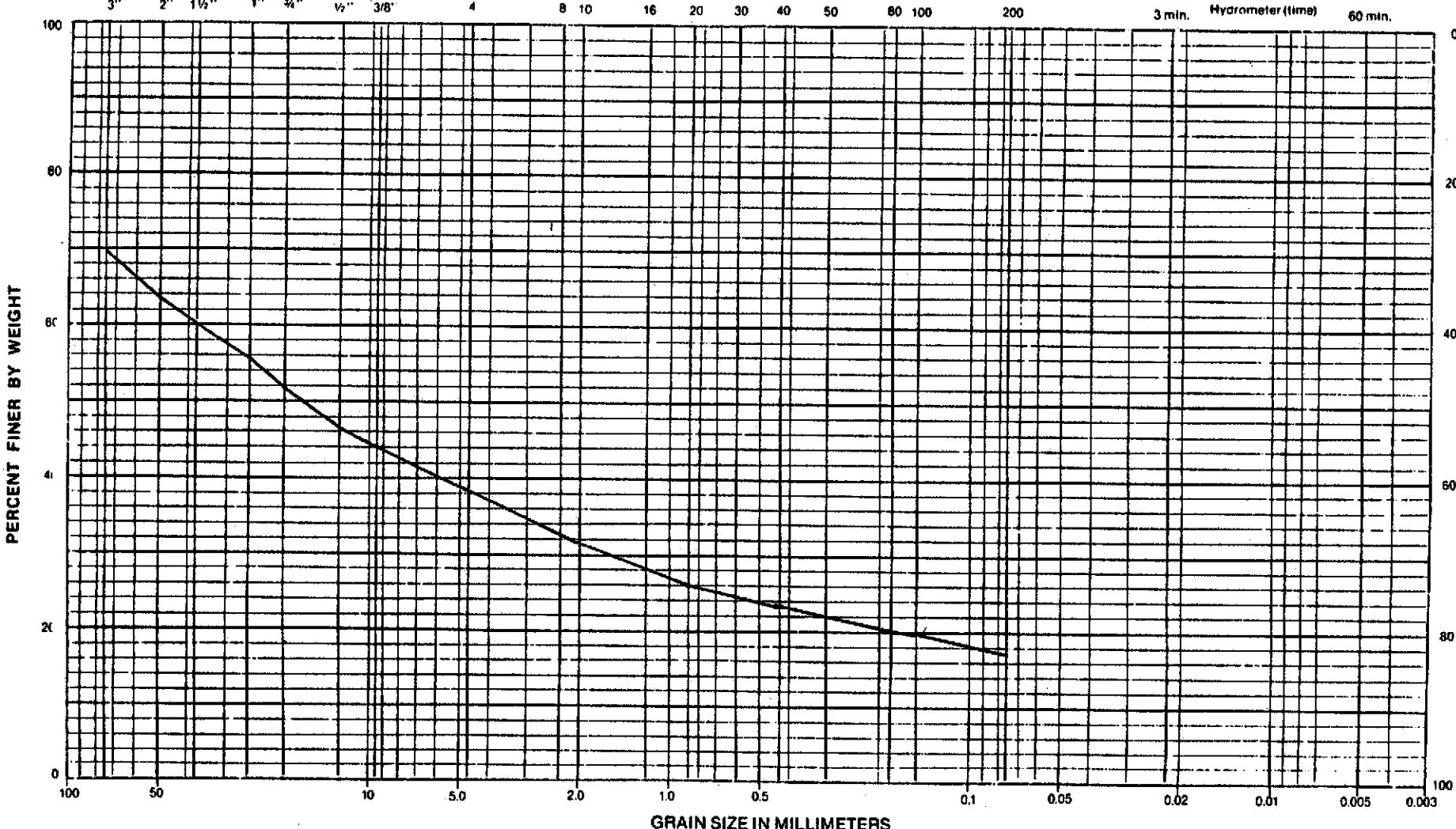
Plasticity Index 3 %

$$\text{Coefficient of Uniformity} = C_U = \frac{D_{60}}{D_{10}}$$

U.S. Standard Sieve Opening in Inches

$$\text{Coefficient of Curvature} = C_Z = \frac{(D_{30})^2}{D_{10} \times D_{60}}$$

U.S. Standard Sieve Numbers



Gravel		Sand			Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

Chen-Northern, Inc.

GRAIN SIZE DISTRIBUTION CURVE

Project: Montanore Project - Libby, MT

Location: TP-208, 1.0' - 3.0'

Classification Clayey GRAVEL with Sand

Moisture Content 6 %

Sample No. 45357

Job No. 90-207

Date October 1990

Liquid Limit -- %

Plasticity Index -- %

$$\text{Coefficient of Uniformity} = C_U = \frac{D_{60}}{D_{10}} = \text{_____}$$

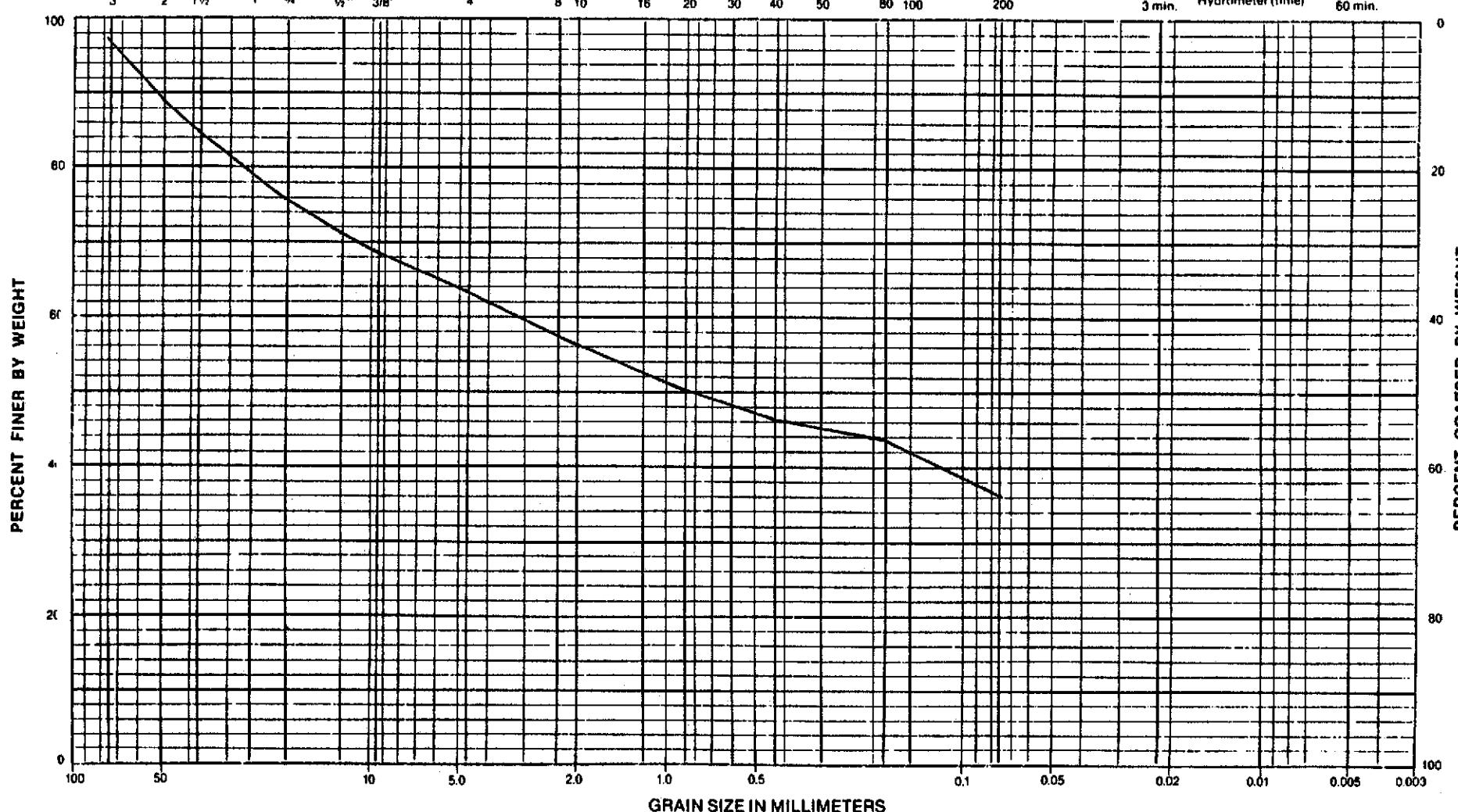
U.S. Standard Sieve Opening in Inches

3"	2"	1 1/2"	1"	5/8"	1/2"	3/8"	1/4"	1/8"	1/16"	1/32"	1/64"	1/128"	1/256"	1/512"	1/1024"
----	----	--------	----	------	------	------	------	------	-------	-------	-------	--------	--------	--------	---------

$$\text{Coefficient of Curvature} = C_Z = \frac{(D_{30})^2}{D_{10} \times D_{60}} = \text{_____}$$

U.S. Standard Sieve Numbers

8	10	16	20	30	40	50	80	100	200
---	----	----	----	----	----	----	----	-----	-----



Gravel		Sand			Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

Chen-Northern, Inc.

GRAIN SIZE DISTRIBUTION CURVE

Project: Montanore Project - Libby, MT

Location: TP-209, 4.0' - 9.5'

Classification Silty Clayey GRAVEL with Sand

Moisture Content 11 %

Sample No. 45359

Job No. 90-207

Date October 1990

Liquid Limit -- %

Plasticity Index -- %

$$\text{Coefficient of Uniformity} = C_U = \frac{D_{60}}{D_{10}} =$$

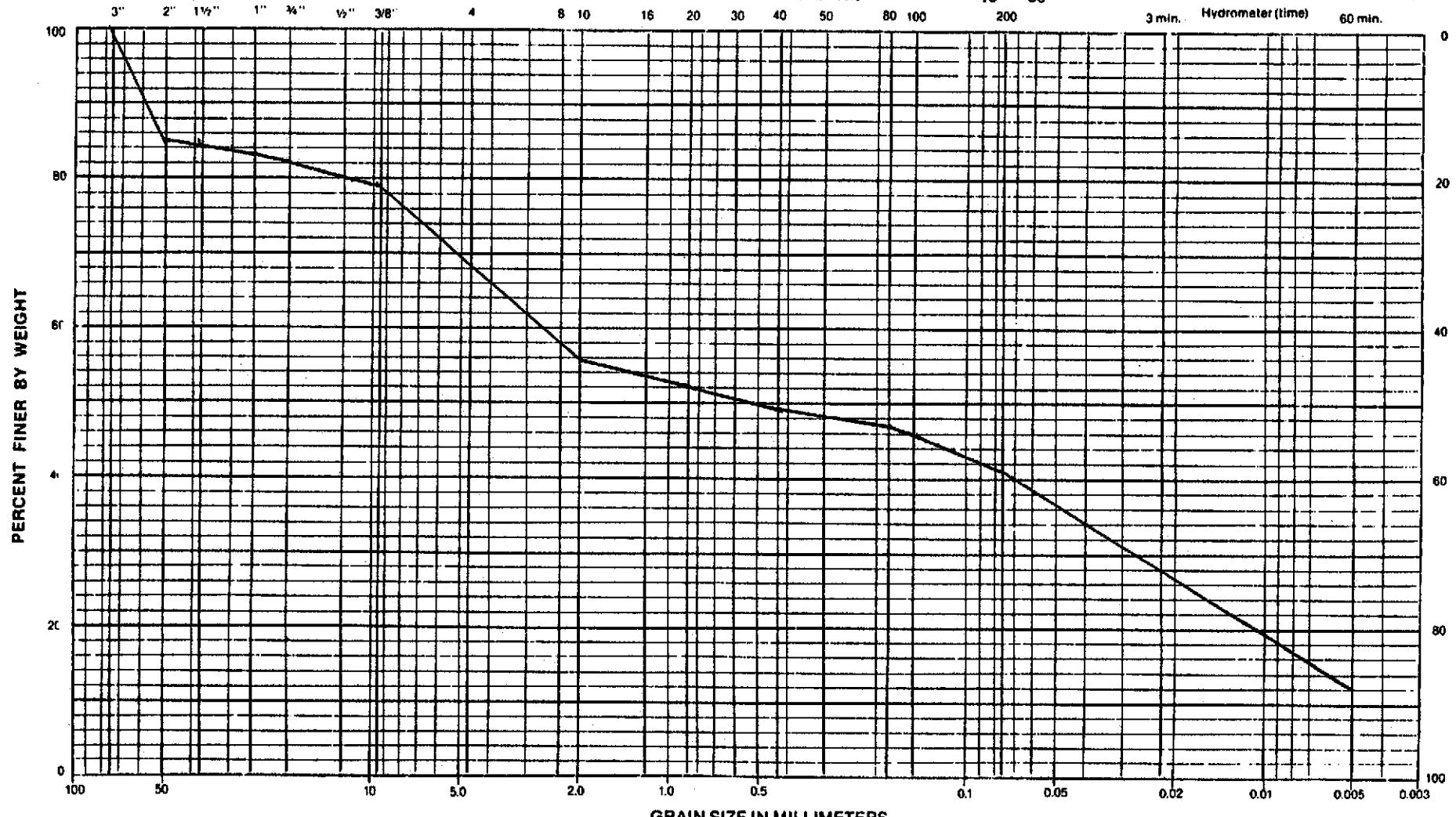
U.S. Standard Sieve Opening in inches

3"	2"	1 1/2"	1"	3/4"	1/2"	3/8"
----	----	--------	----	------	------	------

$$\text{Coefficient of Curvature} = C_Z = \frac{(D_{30})^2}{D_{10} \times D_{60}} =$$

U.S. Standard Sieve Numbers

8	10	16	20	30	40	50	80	100	200
---	----	----	----	----	----	----	----	-----	-----



Gravel		Sand			Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

Chen-Northern, Inc.

GRAIN SIZE DISTRIBUTION CURVE

Project: Montanore Project - Libby, MT

Location: TP-210, 1.0' - 4.0'

Classification Clayey GRAVEL with Sand

Moisture Content 8 %

Sample No. 45360

Job No. 90-207

Date October 1990

Plasticity Index -- %

$$\text{Coefficient of Uniformity} = C_U = \frac{D_{60}}{D_{10}} =$$

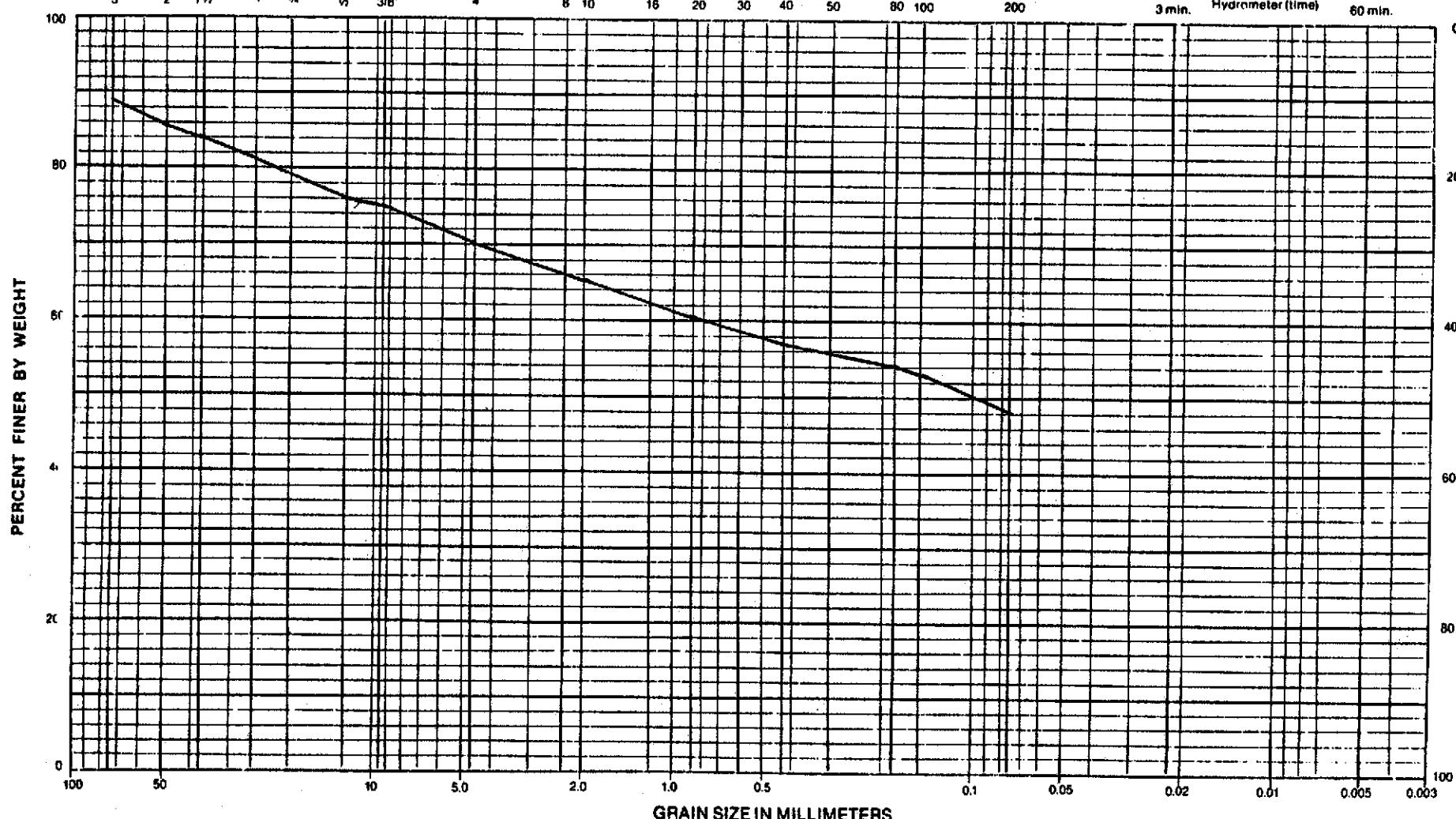
U.S. Standard Sieve Opening in Inches

3"	2"	1 1/2"	1"	5/8"	1/2"	3/8"	4"
----	----	--------	----	------	------	------	----

$$\text{Coefficient of Curvature} = C_Z = \frac{(D_{30})^2}{D_{10} \times D_{60}} =$$

U.S. Standard Sieve Numbers

8	10	16	20	30	40	50	80	100	200
---	----	----	----	----	----	----	----	-----	-----



Gravel		Sand			Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

Chen-Northern, Inc.

GRAIN SIZE DISTRIBUTION CURVE

Project: Montanore Project - Libby, MT

Location: TP-211, 4.0' - 9.0'

Classification Gravelly Lean CLAY with Sand

Moisture Content 16 %

Sample No. 45361

Job No. 90-207

Date October 1990

Plasticity Index 14 %

$$\text{Coefficient of Uniformity} = C_U = \frac{D_{60}}{D_{10}} =$$

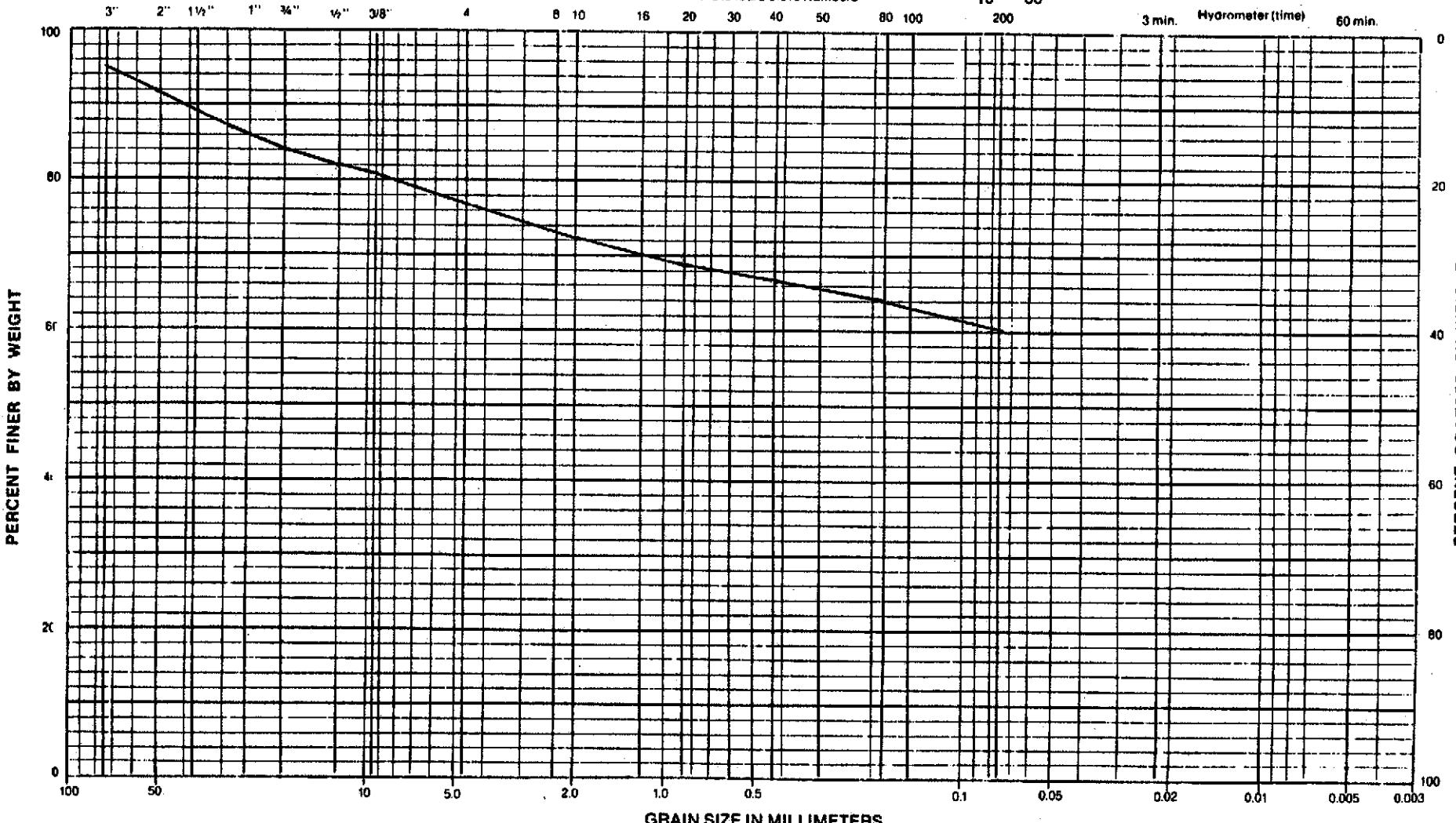
U.S. Standard Sieve Opening in Inches

3"	2"	1½"	1"	¾"	½"	⅜"	4
----	----	-----	----	----	----	----	---

$$\text{Coefficient of Curvature} = C_Z = \frac{(D_{30})^2}{D_{10} \times D_{60}} =$$

U.S. Standard Sieve Numbers

8	10	16	20	30	40	50	80	100	200
---	----	----	----	----	----	----	----	-----	-----



Gravel		Sand			Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

Chen-Northern, Inc.

GRAIN SIZE DISTRIBUTION CURVE

Project: Montanore Project - Libby, MT

Location: TP-212, 4.0' - 8.0'

Classification Gravelly Lean CLAY with Sand

Moisture Content 20 %

Sample No. 45362

Job No. 90-207

Date October 1990

Plasticity Index 16 %

$$\text{Coefficient of Uniformity} = C_U = \frac{D_{60}}{D_{10}} = \text{_____}$$

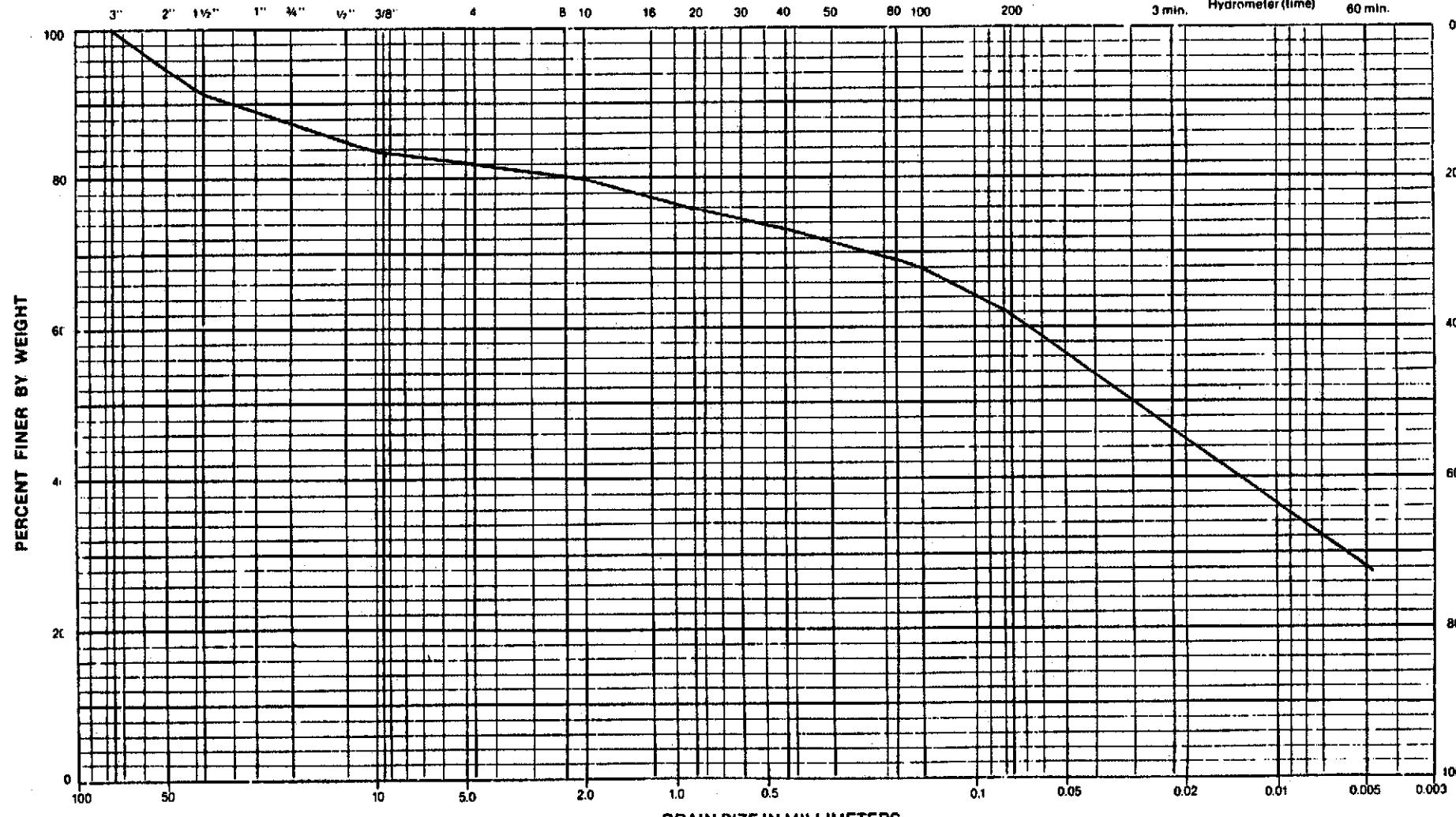
U.S. Standard Sieve Opening in Inches

3"	2"	1½"	1"	¾"	½"	3/8"	4"
----	----	-----	----	----	----	------	----

$$\text{Coefficient of Curvature} = C_Z = \frac{(D_{30})^2}{D_{10} \times D_{60}} = \text{_____}$$

U.S. Standard Sieve Numbers

8	10	16	20	30	40	50	80	100	200
---	----	----	----	----	----	----	----	-----	-----



Gravel		Sand			Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

Chen-Northern, Inc.

GRAIN SIZE DISTRIBUTION CURVE

Project: Montanore Project - Libby, MT

Location: TP-213, 4.0' - 12.0'

Classification Clayey GRAVEL with Sand

Moisture Content 9 %

Liquid Limit --- %

Sample No. 45364

Job No. 90-207

Date October 1990

Plasticity Index --- %

$$\text{Coefficient of Uniformity} = C_U = \frac{D_{60}}{D_{10}} =$$

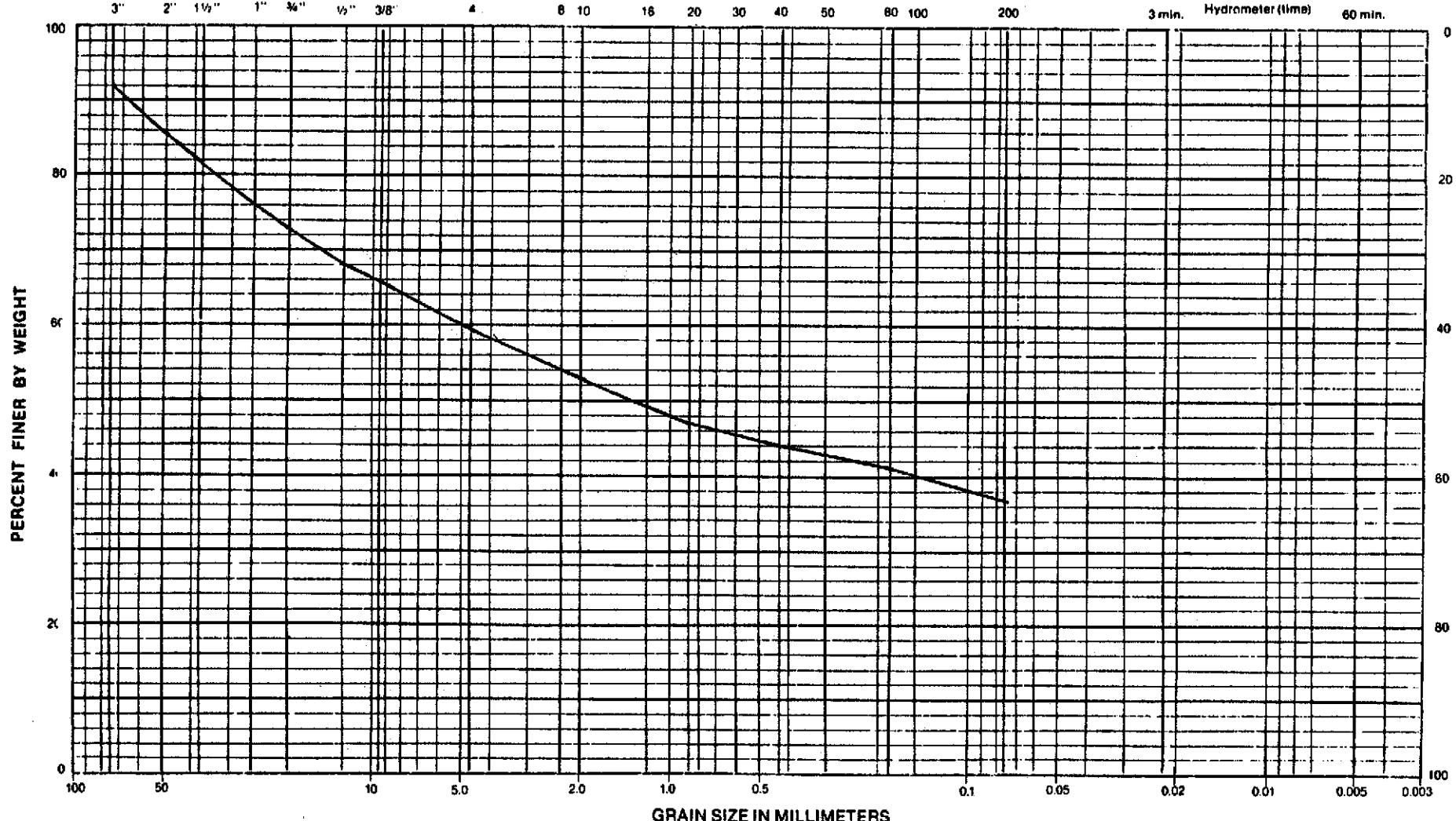
U.S. Standard Sieve Opening in Inches

3"	2"	1 1/2"	1"	5/8"	1/2"	3/8"	4"
----	----	--------	----	------	------	------	----

$$\text{Coefficient of Curvature} = C_Z = \frac{(D_{30})^2}{D_{10} \times D_{60}} =$$

U.S. Standard Sieve Numbers

6	10	16	20	30	40	50	80	100	200
---	----	----	----	----	----	----	----	-----	-----



GRAIN SIZE IN MILLIMETERS

Gravel		Sand			Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

Chen-Northern, Inc.

GRAIN SIZE DISTRIBUTION CURVE

Project: Montanore Project - Libby, MT

Location: TP-214, 3.0' - 10.0'

Classification Clayey GRAVEL with Sand

Moisture Content 9 %

Sample No. 45365

Job No. 90-207

Date October 1990

Liquid Limit -- %

Plasticity Index -- %

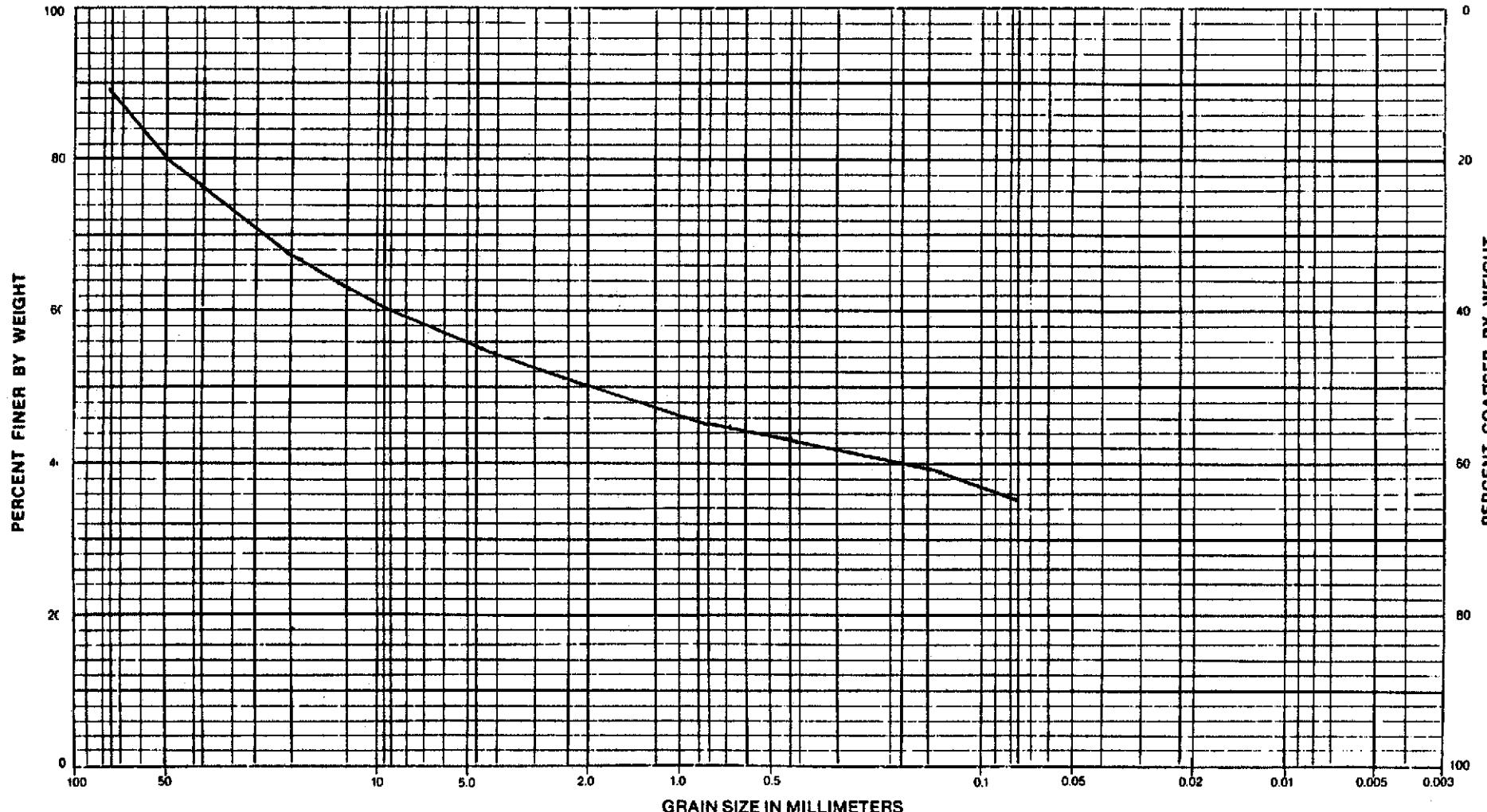
$$\text{Coefficient of Uniformity} = C_U = \frac{D_{60}}{D_{10}} =$$

U.S. Standard Sieve Opening in Inches

$$\text{Coefficient of Curvature} = C_Z = \frac{(D_{30})^2}{D_{10} \times D_{60}} =$$

U.S. Standard Sieve Numbers

3" 2" 1½" 1" ¾" ½" 3/8" 4 8 10 16 20 30 40 50 80 100 200 3 min. Hydrometer (time) 60 min.



Gravel		Sand			Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

Chen-Northern, Inc.

GRAIN SIZE DISTRIBUTION CURVE

Project: Montanore Project - Libby, MT

Location: TP-215, 5.0' - 12.0'

Classification Sandy Lean CLAY

Moisture Content 20 %

Sample No. 45367

Job No. 90-207

Date October 1990

$$\text{Coefficient of Uniformity} = C_U = \frac{D_{60}}{D_{10}} =$$

U.S. Standard Sieve Opening in Inches

3"	2"	1 1/2"	1"	3/4"	1/2"	3/8"	4
----	----	--------	----	------	------	------	---

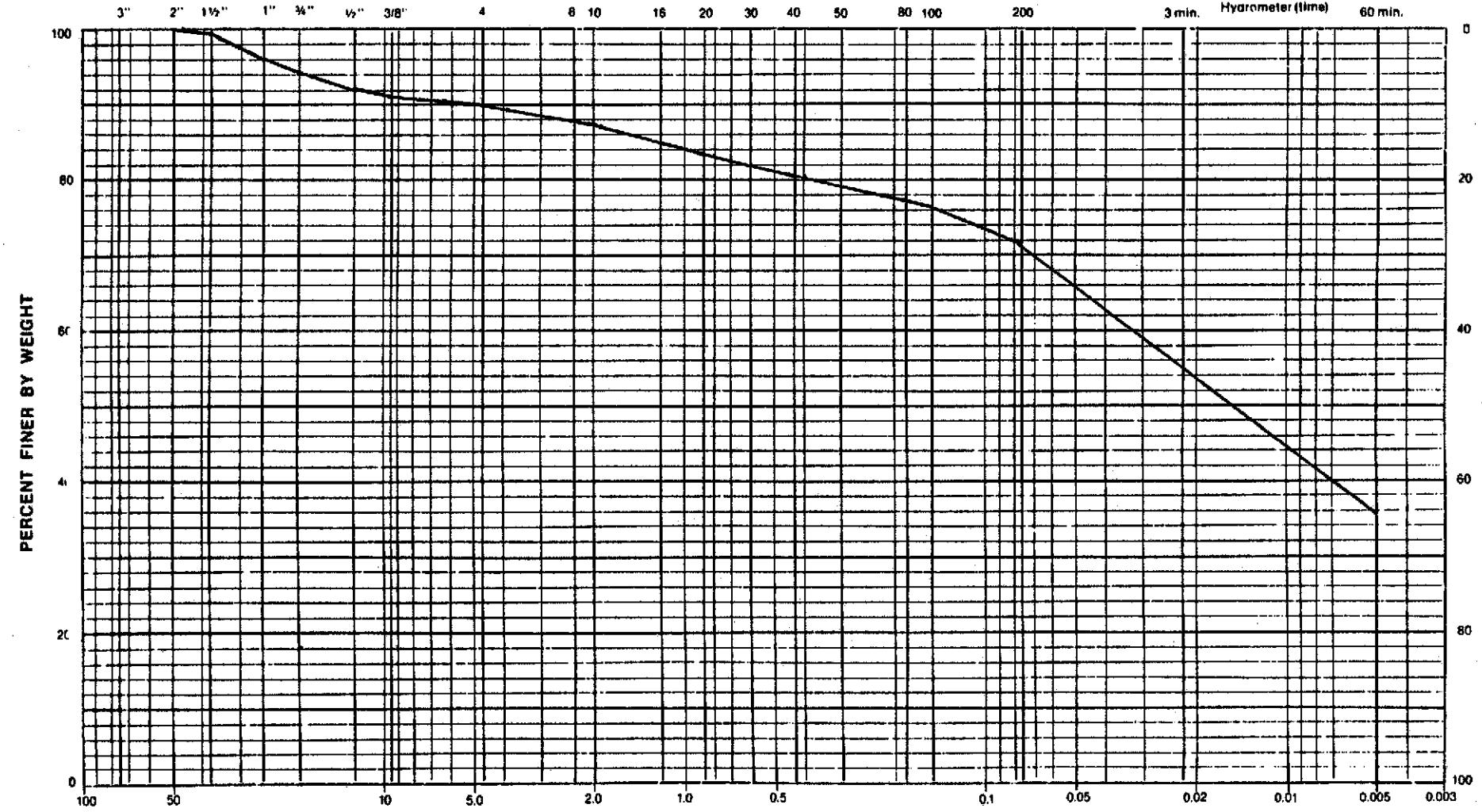
Liquid Limit 34 %

Plasticity Index 16 %

$$\text{Coefficient of Curvature} = C_Z = \frac{(D_{30})^2}{D_{10} \times D_{60}} =$$

U.S. Standard Sieve Numbers

20	30	40	50	80	100	200
----	----	----	----	----	-----	-----



GRAIN SIZE IN MILLIMETERS

Gravel		Sand			Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

Chen-Northern, Inc.

GRAIN SIZE DISTRIBUTION CURVE

Project: Montanore Project - Libby, MT

Location: TP-217A, 5.0' - 10.5'

Classification Clayey GRAVEL with Sand

Moisture Content 8 %

Liquid Limit -- %

Sample No. 45369

Job No. 90-207

Date October 1990

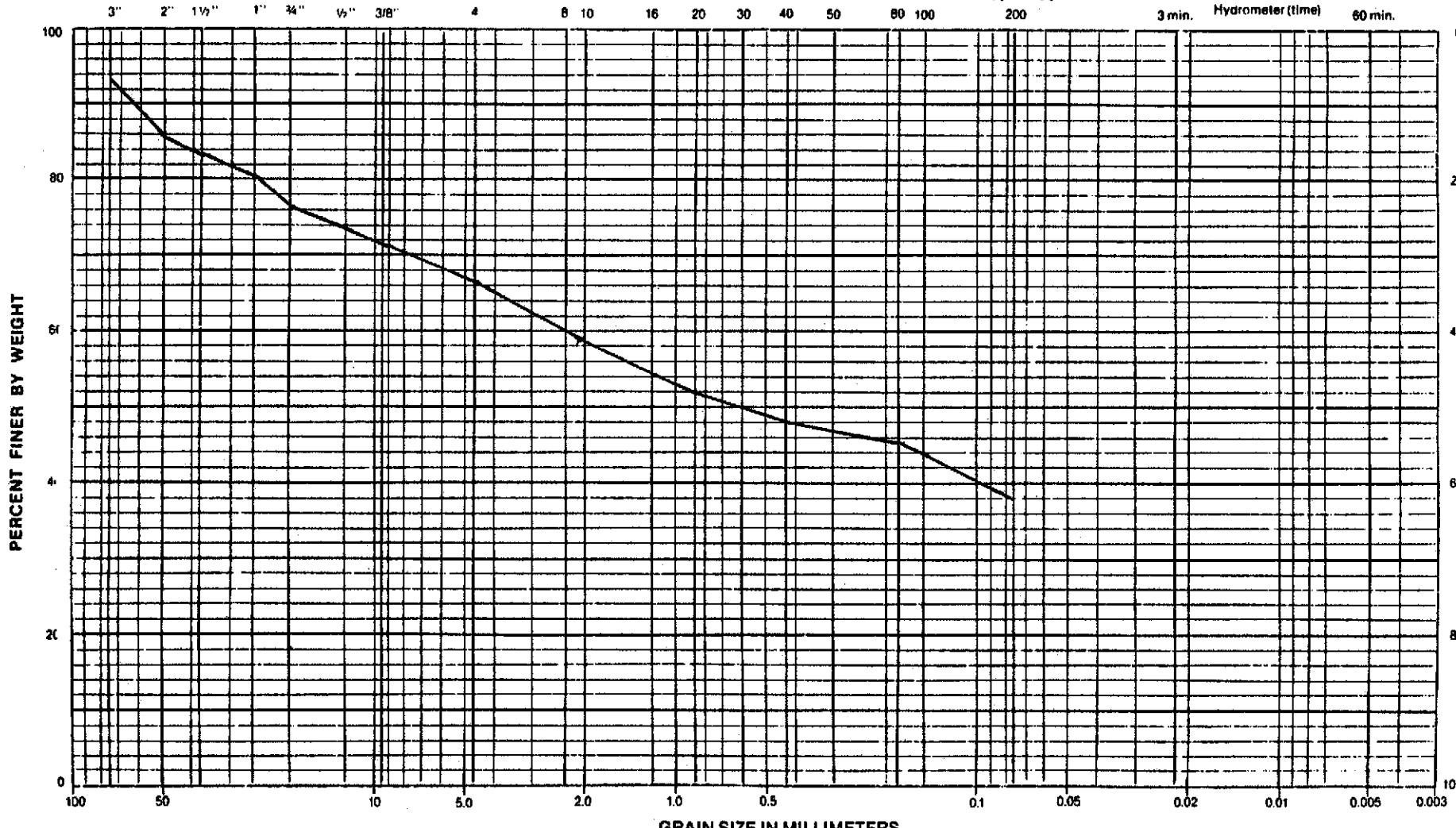
Plasticity Index -- %

$$\text{Coefficient of Uniformity} = C_U = \frac{D_{60}}{D_{10}} = \underline{\quad}$$

U.S. Standard Sieve Opening in Inches
3" 2" 1½" 1" ¾" ½" 3/8" 4"

$$\text{Coefficient of Curvature} = C_Z = \frac{(D_{30})^2}{D_{10} \times D_{60}} = \underline{\quad}$$

U.S. Standard Sieve Numbers
8 10 16 20 30 40 50 80 100 200



Gravel		Sand			Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

Chen-Northern, Inc.

GRAIN SIZE DISTRIBUTION CURVE

Project: Montanore Project - Libby, MT

Location: TP-217C, 6.0' - 14.5'

Classification Clayey GRAVEL with Sand

Moisture Content 11 %

Liquid Limit --- %

Sample No. 45373

Job No. 90-207

Date October 1990

Plasticity Index --- %

$$\text{Coefficient of Uniformity} = C_U = \frac{D_{60}}{D_{10}} =$$

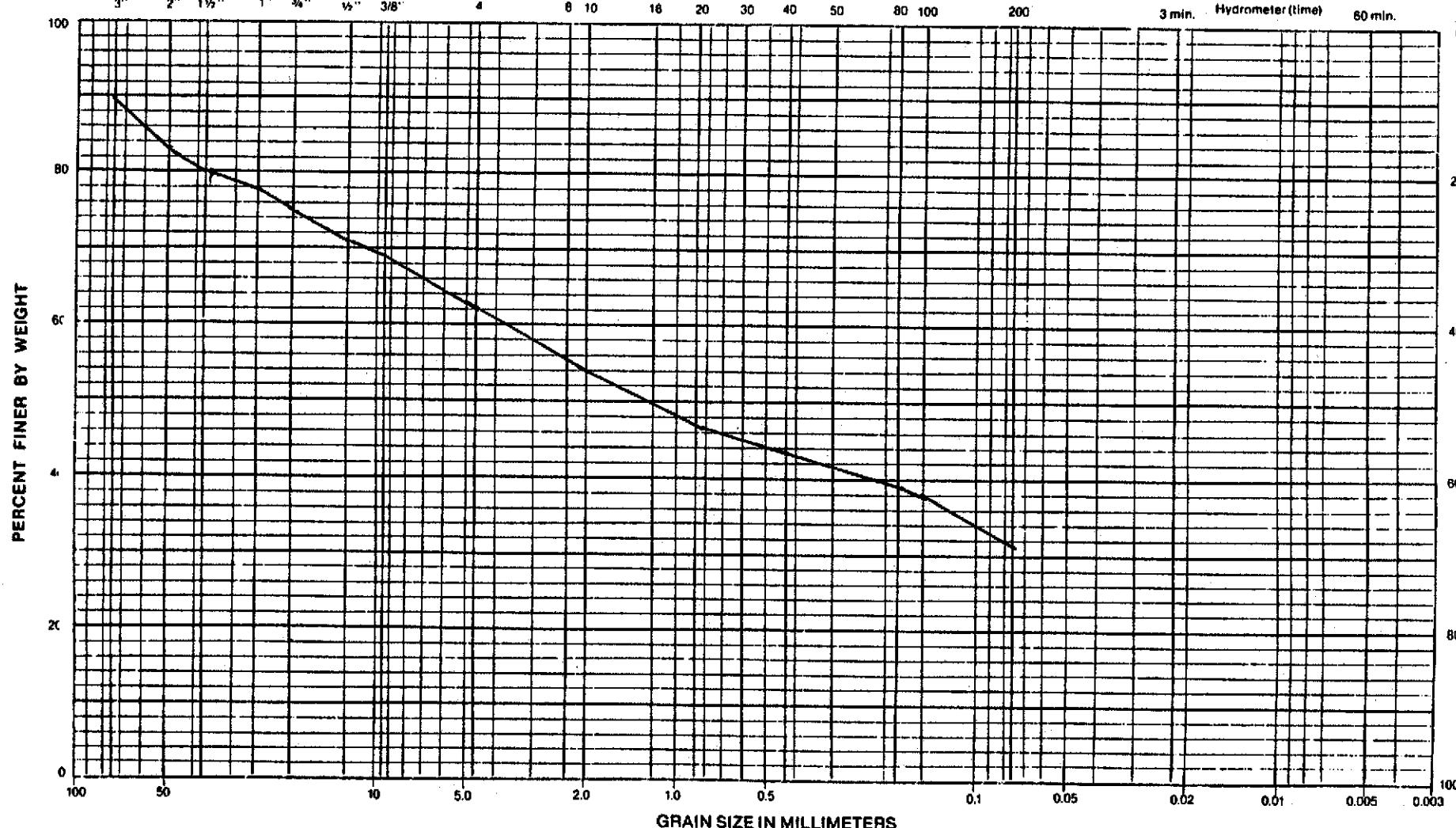
U.S. Standard Sieve Opening in Inches

3"	2"	1 1/2"	1"	3/4"	1/2"	3/8"	4
----	----	--------	----	------	------	------	---

$$\text{Coefficient of Curvature} = C_Z = \frac{(D_{30})^2}{D_{10} \times D_{60}} =$$

U.S. Standard Sieve Numbers

8	10	16	20	30	40	50	80	100	200
---	----	----	----	----	----	----	----	-----	-----



Gravel		Sand			Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

Chen-Northern, Inc.

GRAIN SIZE DISTRIBUTION CURVE

Project: Montanore Project - Libby, MT

Location: TP-219, 5.0' - 13.5'

Classification Clayey GRAVEL with Sand

Moisture Content 18 %

Sample No. 45375

Job No. 90-207

Date October 1990

$$\text{Coefficient of Uniformity} = C_U = \frac{D_{60}}{D_{10}} =$$

U.S. Standard Sieve Opening in Inches

3"	2"	1 1/2"	1"	3/4"	1/2"	3/8"	4
----	----	--------	----	------	------	------	---

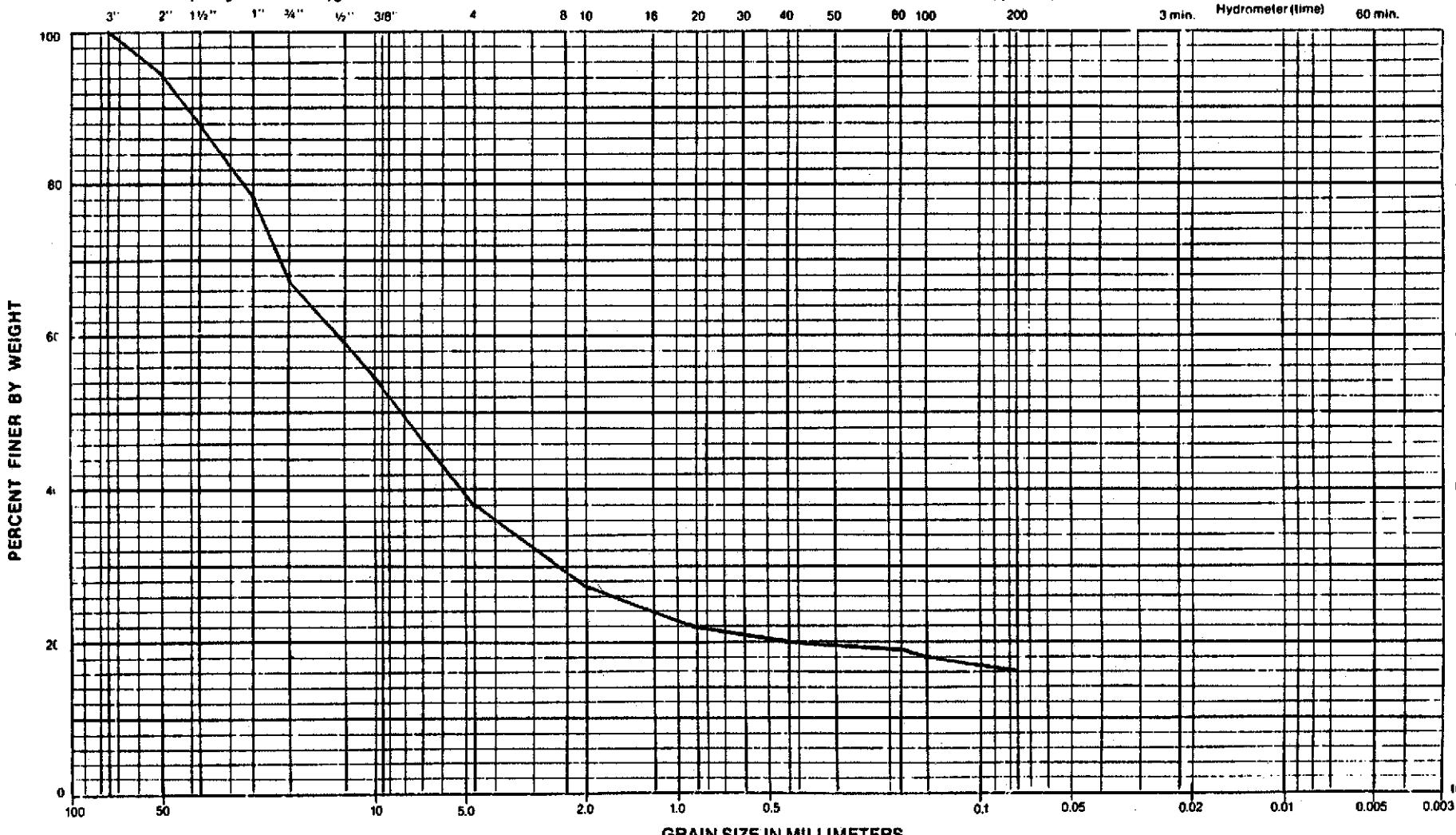
Liquid Limit -- %

Plasticity Index -- %

$$\text{Coefficient of Curvature} = C_Z = \frac{(D_{30})^2}{D_{10} \times D_{60}} =$$

U.S. Standard Sieve Numbers

20	30	40	50	60	100	200
----	----	----	----	----	-----	-----



Gravel		Sand			Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

Chen-Northern, Inc.

GRAIN SIZE DISTRIBUTION CURVE

Project: Montanore Project - Libby, MT

Location: TP-220, 4.0' - 13.0'

Classification Clayey GRAVEL with Sand

Moisture Content 11 %

Sample No. 45376

Job No. 90-207

Date October 1990

Liquid Limit -- %

Plasticity Index -- %

$$\text{Coefficient of Uniformity} = C_U = \frac{D_{60}}{D_{10}} =$$

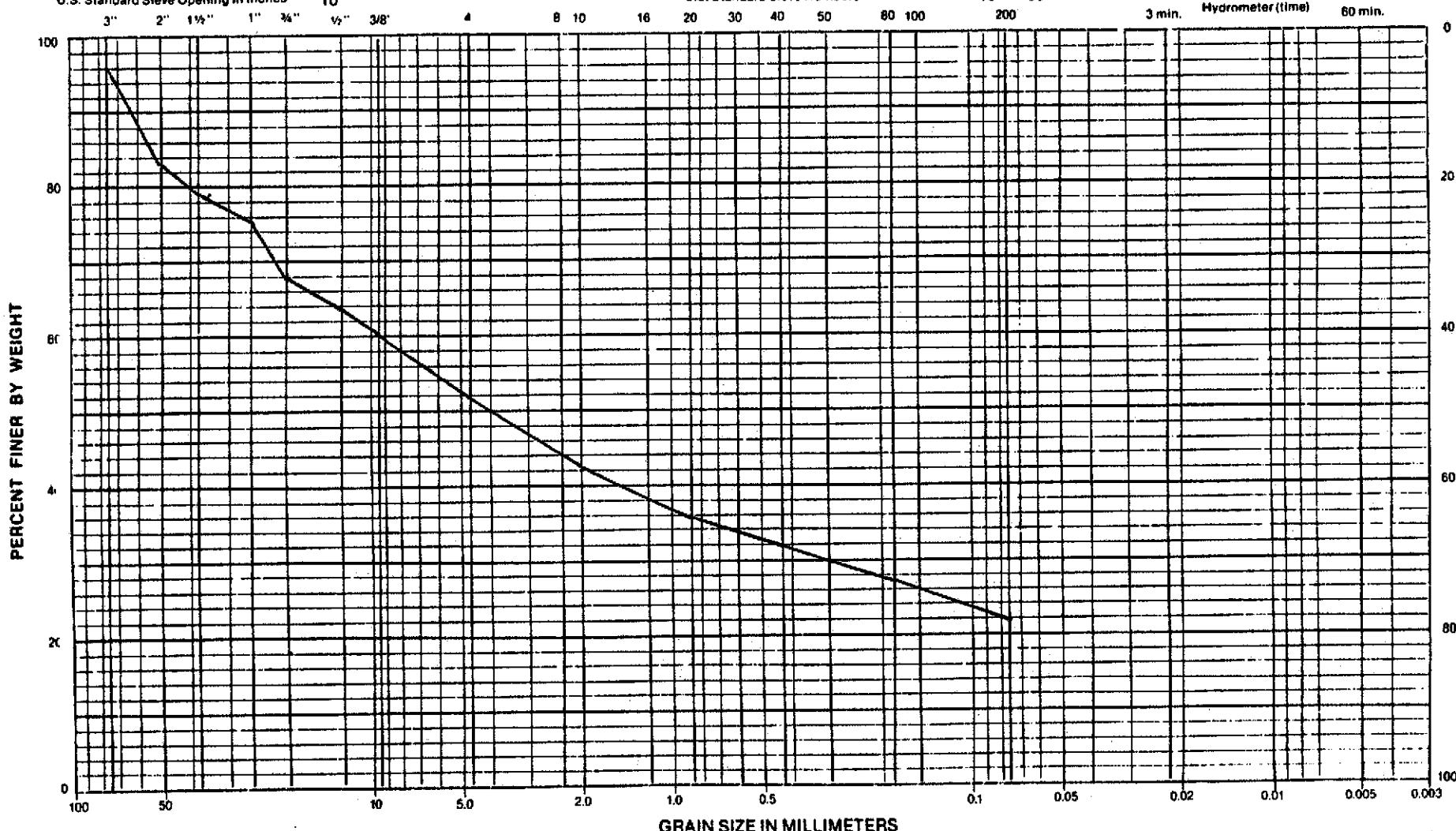
U.S. Standard Sieve Opening in Inches

3"	2"	1 1/2"	1"	3/4"	1/2"	3/8"
100	50	30	20	16	10	8

$$\text{Coefficient of Curvature} = C_Z = \frac{(D_{30})^2}{D_{10} \times D_{60}} =$$

U.S. Standard Sieve Numbers

100	80	60	50	40	30	20	16	10	8
200	160	120	100	80	60	50	40	30	20



Gravel		Sand			Fines	
Coarse	Fine	Coarse	Medium	Fine	Slit	Clay

Chen-Northern, Inc.

GRAIN SIZE DISTRIBUTION CURVE

Project: Montanore Project - Libby, MT

Location: TP-224, 2.0' - 16.0'

Classification Clayey GRAVEL with Sand

Moisture Content 16 %

Sample No. 45377

Job No. 90-207

Date October 1990

$$\text{Coefficient of Uniformity} = C_U = \frac{D_{60}}{D_{10}} =$$

U.S. Standard Sieve Opening in Inches

3"	2"	1 1/2"	1"	3/4"	1/2"	3/8"	4
----	----	--------	----	------	------	------	---

Liquid Limit --- %

Plasticity Index --- %

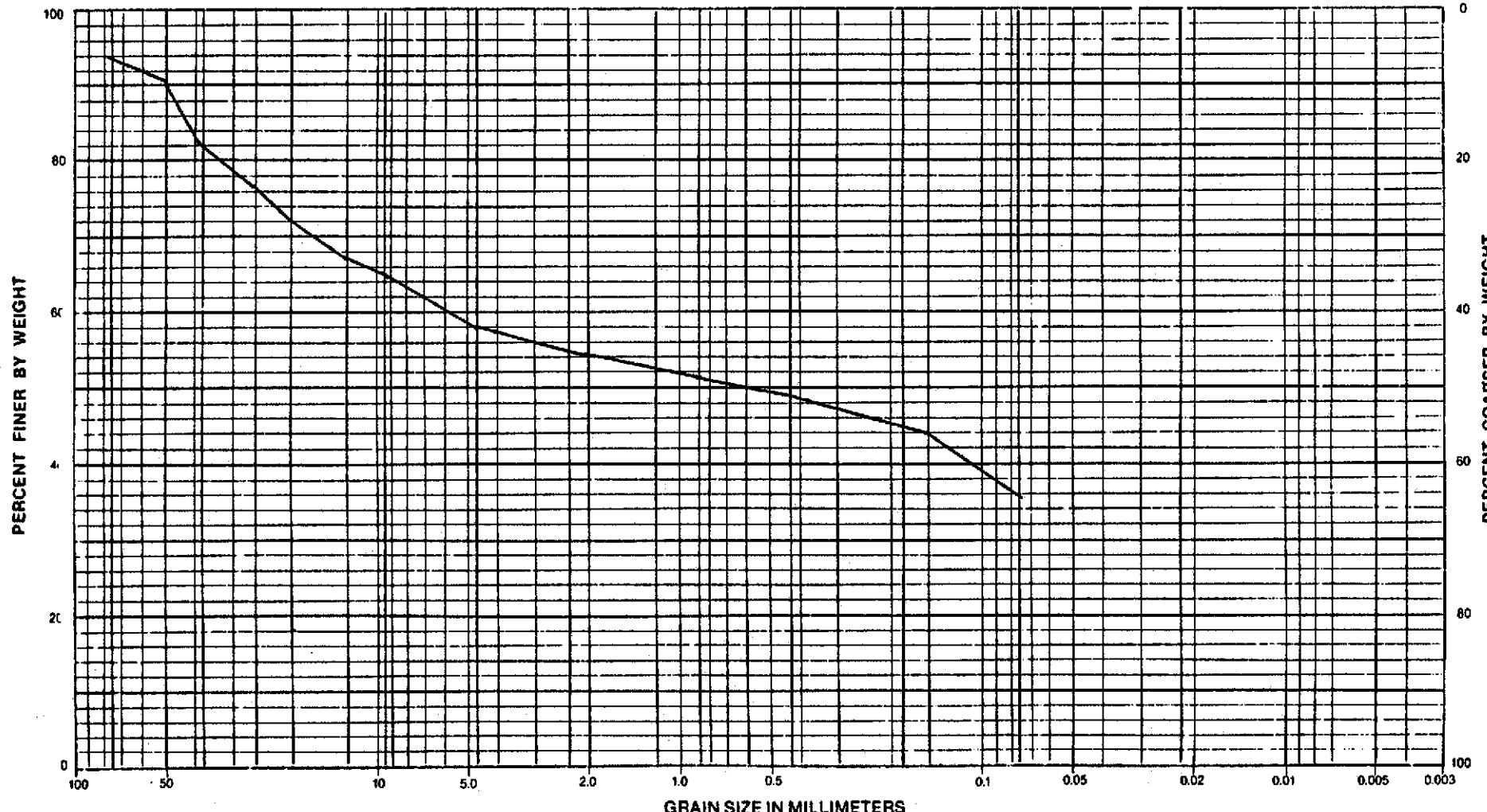
$$\text{Coefficient of Curvature} = C_Z = \frac{(D_{30})^2}{D_{10} \times D_{60}} =$$

U.S. Standard Sieve Numbers

8	10	16	20	30	40	50	80	100	200
---	----	----	----	----	----	----	----	-----	-----

3 min. Hydrometer (time)

60 min.



Gravel		Sand			Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

Chen-Northern, Inc.

GRAIN SIZE DISTRIBUTION CURVE

Project: Montanore Project - Libby, MT

Location: TP-226, 3.0' - 16.5'

Classification Clayey SAND with Gravel

Moisture Content 18 %

Sample No. 45379

Job No. 90-207

Date October 1990

Liquid Limit -- %

Plasticity Index -- %

$$\text{Coefficient of Uniformity} = C_U = \frac{D_{60}}{D_{10}} = \underline{\quad}$$

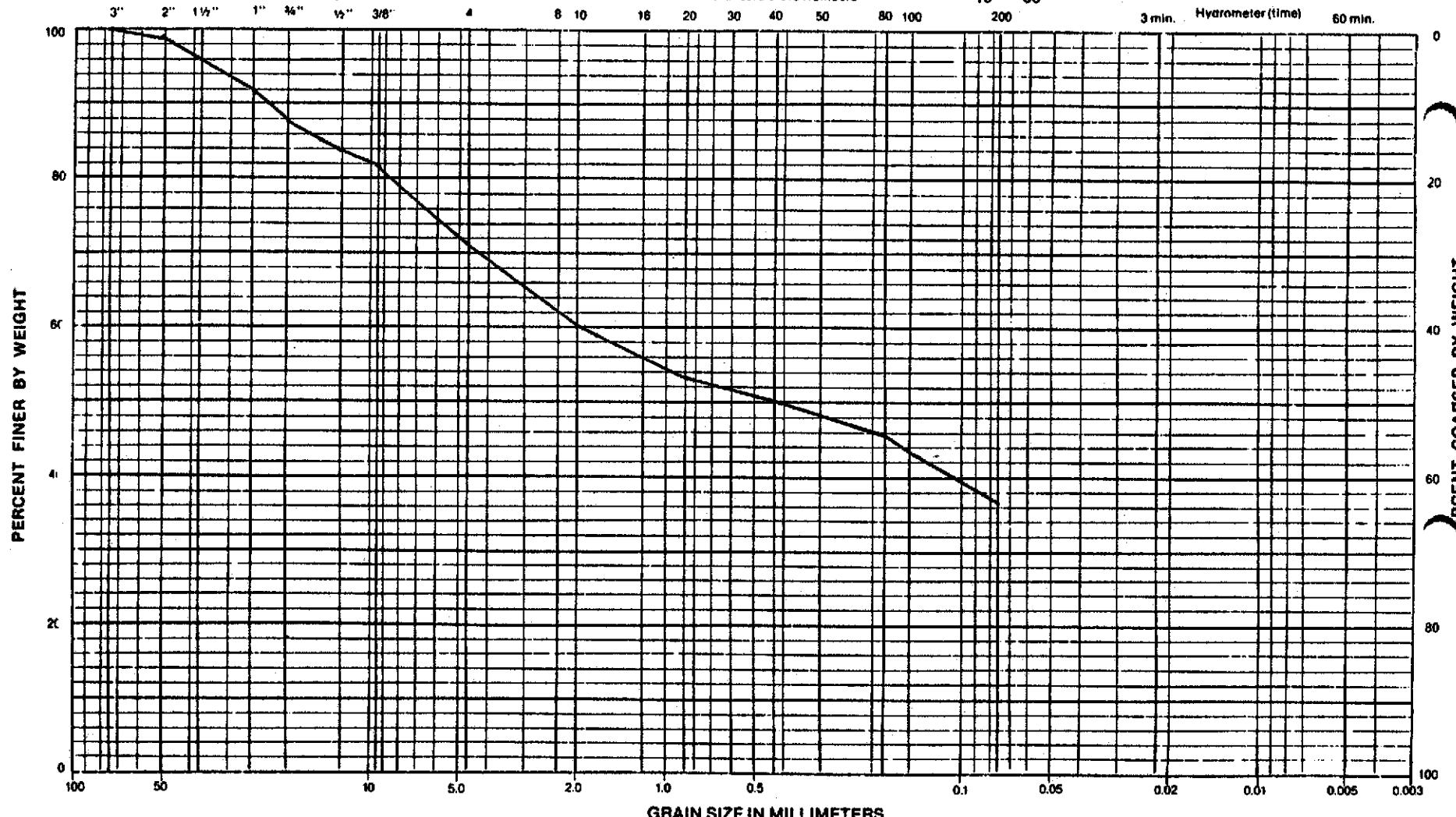
U.S. Standard Sieve Opening in Inches

3"	2"	1 1/2"	1"	4"	1/2"	3/8"	4
----	----	--------	----	----	------	------	---

$$\text{Coefficient of Curvature} = C_Z = \frac{(D_{30})^2}{D_{10} \times D_{60}} = \underline{\quad}$$

U.S. Standard Sieve Numbers

6	10	16	20	30	40	50	80	100	200
---	----	----	----	----	----	----	----	-----	-----



Gravel		Sand			Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

Chen-Northern, Inc.

GRAIN SIZE DISTRIBUTION CURVE

Project: Montanore Project - Libby, MT

Location: TP-227, 4.0' - 9.0'

Classification Sandy Silty CLAY with Gravel

Moisture Content 9 %

Liquid Limit 21 %

Sample No. 45380

Job No. 90-207

Date October 1990

Plasticity Index 6 %

$$\text{Coefficient of Uniformity} = C_U = \frac{D_{60}}{D_{10}} = \text{_____}$$

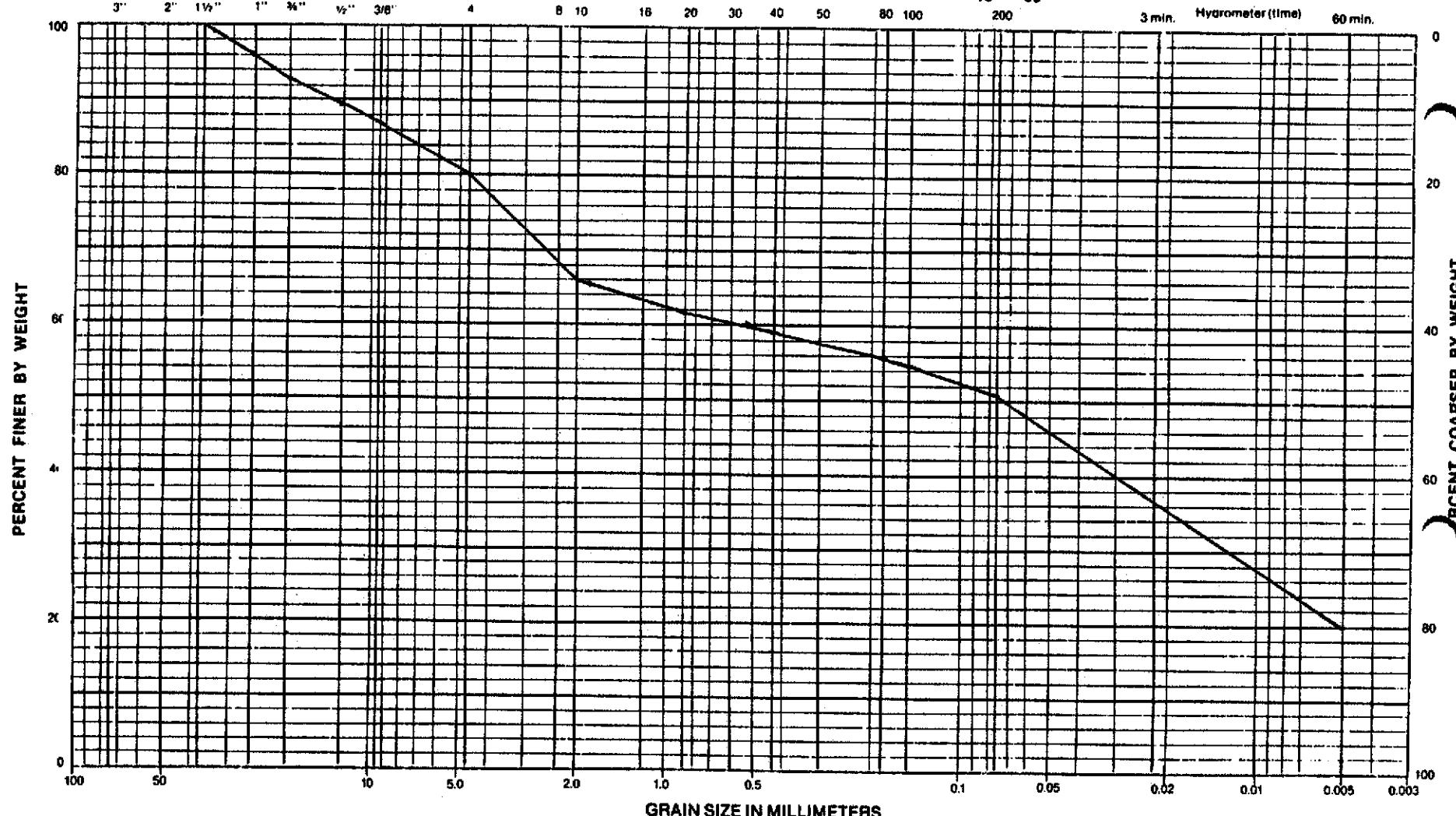
U.S. Standard Sieve Opening in inches

3"	2"	1 1/2"	1"	5/8"	1/2"	3/8"	4
----	----	--------	----	------	------	------	---

$$\text{Coefficient of Curvature} = C_Z = \frac{(D_{30})^2}{D_{10} \times D_{60}} = \text{_____}$$

U.S. Standard Sieve Numbers

80	100	200							
20	30	40	50	80	100				
8	10	16	20	30	40	50	80	100	
4									



GRAIN SIZE IN MILLIMETERS

Gravel		Sand			Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

Chen-Northern, Inc.

GRAIN SIZE DISTRIBUTION CURVE

Project: Montanore Project - Libby, MT

Location: TP-230, 8.0' - 14.0'

Classification Clayey GRAVEL with Sand

Moisture Content 13 %

Sample No. 45385

Job No. 90-207

Date October 1990

$$\text{Coefficient of Uniformity} = C_U = \frac{D_{60}}{D_{10}}$$

U.S. Standard Sieve Opening in Inches

3"	2"	1 1/2"	1"	3/4"	1/2"	3/8"
----	----	--------	----	------	------	------

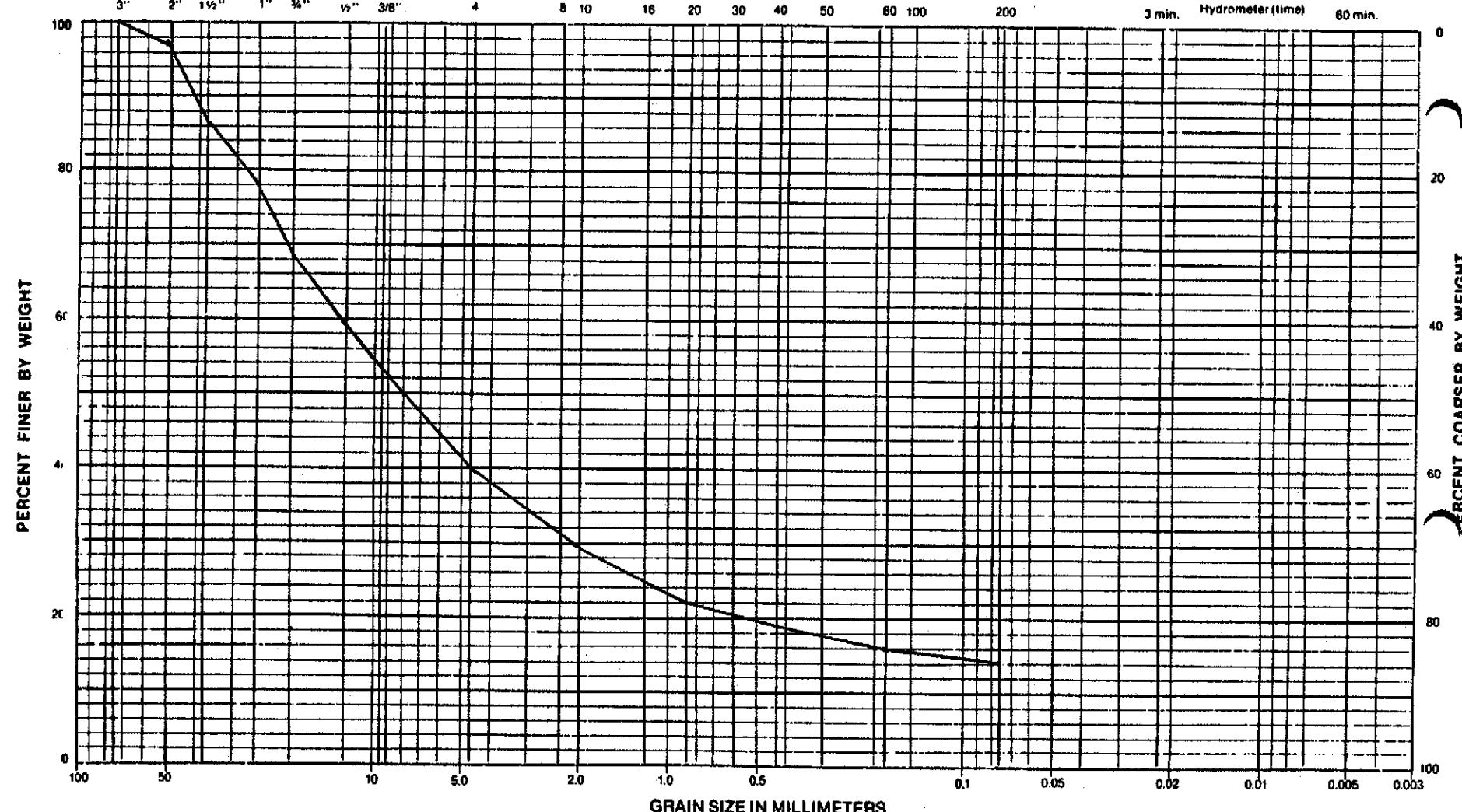
Liquid Limit -- %

Plasticity Index -- %

$$\text{Coefficient of Curvature} = C_Z = \frac{(D_{30})^2}{D_{10} \times D_{60}} =$$

U.S. Standard Sieve Numbers

8	10	16	20	30	40	50	60	100	200
---	----	----	----	----	----	----	----	-----	-----



Gravel		Sand			Fines		
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay	

Chen-Northern, Inc.

GRAIN SIZE DISTRIBUTION CURVE

Project: Montanore Project - Libby, MT

Location: TP-233, 5.0' - 14.0'

Classification Sandy Lean CLAY with Gravel

Moisture Content 12 %

Sample No. 45387

Job No. 90-207

Date October 1990

Liquid Limit -- %

Plasticity Index -- %

$$\text{Coefficient of Uniformity} = C_U = \frac{D_{60}}{D_{10}} =$$

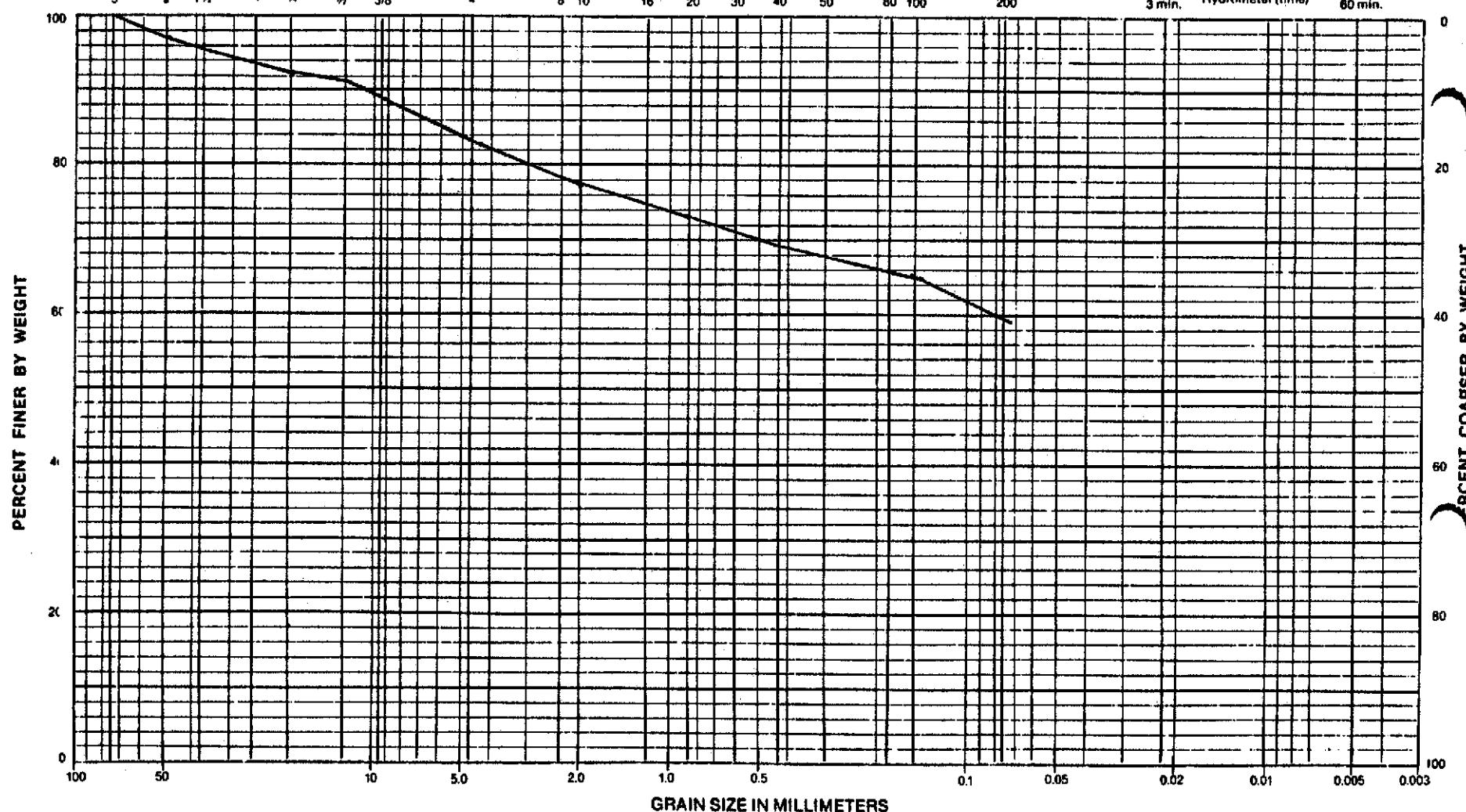
U.S. Standard Sieve Opening in Inches

3"	2"	1 1/2"	1"	3/4"	1/2"	3/8"
----	----	--------	----	------	------	------

$$\text{Coefficient of Curvature} = C_Z = \frac{(D_{30})^2}{D_{10} \times D_{60}} =$$

U.S. Standard Sieve Numbers

4	8	10	16	20	30	40	50	80	100	200
---	---	----	----	----	----	----	----	----	-----	-----



Gravel		Sand			Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

Chen-Nortnern, Inc.

GRAIN SIZE DISTRIBUTION CURVE

Project: Montanore Project - Libby, MT

Location: TP-234, 5.0' - 12.5'

Classification Clayey GRAVEL

Moisture Content 14 %

Sample No. 45388

Job No. 90-207

Date October 1990

$$\text{Coefficient of Uniformity} = C_U = \frac{D_{60}}{D_{10}}$$

U.S. Standard Sieve Opening in Inches

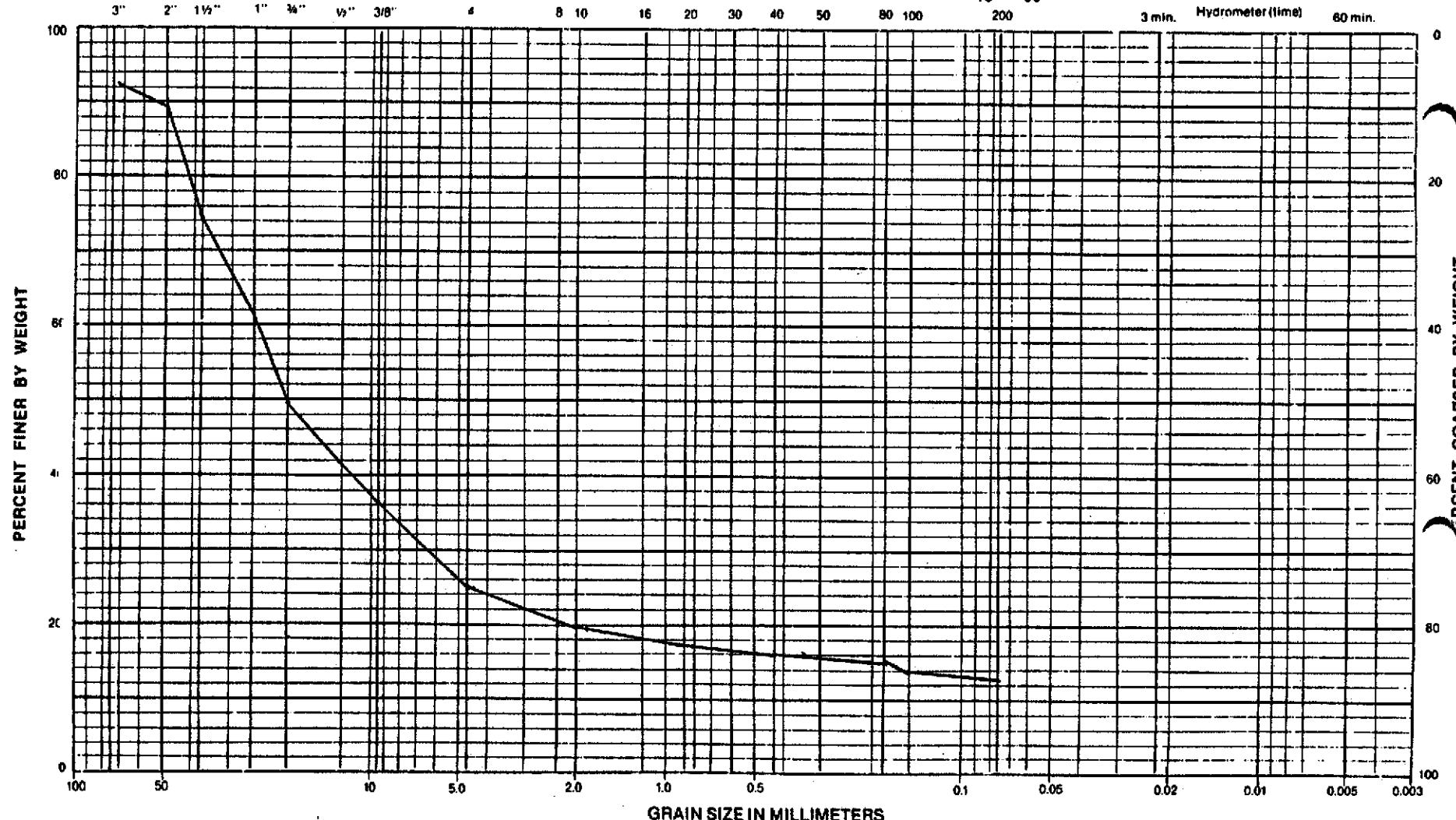
3"	2"	1 1/2"	1"	3/4"	1/2"	3/8"	1/4"	1/8"	1/16"	1/32"	1/64"	1/128"	1/256"	1/512"	1/1024"
----	----	--------	----	------	------	------	------	------	-------	-------	-------	--------	--------	--------	---------

$$\text{Coefficient of Curvature} = C_Z = \frac{(D_{30})^2}{D_{10} \times D_{60}}$$

U.S. Standard Sieve Numbers

8	10	16	20	30	40	50	80	100	200
---	----	----	----	----	----	----	----	-----	-----

Plasticity Index -- %



Gravel		Sand			Fines		
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay	

Chen-Northern, Inc.

GRAIN SIZE DISTRIBUTION CURVE

Project: Montanore Project - Libby, MT

Location: TP-235, 4.0' - 12.0'

Classification Sandy Lean CLAY

Moisture Content 24 %

Sample No. 45389

Job No. 90-207

Date October 1990

Liquid Limit -- %

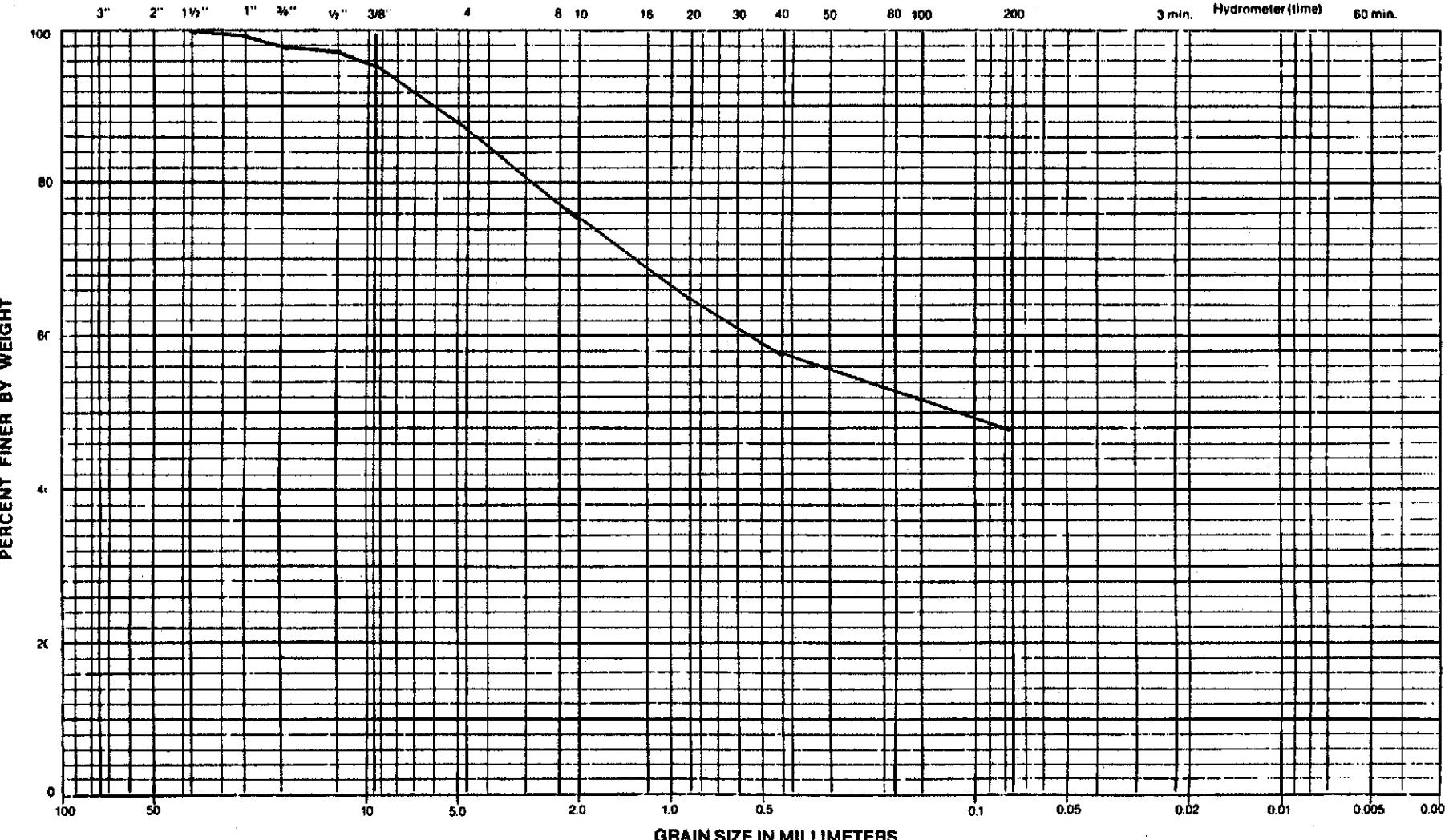
Plasticity Index -- %

$$\text{Coefficient of Uniformity} = C_U = \frac{D_{60}}{D_{10}} = \text{_____}$$

U.S. Standard Sieve Opening in Inches

$$\text{Coefficient of Curvature} = C_Z = \frac{(D_{30})^2}{D_{10} \times D_{60}} = \text{_____}$$

U.S. Standard Sieve Numbers



GRAIN SIZE IN MILLIMETERS

Gravel		Sand			Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

Chen-Northern, Inc.

GRAIN SIZE DISTRIBUTION CURVE

Project: Montanore Project - Libby, MT

Location: TP-236, 5.0' - 15.0'

Classification Gravelly Lean CLAY with Sand

Moisture Content 30 %

Sample No. 45390

Job No. 90-207

Date October 1990

$$\text{Coefficient of Uniformity} = C_U = \frac{D_{60}}{D_{10}} =$$

U.S. Standard Sieve Opening in Inches

3"	2"	1 1/2"	1"	3/4"	1/2"	3/8"	4
----	----	--------	----	------	------	------	---

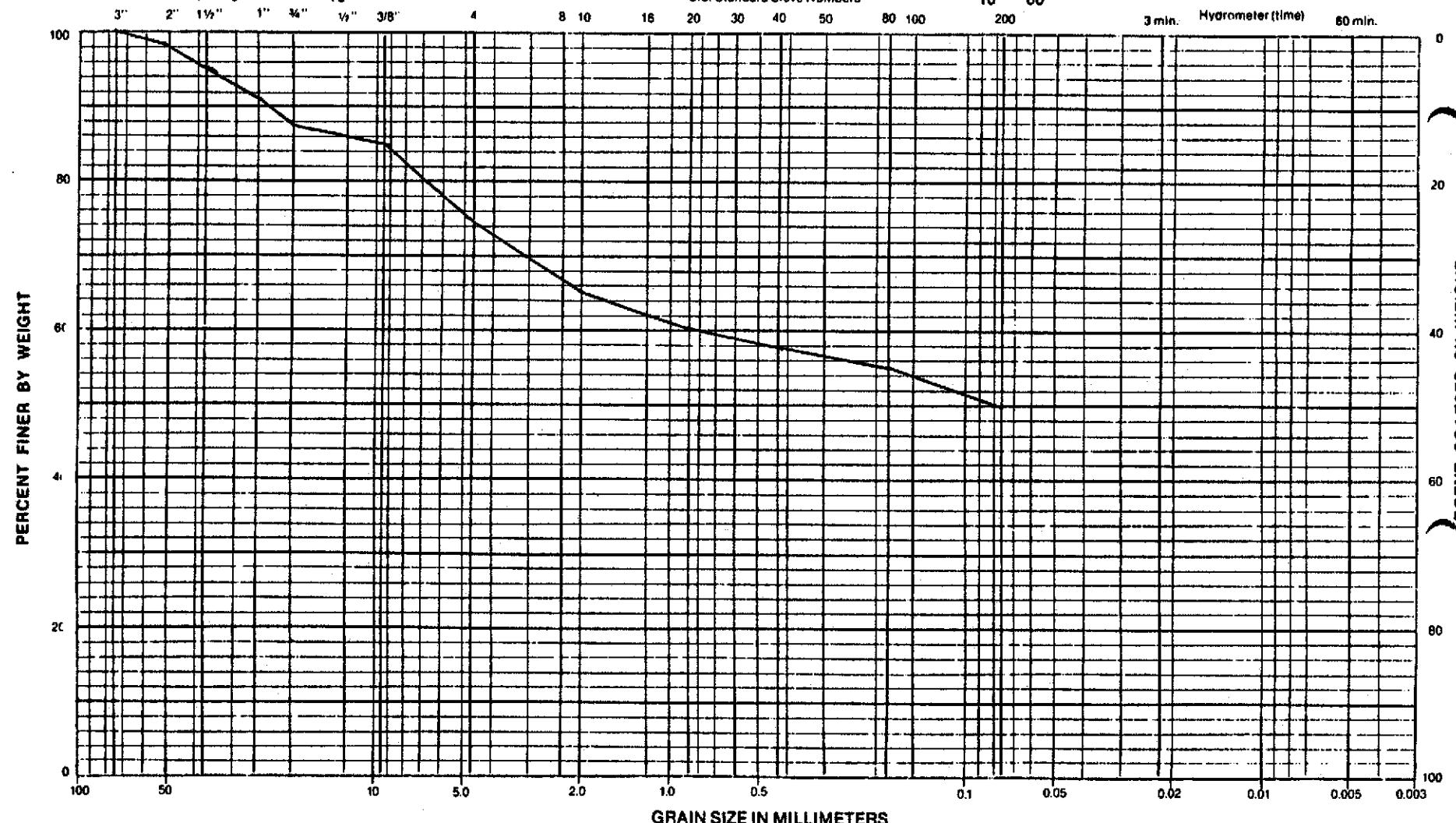
Liquid Limit -- %

Plasticity Index -- %

$$\text{Coefficient of Curvature} = C_Z = \frac{(D_{30})^2}{D_{10} \times D_{60}} =$$

U.S. Standard Sieve Numbers

8	10	16	20	30	40	50	80	100	200
---	----	----	----	----	----	----	----	-----	-----



Gravel		Sand			Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

Chen-Northern, Inc.

GRAIN SIZE DISTRIBUTION CURVE

Project: Montanore Project - Libby, MT

Location: TP-237, 5.0' - 12.5'

Classification Clayey SAND with Gravel

Moisture Content 15 %

Liquid Limit -- %

Sample No. 45392

Job No. 90-207

Date October 1990

Plasticity Index -- %

$$\text{Coefficient of Uniformity} = C_U = \frac{D_{60}}{D_{10}} =$$

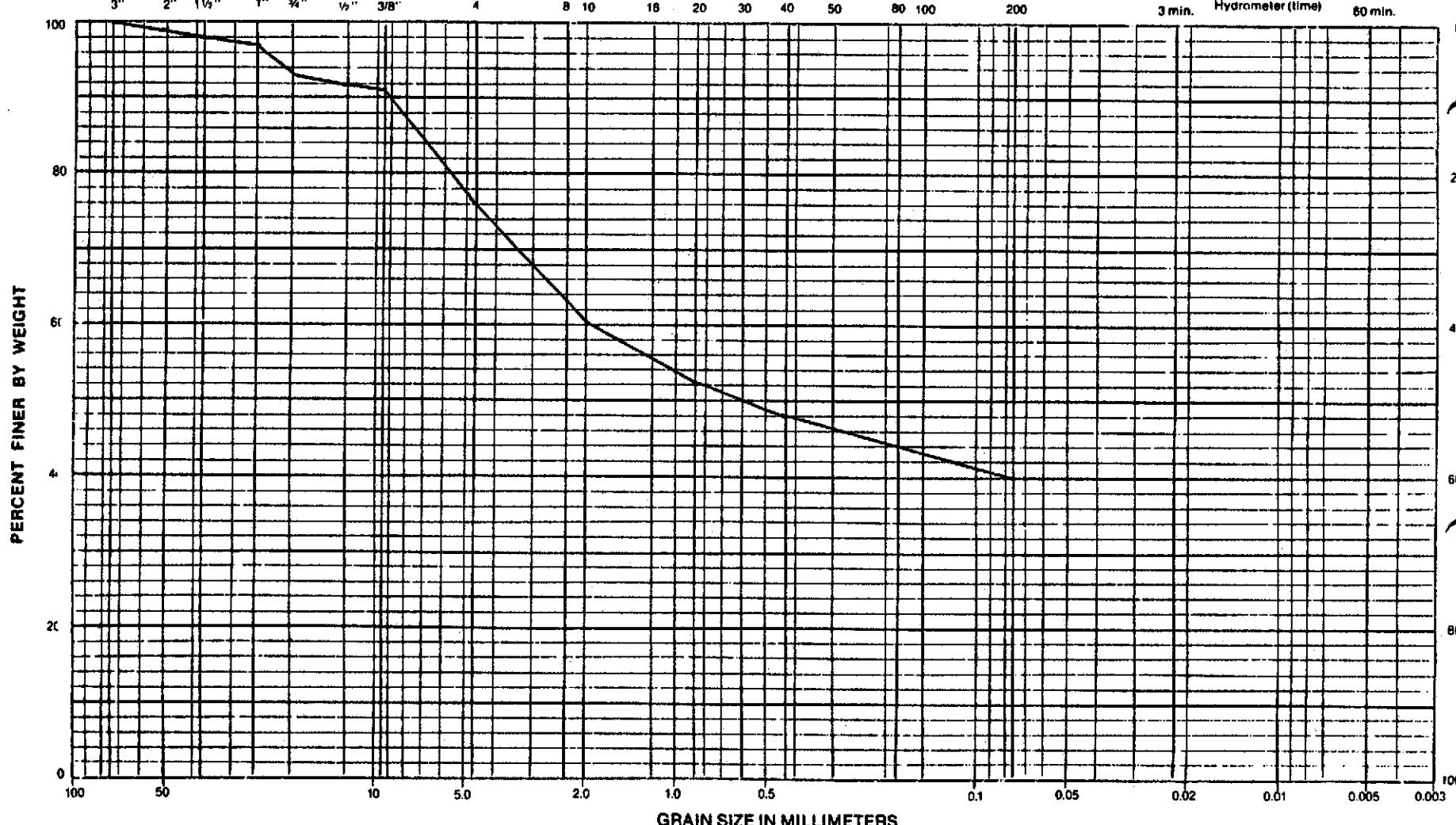
U.S. Standard Sieve Opening in Inches

3"	2"	1 1/4"	1"	3/4"	1/2"	3/8"
----	----	--------	----	------	------	------

$$\text{Coefficient of Curvature} = C_Z = \frac{(D_{30})^2}{D_{10} \times D_{60}} =$$

U.S. Standard Sieve Numbers

4	8	10	16	20	30	40	50	80	100	200
---	---	----	----	----	----	----	----	----	-----	-----



Gravel		Sand			Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

Chen-Northern, Inc.

GRAIN SIZE DISTRIBUTION CURVE

Project: Montanore Project - Libby, MT

Location: TP-243, 3.0' - 9.0'

Classification Clayey SAND with Gravel

Moisture Content 12 %

Liquid Limit --- %

Sample No. 45398

Job No. 90-207

Date October 1990

$$\text{Coefficient of Uniformity} = C_U = \frac{D_{60}}{D_{10}} =$$

U.S. Standard Sieve Opening in Inches

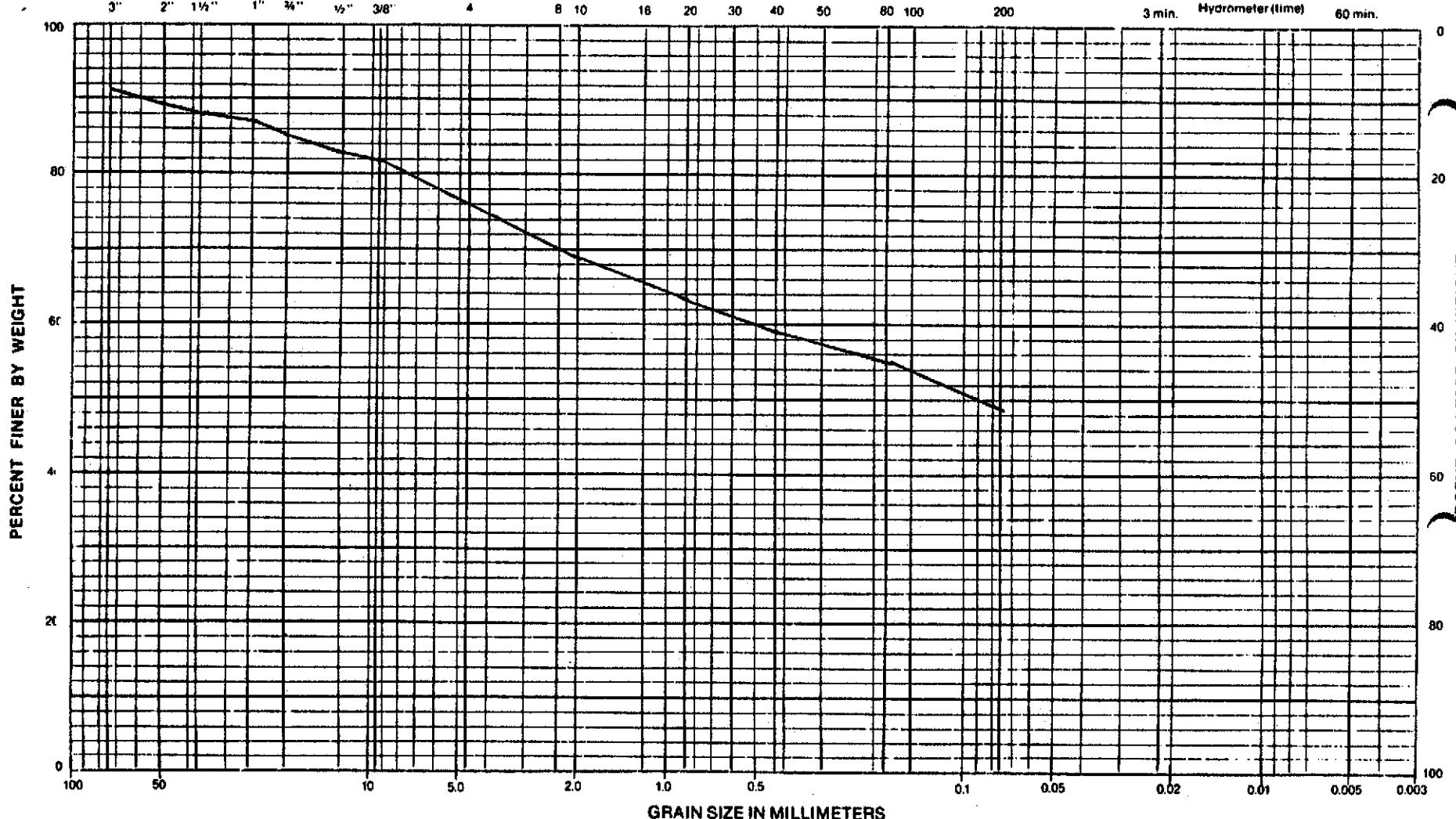
3"	2"	1 1/4"	1"	3/4"	1/2"	3/8"
----	----	--------	----	------	------	------

$$\text{Coefficient of Curvature} = C_Z = \frac{(D_{30})^2}{D_{10} \times D_{60}} =$$

U.S. Standard Sieve Numbers

4	8	10	16	20	30	40	50	80	100	200
---	---	----	----	----	----	----	----	----	-----	-----

Plasticity Index --- %



Gravel		Sand			Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

Chen-Northern, Inc.

GRAIN SIZE DISTRIBUTION CURVE

Project: Montanore Project - Libby, MT

Location: TP-244, 4.0' - 10.0'

Classification Clayey GRAVEL with Sand

Moisture Content 15 %

Sample No. 45399

Job No. 90-207

Date October 1990

Liquid Limit -- %

Plasticity Index -- %

$$\text{Coefficient of Uniformity} = C_U = \frac{D_{60}}{D_{10}} = \text{_____}$$

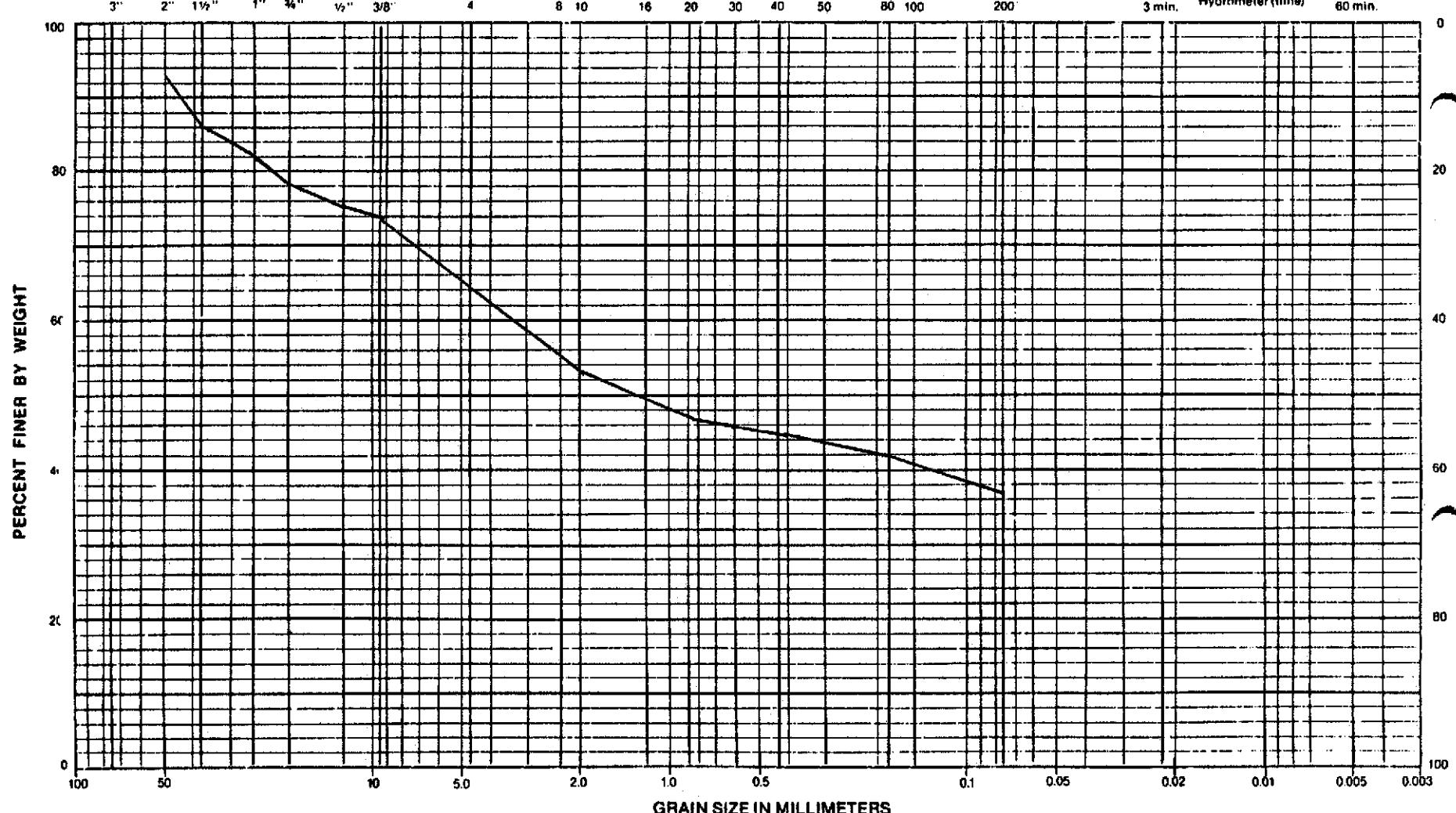
U.S. Standard Sieve Opening in Inches

3"	2"	1 1/2"	1"	3/4"	1/2"	3/8"	4
----	----	--------	----	------	------	------	---

$$\text{Coefficient of Curvature} = C_Z = \frac{(D_{30})^2}{D_{10} \times D_{60}} = \text{_____}$$

U.S. Standard Sieve Numbers

20	30	40	50	80	100	200
----	----	----	----	----	-----	-----



Gravel		Sand			Fines		
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay	

Chen-Northern, Inc.

GRAIN SIZE DISTRIBUTION CURVE

Project: Montanore Project - Libby, MT

Location: TP-246, 2.0' - 8.0'

Classification Clayey GRAVEL with Sand

Moisture Content 13 %

Sample No. 45402

Job No. 90-207

Date October 1990

$$\text{Coefficient of Uniformity} = C_U = \frac{D_{60}}{D_{10}} =$$

U.S. Standard Sieve Opening in Inches

3"	2"	1½"	1"	¾"	½"	3/8"	4"
----	----	-----	----	----	----	------	----

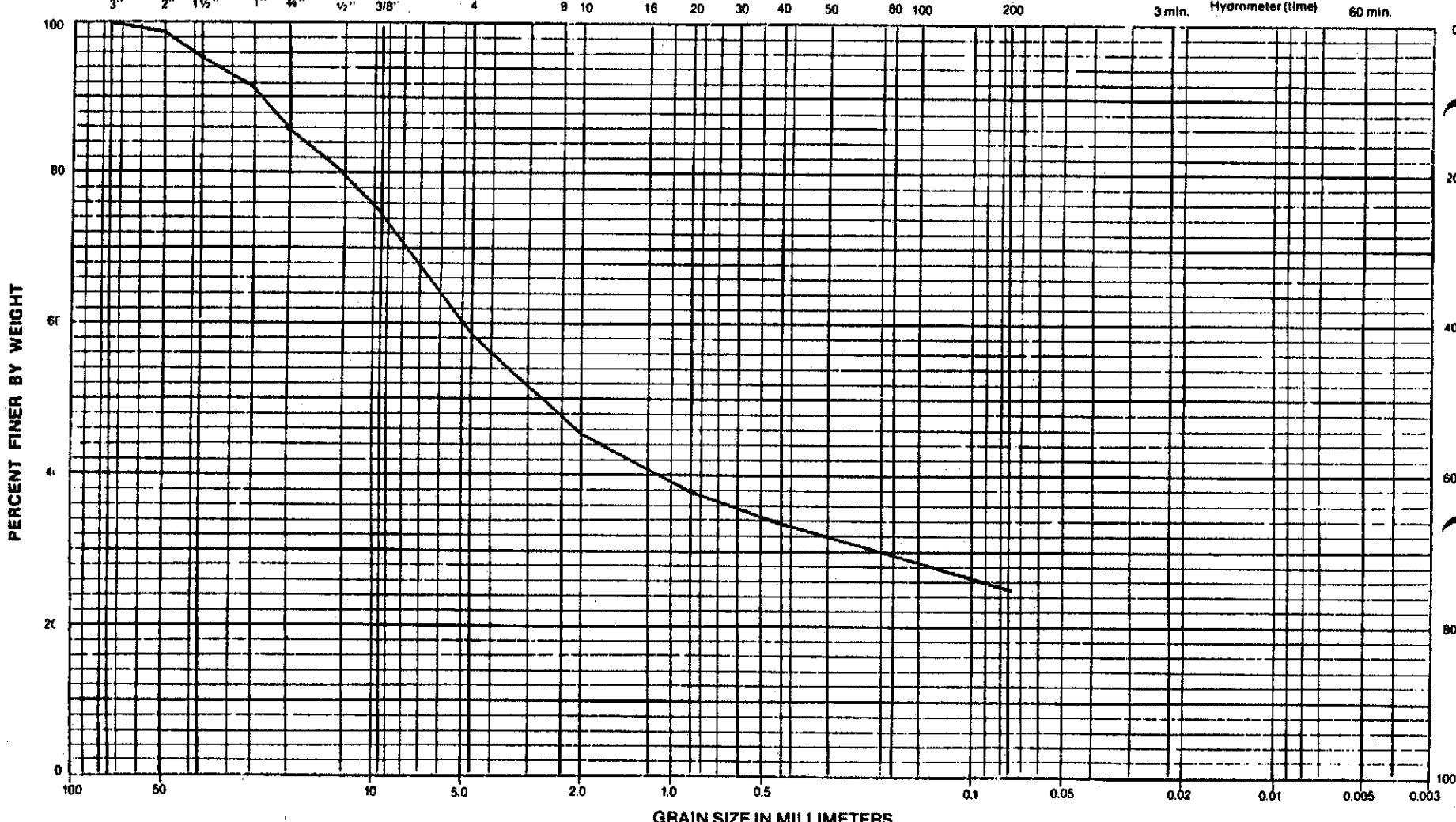
Liquid Limit -- %

Plasticity Index -- %

$$\text{Coefficient of Curvature} = C_Z = \frac{(D_{30})^2}{D_{10} \times D_{60}} =$$

U.S. Standard Sieve Numbers

8	10	16	20	30	40	50	60	100	200
---	----	----	----	----	----	----	----	-----	-----



Gravel		Sand			Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

Chen-Northern, Inc.

GRAIN SIZE DISTRIBUTION CURVE

Project: Montanore Project, Libby, MT

Location: TP-247, 2.0' - 12.0'

Classification Silty Clayey GRAVEL with Sand

Moisture Content -- %

Sample No. 45983

Job No. 90-207

Date November 1990

Liquid Limit Granular %

Plasticity Index Non-Plastic %

$$\text{Coefficient of Uniformity} = C_U = \frac{D_{60}}{D_{10}} =$$

U.S. Standard Sieve Opening in Inches

3"	2"	1 1/2"	1"	3/4"	1/2"	3/8"	4
----	----	--------	----	------	------	------	---

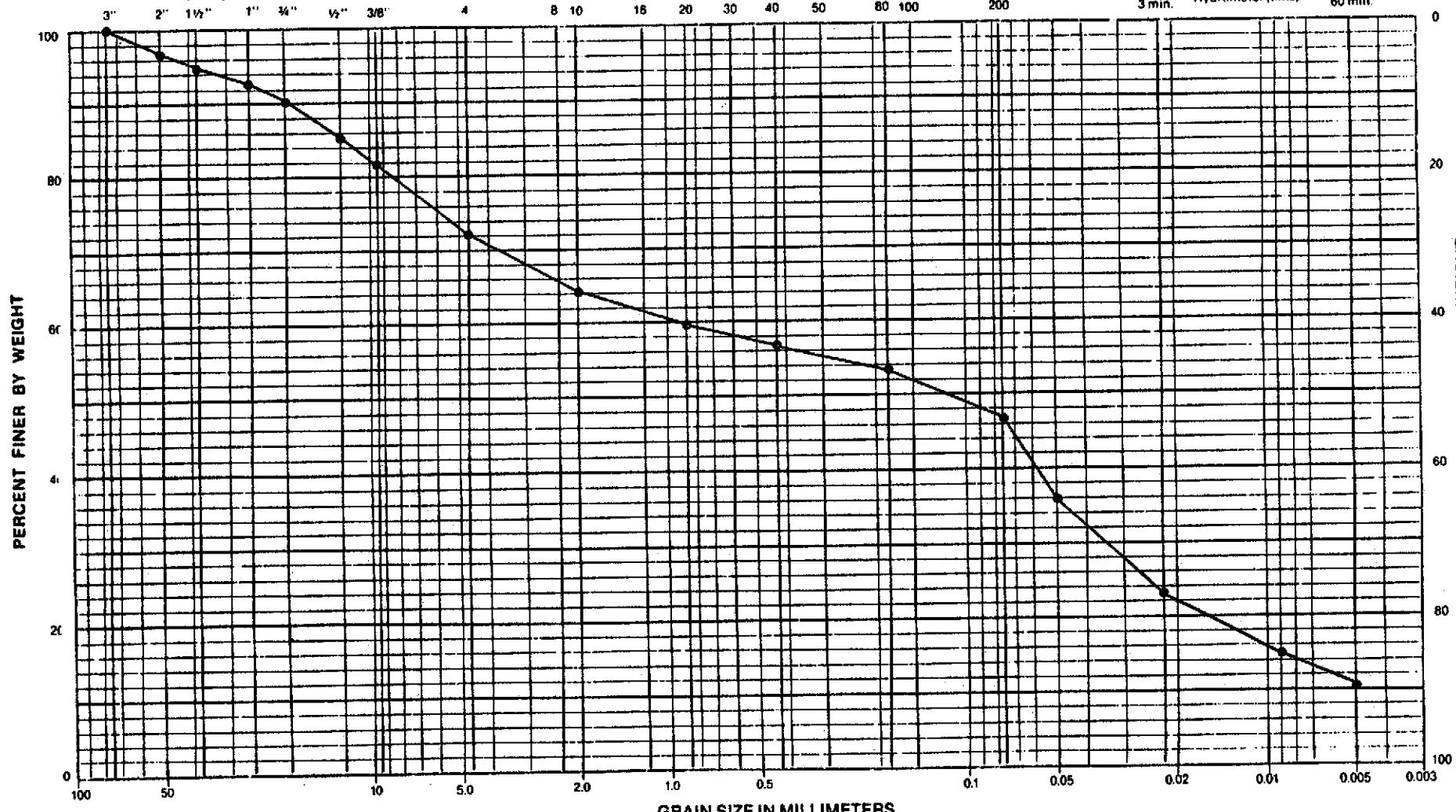
$$\text{Coefficient of Curvature} = C_Z = \frac{(D_{30})^2}{D_{10} \times D_{60}} =$$

U.S. Standard Sieve Numbers

8	10	15	20	30	40	50	80	100	200
---	----	----	----	----	----	----	----	-----	-----

3 min. Hydrometer (time)

60 min.



GRAIN SIZE IN MILLIMETERS

Gravel		Sand			Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

Chen-Northern, Inc.

GRAIN SIZE DISTRIBUTION CURVE

Project: Montanore Project, Libby, MT

Location: TP 248 2' to 12'

Classification Silty GRAVEL w/Sand

Moisture Content 14 %

Sample No. 45809

Job No. 90-207

Date Nov. 1990

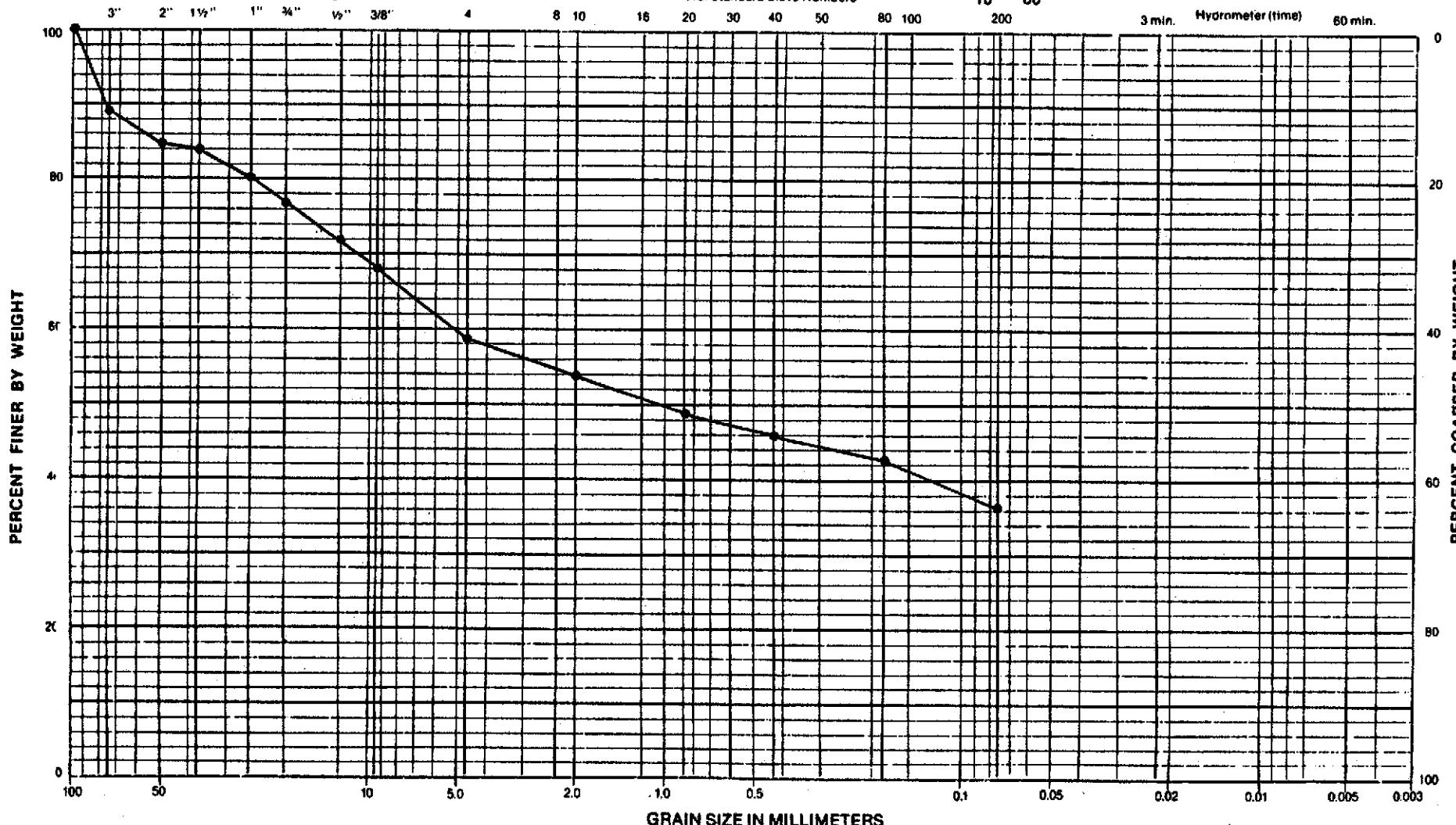
Plasticity Index Non-Plastic

$$\text{Coefficient of Uniformity} = C_U = \frac{D_{60}}{D_{10}} =$$

U.S. Standard Sieve Opening in Inches

$$\text{Coefficient of Curvature} = C_Z = \frac{(D_{30})^2}{D_{10} \times D_{60}} =$$

U.S. Standard Sieve Numbers



Gravel		Sand			Fines		
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay	

Chen-Northern, Inc.

GRAIN SIZE DISTRIBUTION CURVE

Project: Montanore Project, Libby, MT
 Location: TP-249 1.0' -- 12.5'
 Classification Silty GRAVEL w/Sand
 Moisture Content 11 %

Sample No. 45180

Job No. 90-207

Date Nov. 1990

Plasticity Index 2 %

Liquid Limit 21 %

$$\text{Coefficient of Uniformity} = C_U = \frac{D_{60}}{D_{10}} =$$

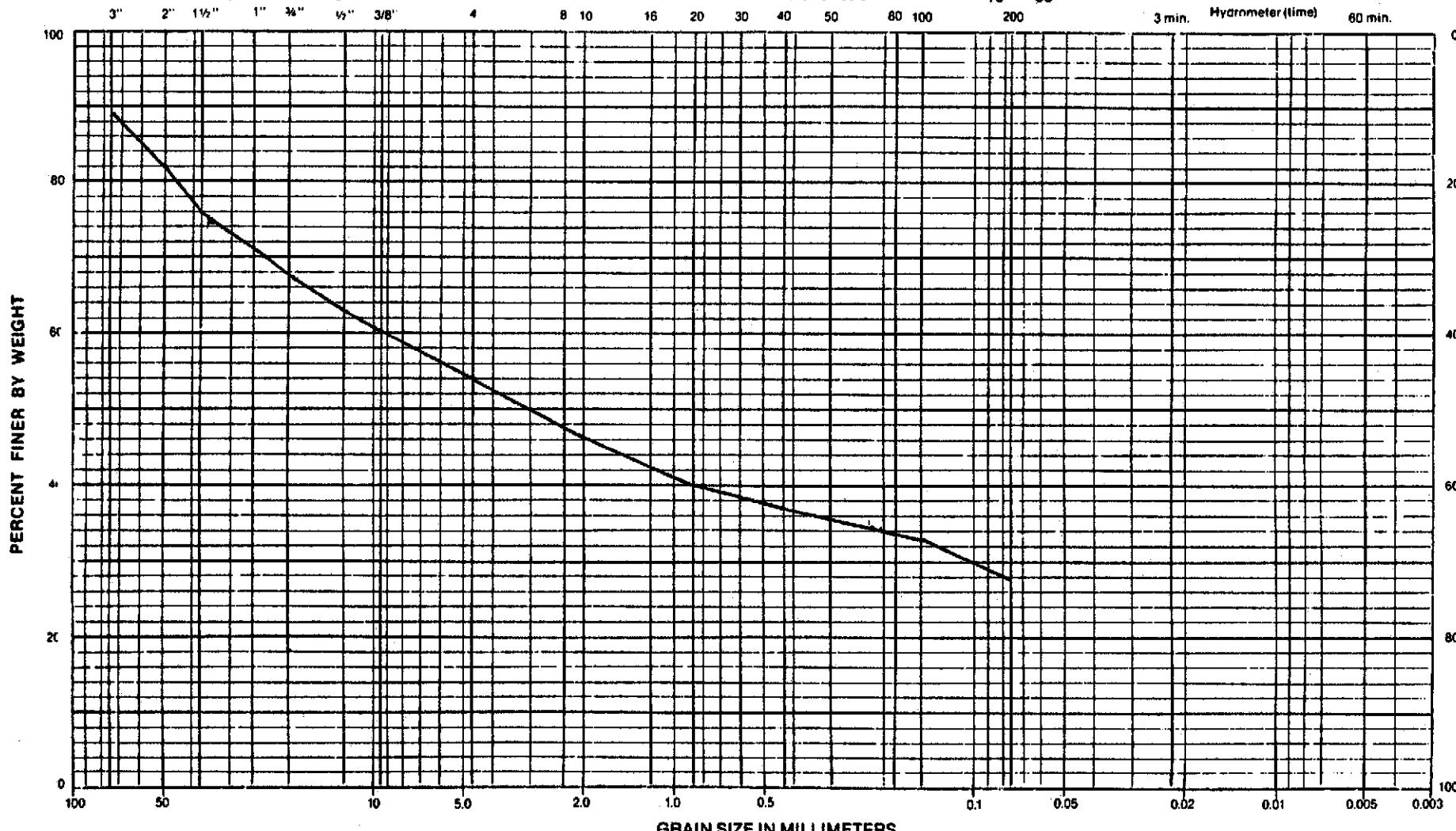
U.S. Standard Sieve Opening in inches

3"	2"	1 1/2"	1"	5/8"	1/2"	3/8"	4
----	----	--------	----	------	------	------	---

$$\text{Coefficient of Curvature} = C_Z = \frac{(D_{30})^2}{D_{10} \times D_{60}} =$$

U.S. Standard Sieve Numbers

8	10	16	20	30	40	50	80	100	200
---	----	----	----	----	----	----	----	-----	-----



Gravel		Sand			Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

Chen-Northern, Inc.

GRAIN SIZE DISTRIBUTION CURVE

Project: Montanore Project, Libby, MT

Location: TP-250, 2.0' - 11.5'

Classification Silty GRAVEL with Sand

Moisture Content 17 %

Sample No. 45811

Job No. 90-207

Date November 1990

$$\text{Coefficient of Uniformity} = C_U = \frac{D_{60}}{D_{10}} =$$

U.S. Standard Sieve Opening in Inches

3"	2"	1 1/2"	1"	5/8"	1/2"	3/8"
----	----	--------	----	------	------	------

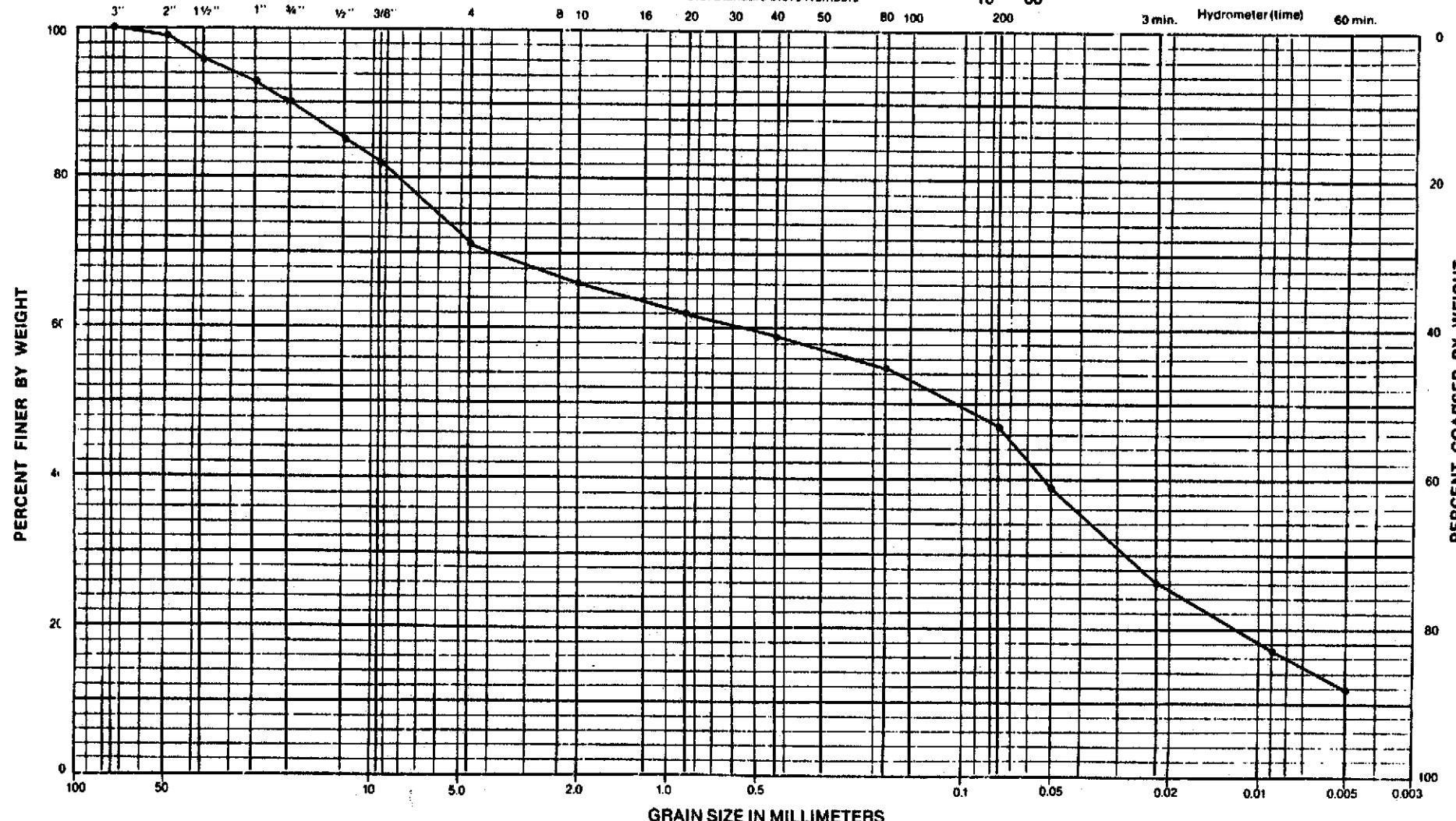
Liquid Limit Granular %

Plasticity Index Non-Plastic %

$$\text{Coefficient of Curvature} = C_Z = \frac{(D_{30})^2}{D_{10} \times D_{60}} =$$

U.S. Standard Sieve Numbers

8	10	16	20	30	40	50	80	100	200
---	----	----	----	----	----	----	----	-----	-----



Gravel		Sand			Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

WASTE ROCK TEST RESULTS

Chen-Northern, Inc.
Consulting Geotechnical Engineers

Table II
Summary of Laboratory Test Results
Montanore Project
Libby, Montana

October 26, 1990
Job No. 90-207
Sheet: 1 of 1

M-K Sample ID CNI Lab No.	Waste Rock 45415	Waste Rock 45416
Sodium Sulfate Soundness (ASTM C88) % loss, 5 cycles	1.1	4.3
Specific Gravity (ASTM C127)		
Bulk Dry	2.74	2.73
Bulk (SSD)	2.75	2.74
Apparent	2.76	2.75
Absorption, %	0.24	0.35
Los Angeles Abrasion (ASTM C535) % loss, Grading T		
Loss @ 200 Revolutions	4.3	---
Loss @ 1000 Revolutions	16.6	---

MONTANORE PROJECT
SUMMARY OF WASTE ROCK
QUALITY TESTS
FIGURE C-17

Chen-Northern, Inc.
Consulting Geotechnical Engineers

Table IV
Summary of Laboratory Test Results
Montanore Project
Libby, Montana

November 6, 1990
Job No. 90-207
Sheet: 1 of 1

Location: Waste Rock
CNI Lab Nos. Bag 1 & 3
45415 & 45417

Relative Density Determination ASTM D4253/D4254

Minimum Density Determination	
0% Relative Density	78.5 pcf
Maximum Density Determination	
100% Relative Density (Dry Method)	94.4 pcf
100% Relative Density (Wet Method)	92.4 pcf

MONTANORE PROJECT
MAXIMUM AND MINIMUM DENSITY
FIGURE C-1B

TAILINGS TEST RESULTS

MONTANORE TAILINGS TESTING PROGRAM (89-614)

Item No. 1: Specific Gravity, Liquid Limit and Plasticity Index
(WHOLE TAILINGS)

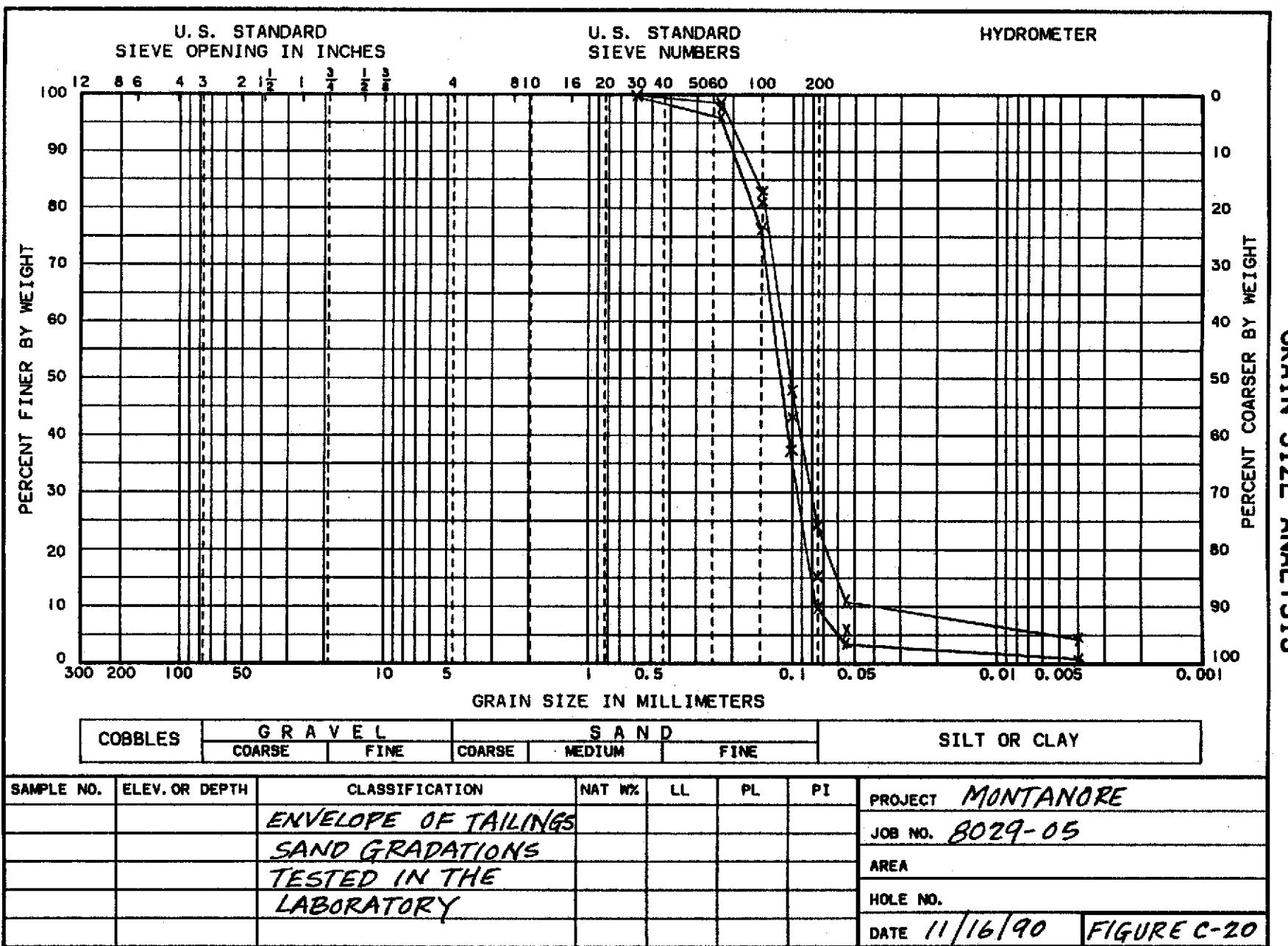
Specific Gravity: 2.713

Liquid Limit and Plasticity Index: Granular non-plastic

Item No. 2: Sieve Analysis

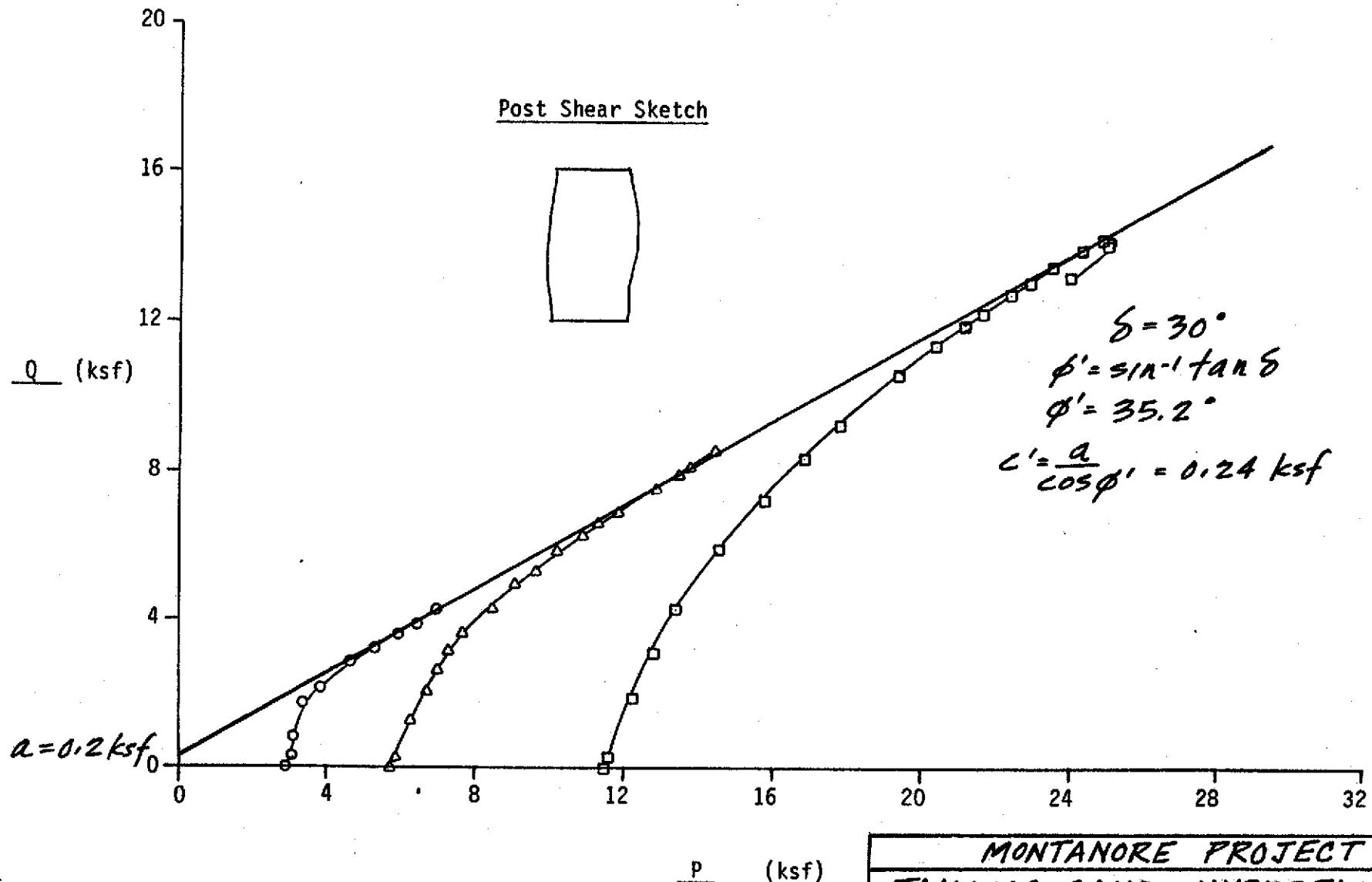
Sieve Size	Underflow No.5 Gradation of Sample Made From Bags Supplied By Brenda	UNDERFLOW NO.5 Item No. 2 Specified Gradation
30	100	-
65	99	99
100	77	77
150	37	33
200	12	10
270	5.0	2.5
400	0.1	0.7

MONTANORE PROJECT
WHOLE TAILINGS DATA AND
UNDERFLOW NO. 5 GRADATION
FIGURE C-19



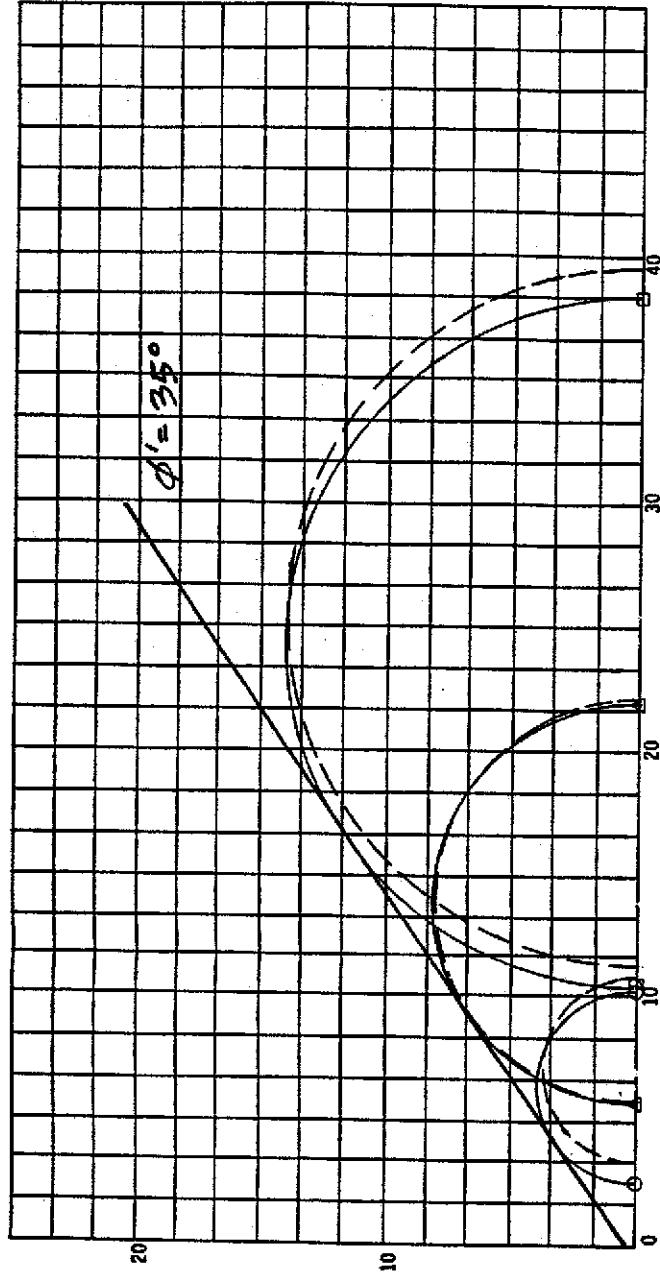
CU TRIAXIAL TESTS - UNDERFLOW NO. 5

MONTANORE TAILINGS TESTING PROGRAM
 ITEM NO. 2 - CONSOLIDATED UNDRAINED TRIAXIAL SHEAR TEST - P-Q STRESS PATCH PLOT

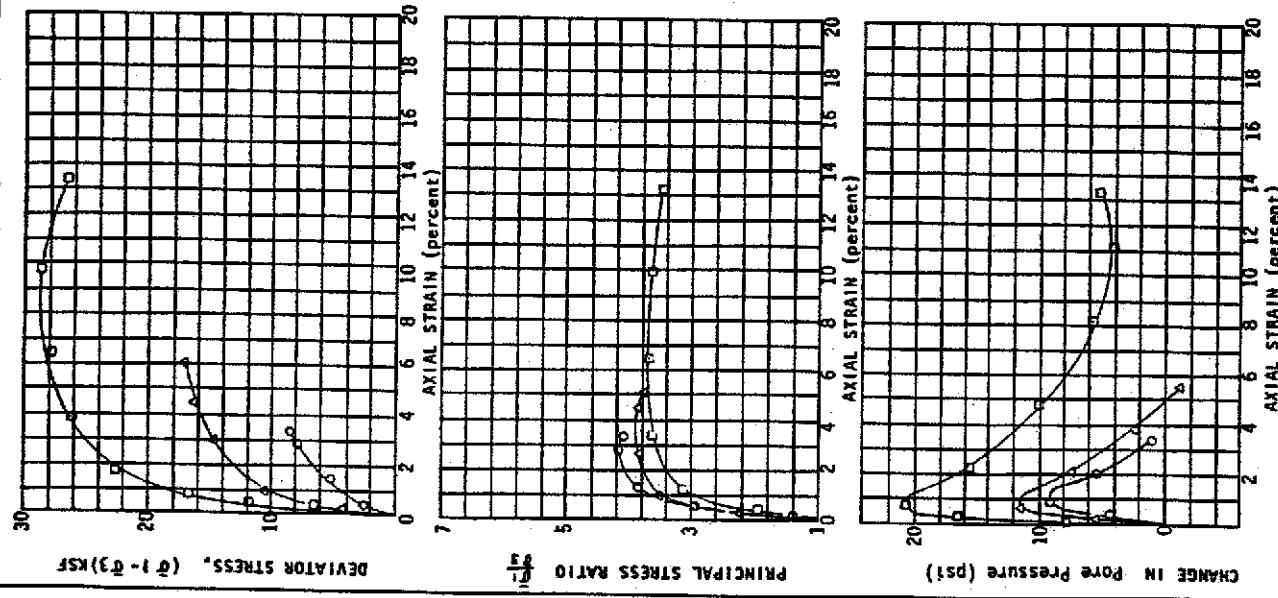


MONTANORE PROJECT	
TAILINGS SAND - UNDERFLOW No.5	
CUTRIAXIAL TESTS: P-Q STRESS PATHS	
FIGURE 1-21A (SHEET 1 OF 2)	

MUL 11-STAGED CONSOLIDATED UNDRAINED TRIAXIAL SHEAR TEST - REBOLDED



SHEAR STRESS AT Maximum Stress Ratio (ksf)



TEST NO.	SAMPLE DATA			VALUES AT MOHR-COULOMB FAILURE			HEIGHT TO DIAMETER RATIO	RATE OF STRAIN INCHES/MINUTE	COEFFICIENT OF PERMEABILITY CM/SEC
	BORING NO. OR SYMBOL	DRY DENSITY (G/cm³)	MOISTURE CONTENT (percent)	INITIAL POLE PRESSURE RESPONSE (percent)	MAXIMUM PRINCIPAL STRESS & 1-Q'S KSF	MINOR PRINCIPAL STRESS Q KSF			
O Item	90.0	20.0	--	99	20	7.81	4.17	2.46	10.27
△ No. 2	--	--	--	--	40	16.17	3.86	5.66	21.83
□	--	--	30.2	--	80	27.85	3.68	10.41	38.24

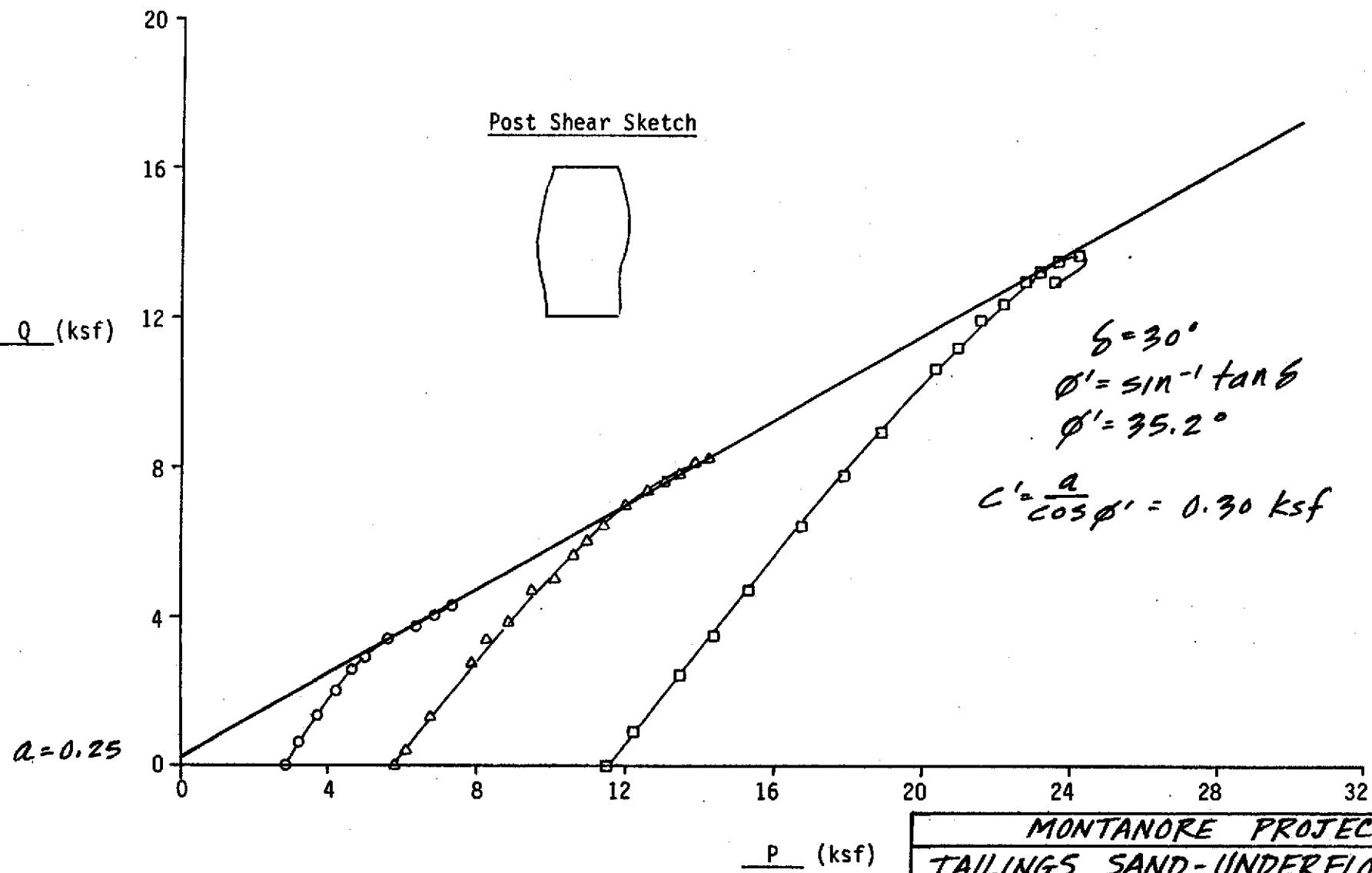
TRIAxIAL SHEAR TEST RESULTS		MONTANORE TAILINGS TESTING PROGRAM	
Job No.	Date	Plate No.	
89-614	June, 1990		

MONTANORE PROJECT	
TAILINGS SAND - UNDERFLOW No. 5	
CUTRIAXIAL TESTS: MOHR ENVELOPE	
FIGURE C-21B (SHEET 2 OF 2)	

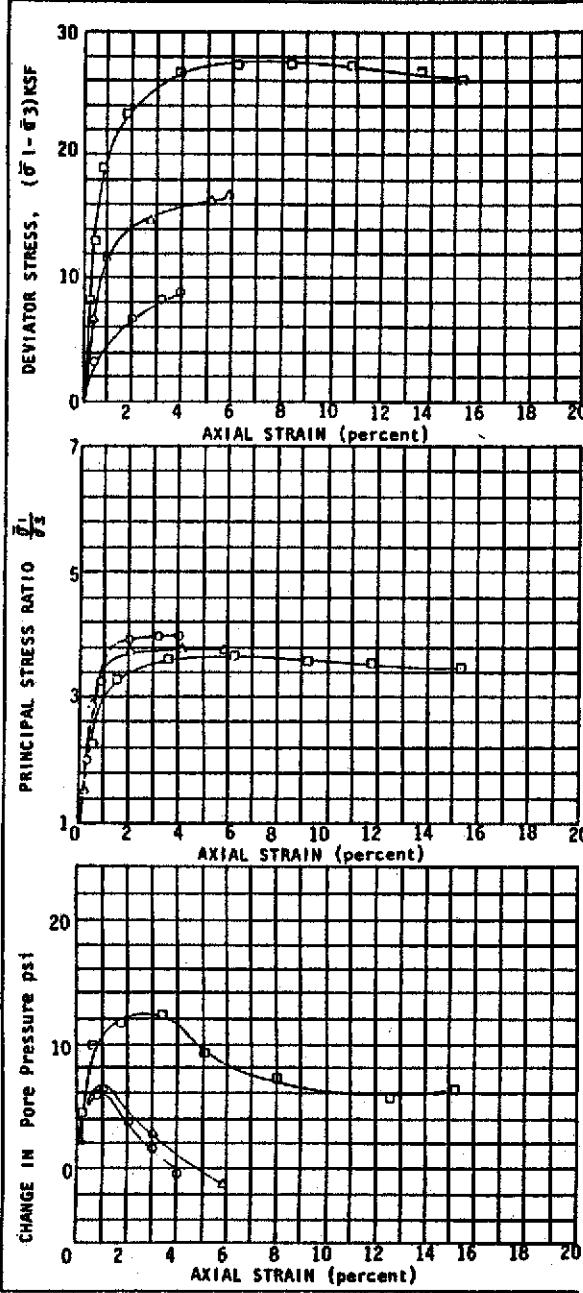
CU TRIAXIAL TEST - UNDERFLOW NO. 7

MONTANORE TAILINGS TESTING PROGRAM

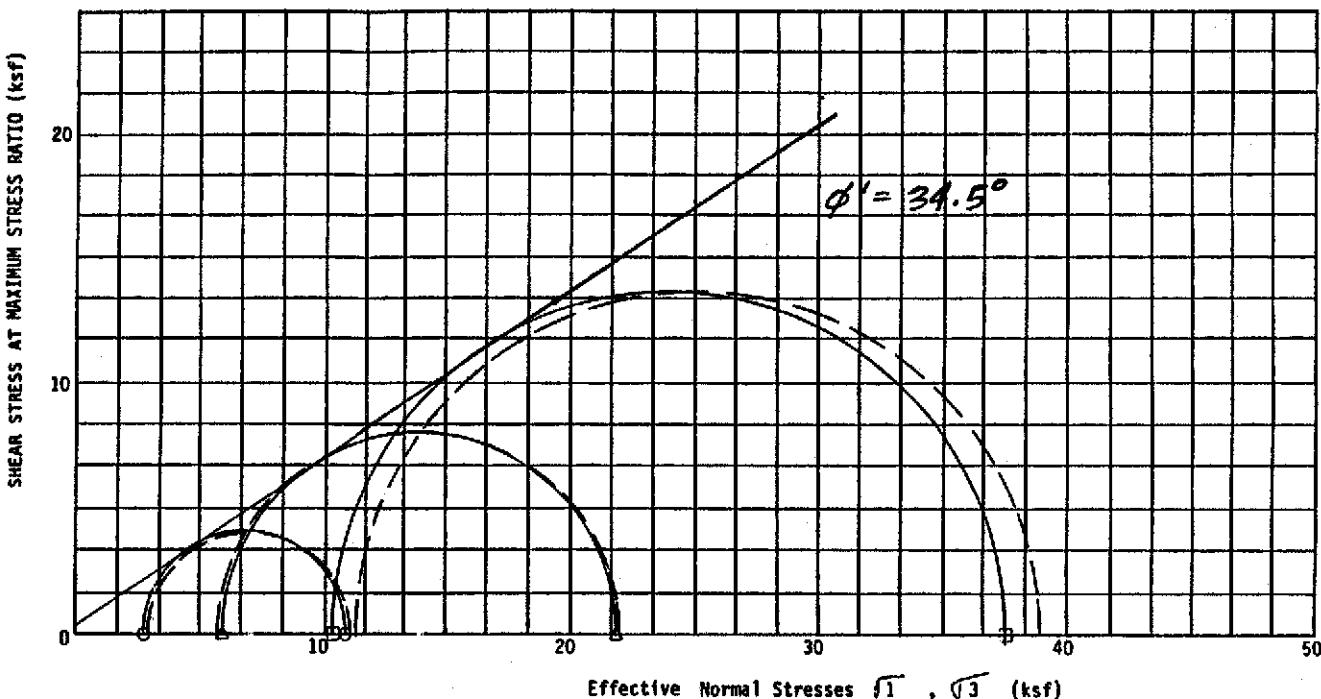
Item No. 3 - Consolidated Undrained Triaxial Shear Test P-Q Stress Path Plot



<p>MONTANORE PROJECT TAILINGS SAND - UNDERFLOW No. 7 CU TRIAXIAL TESTS: P-Q STRESS PATH FIGURE C-22A (SHEET 1 OF 21)</p>



MULTI-STAGED TRIAXIAL CONSOLIDATED UNDRAINED TRIAXIAL SHEAR TEST - REMOLDED



TEST NO. OR SYMBOL	BORING NO. AND DEPTH	SAMPLE DATA		PORE PRESSURE RESPONSE (percent)	CONFINING PRESSURE σ_3 psi	MAXIMUM DEVIATOR STRESS $\sigma_1 - \sigma_3$ ksf	MAXIMUM PRINCIPAL STRESS RATIO σ_1/σ_3	VALUES AT MOHR COULOMB FAILURE		HEIGHT TO DIAMETER RATIO	RATE OF STRAIN INCHES/MINUTE	Coefficient of Permeability cm/sec.	
		DRY DENSITY (pcf)	MOISTURE CONTENT (percent)	Initial	Final			MINOR PRINCIPAL STRESS σ_3 ksf	MAJOR PRINCIPAL STRESS σ_1 ksf				
(○)	Item No. 3	88.2	20.0	--	99	20	8.16	3.97	2.75	10.91	2.14	0.009	3×10^{-3}
(△)		--	--	--	--	40	16.07	3.79	5.76	21.83	2.14	0.009	--
(□)		--	--	30.5	--	80	27.17	3.64	10.31	37.48	2.14	0.009	--

TRIAXIAL SHEAR TEST RESULTS		
MONTANORE TAILINGS TESTING PROGRAM		
JOB NO.	DATE	PLATE NO.
89-614	June, 1990	

MONTANORE PROJECT
TAILINGS SAND - UNDERFLOW No. 7
CUTRIAXIAL TESTS: MOHR ENVELOPE
FIGURE C-22B (SHEET 2 OF 2)

MONTANORE TAILINGS TESTING PROGRAM (89-614)

Item No. 2: Constant Head Permeability and Sieve Analysis
Underflow Gradation No. 5

Dry Density (pcf)	Moisture Content (%)	Hydraulic Gradient	Coefficient of Permeability (cm/sec)	Sieve Analysis
				Sieve Size % Passing
(1) 85	18	0.11	1.5×10^{-3}	(Not Performed)
		0.39	1.7×10^{-3}	
		0.49	1.5×10^{-3}	
		1.01	1.7×10^{-3}	
		2.09	1.5×10^{-3}	
<i>TEST NO.</i>				
(2) 90	20	0.10	1.6×10^{-3}	30 100
		0.12	1.7×10^{-3}	65 (Test 97
		0.27	1.3×10^{-3}	100 performed 83
		0.27	1.5×10^{-3}	150 from CU 48
		0.49	1.3×10^{-3}	200 test) 23
			1.3×10^{-3}	270 11.5
				400 6.6
(3) 90	20	0.07	3.2×10^{-3}	30 100
		0.13	3.2×10^{-3}	65 99
		0.28	2.9×10^{-3}	100 77
		0.54	3.0×10^{-3}	150 33
		1.04	2.9×10^{-3}	200 10
		1.97	2.9×10^{-3}	270 2.7
				400 0.7

MONTANORE PROJECT
SUMMARY OF CONSTANT HEAD
PERMEABILITY TESTS
FIGURE C-23

MONTANORE TAILINGS TESTING PROGRAM (89-614)

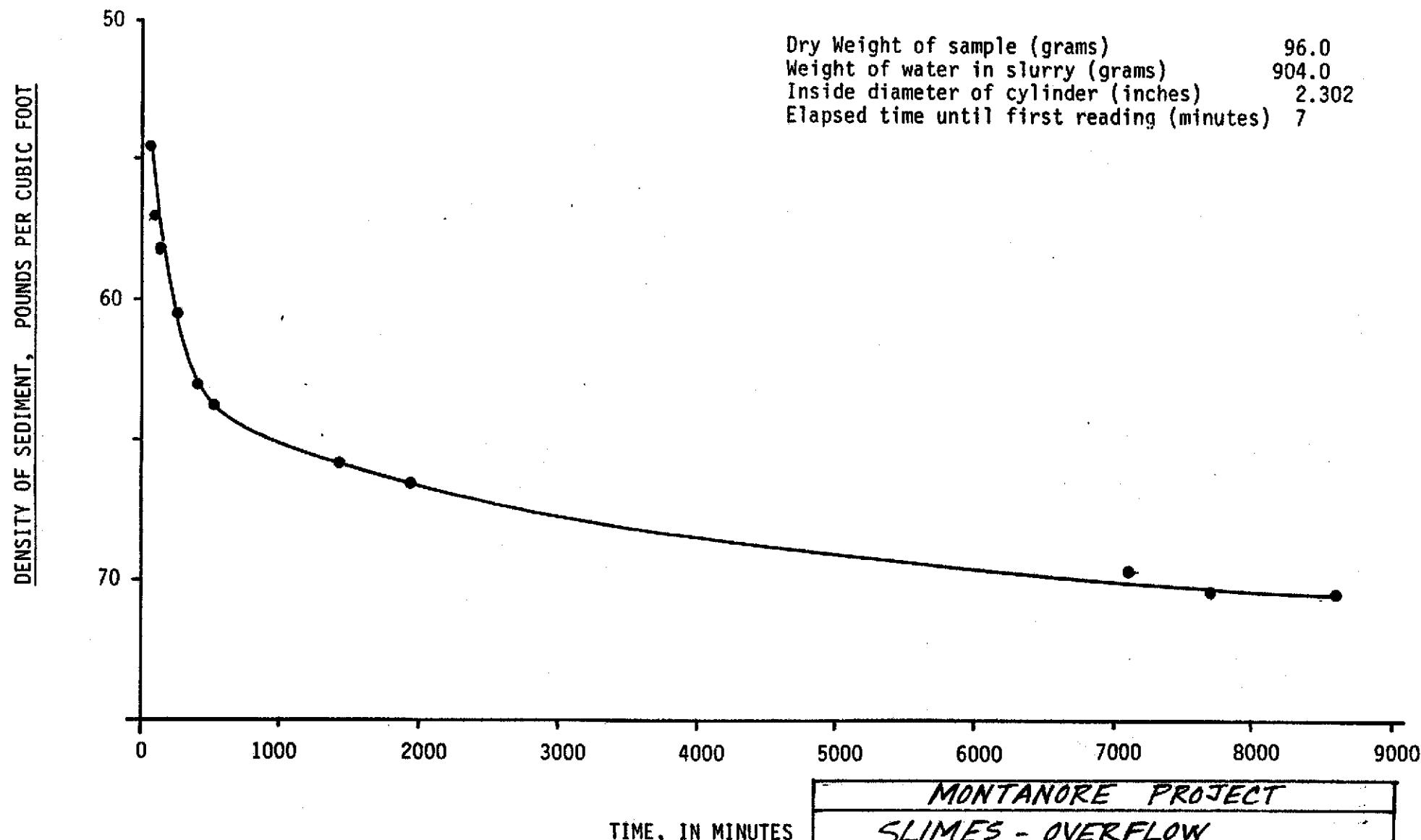
**Item No. 3: Constant Head Permeability and Sieve Analysis
Underflow Gradation No. 7**

Dry Density (pcf)	Moisture Content (%)	Hydraulic Gradient	Coefficient of Permeability (cm/sec)	Sieve Analysis	
				Sieve Size	% Passing
(4) 83.5	18	0.11	3.0×10^{-3}	(Not Performed)	
		0.18	3.0×10^{-3}		
		0.30	2.8×10^{-3}		
		0.45	2.7×10^{-3}		
		0.94	2.8×10^{-3}		
		1.87	2.8×10^{-3}		
(5) 88.2	20	0.07	2.5×10^{-3}	30	100
		0.15	2.1×10^{-3}	65	98
		0.24	1.8×10^{-3}	100	83
		0.38	1.8×10^{-3}	150	46
		0.86	1.8×10^{-3}	200	22
		1.94	1.8×10^{-3}	275	10.1
				400	4.4
(6) 88.2	20	0.09	3.5×10^{-3}	30	100
		0.15	3.2×10^{-3}	65	90
		0.30	3.2×10^{-3}	100	81
		0.57	3.2×10^{-3}	150	41
		1.07	3.4×10^{-3}	200	14
		1.99	3.3×10^{-3}	275	3.1
				400	0.8

MONTANORE PROJECT	
SUMMARY OF CONSTANT HEAD	
PERMEABILITY TESTS	
FIGURE C-24	

MONTANORE TAILINGS TESTING PROGRAM (89-614)

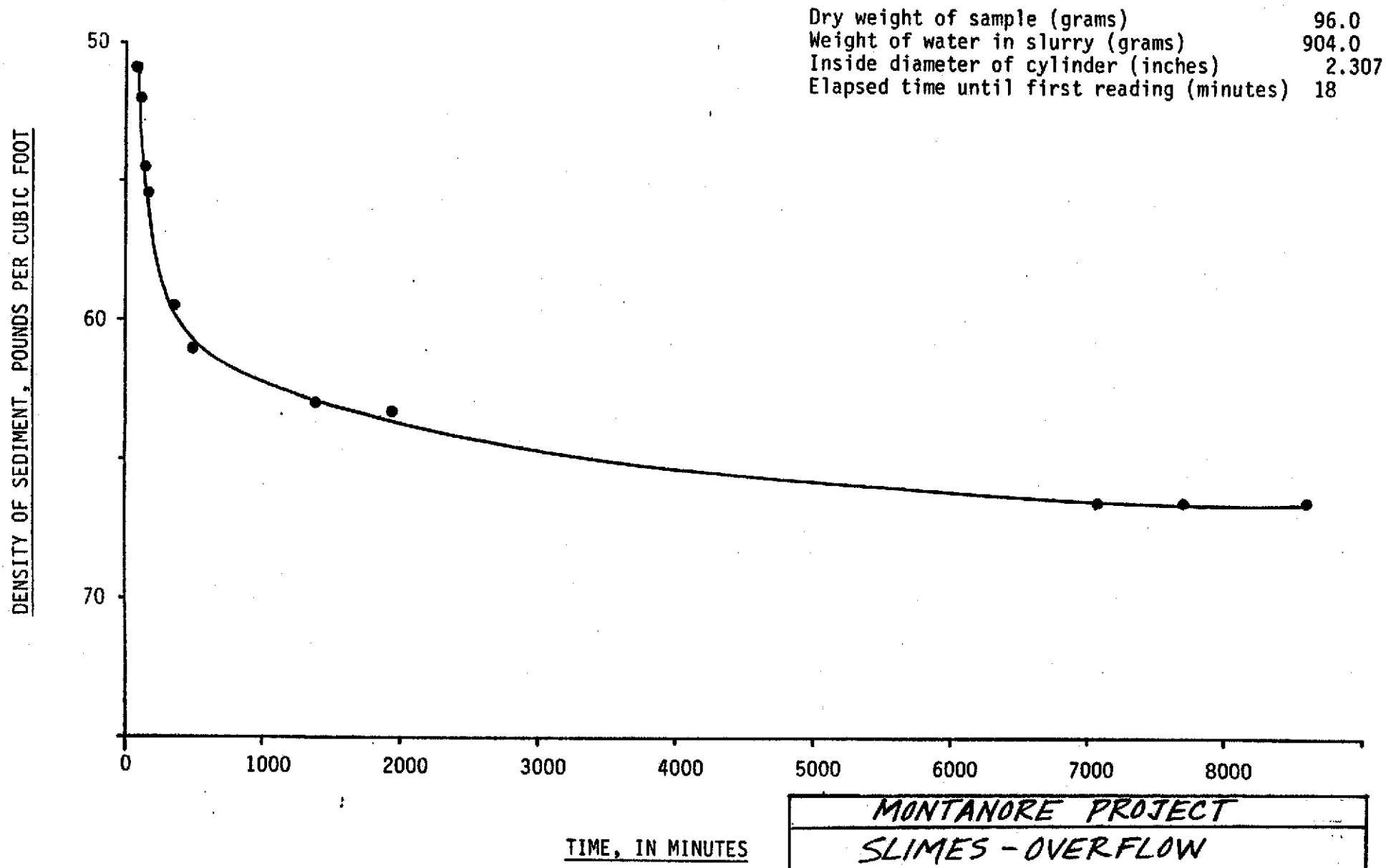
Item No. 4 - Sedimentation Density Test No. 1



MONTANORE PROJECT
SLIMES - OVERFLOW
SEDIMENTATION DENSITY
FIGURE C-25

MONTANORE TAILINGS TESTING PROGRAM (89-614)

Item No. 4 - Sedimentation Density Test No. 2



MONTANORE PROJECT
SLIMES - OVERFLOW
SEDIMENTATION DENSITY
FIGURE C-26

CONSOLIDATION TEST NO. 1

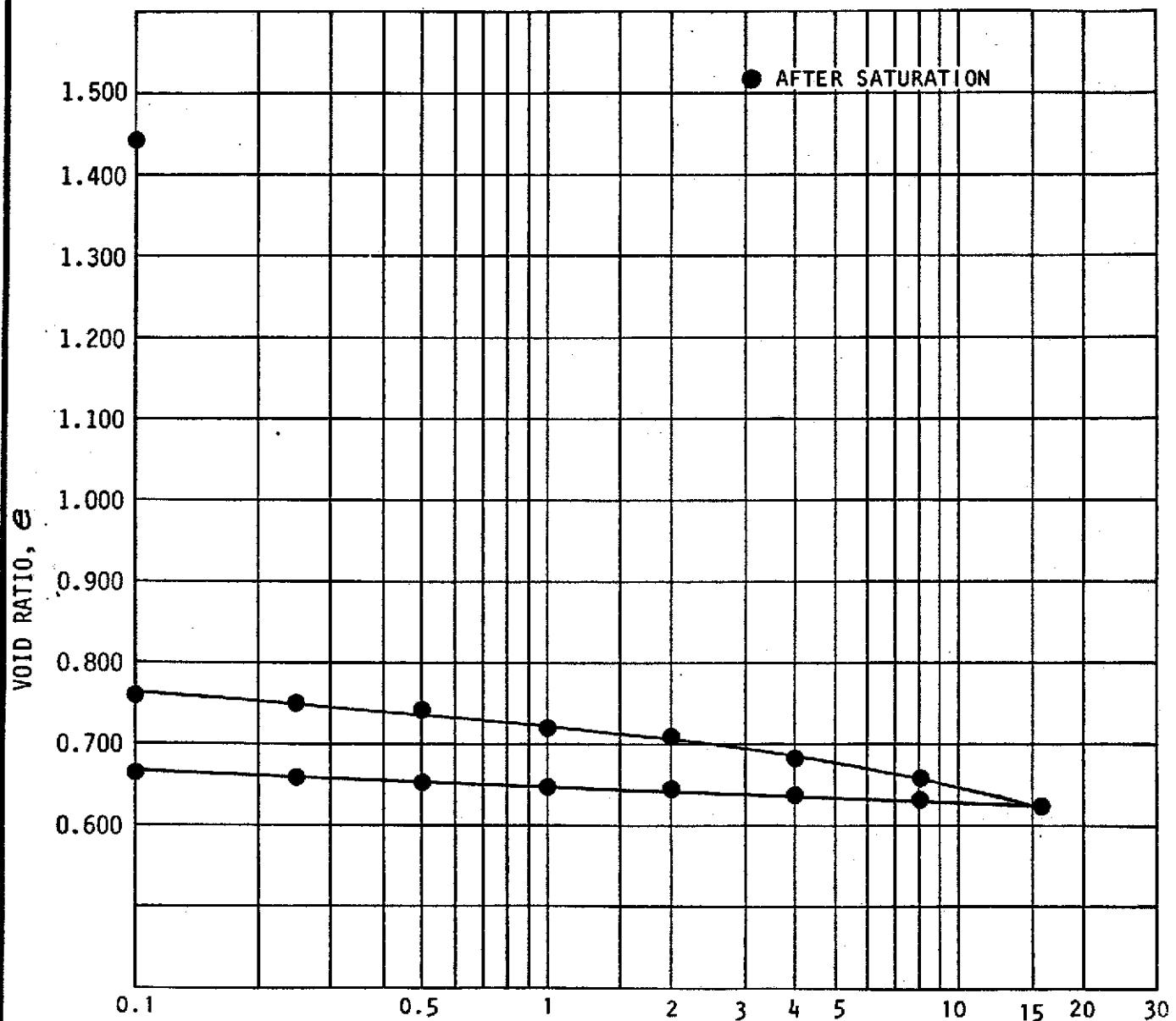
CONSOLIDATION TEST No. 1

DRILL HOLE Item No. 4

DEPTH

SAMPLE NO.

MOIST UNIT WEIGHT :
 DRY UNIT WEIGHT : 69.0pcf
 INITIAL MOISTURE CONTENT:
 FINAL MOISTURE CONTENT : 34.3%
 CLASSIFICATION :



NORMAL PRESSURE, KIPS PER SQUARE FOOT

SHEET 1 OF 8

SLIMES - OVERFLOW

Morrison - Knudson Engineers, Inc.
 San Francisco, CA

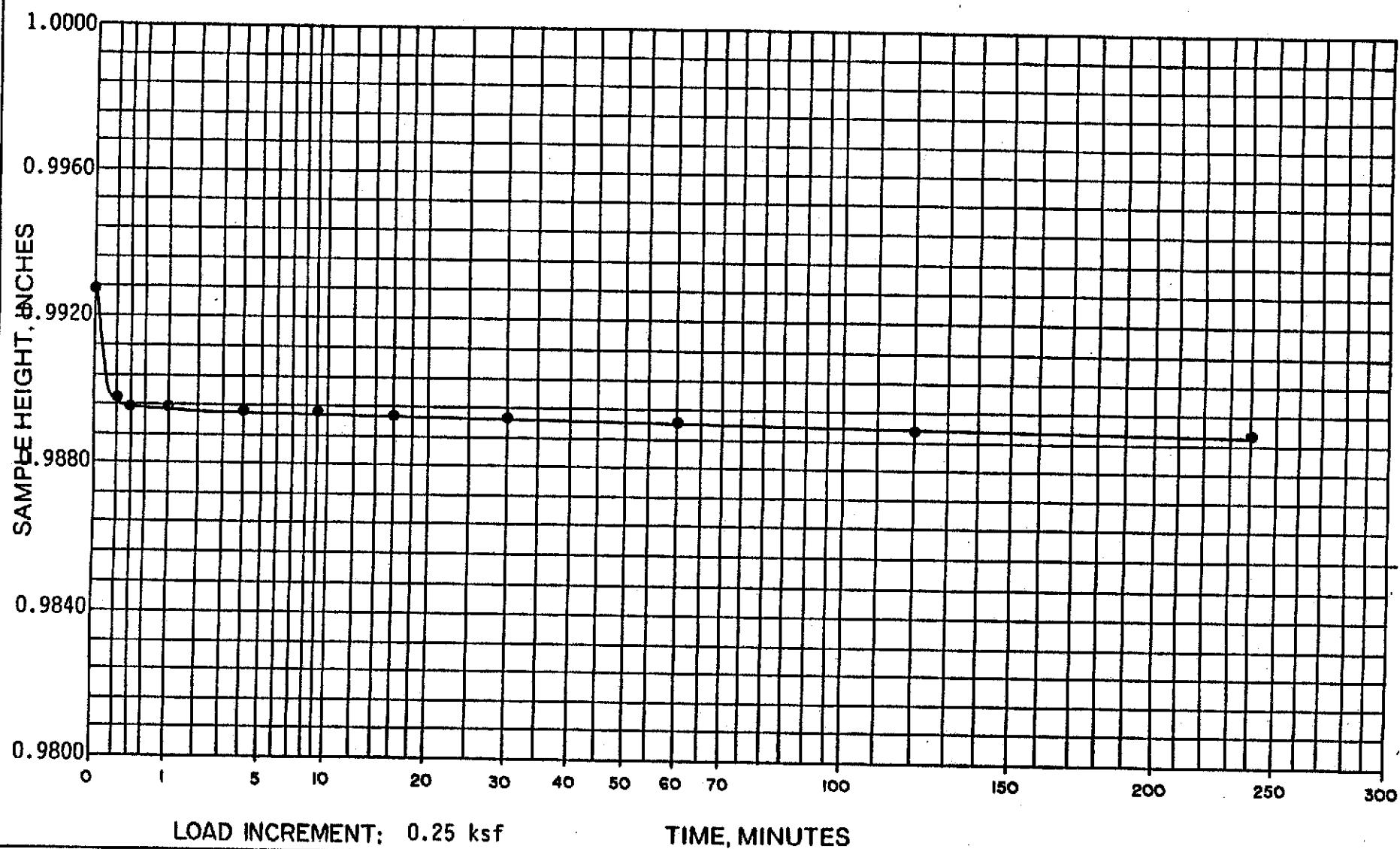
Chen-Northern, Inc.
A member of the group of companies

Montanore

JOB NO. 89-614

PLATE NO.

TIME RATE CONSOLIDATION TEST NO. 1



LOAD INCREMENT: 0.25 ksf

TIME, MINUTES

ITEM NO. 4	MOIST UNIT WEIGHT
DRILL HOLE _____	DRY UNIT WEIGHT _____
DEPTH _____	INITIAL MOISTURE CONTENT _____
CLASSIFICATION: _____	FINAL MOISTURE CONTENT _____

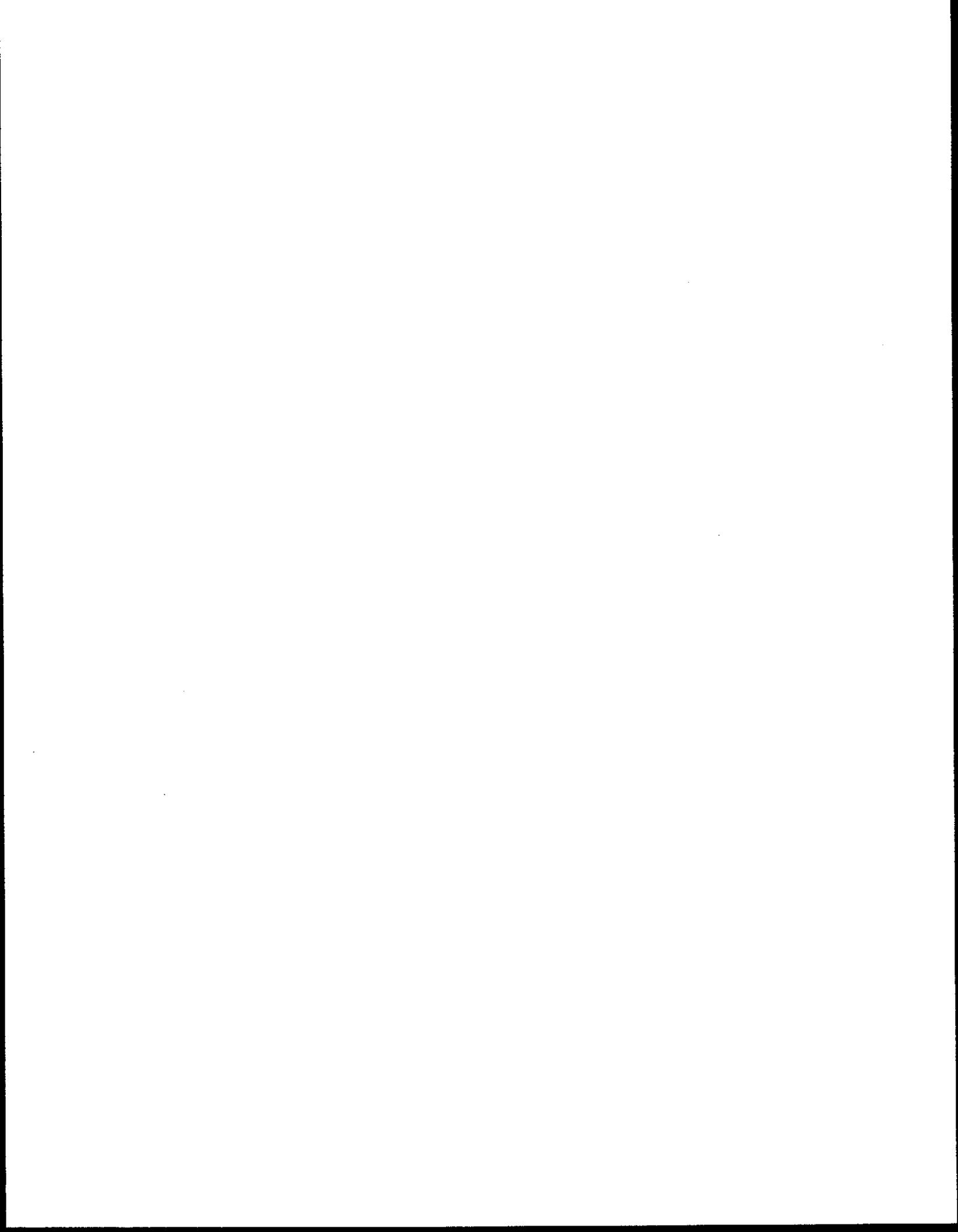
Chen Northern, Inc.

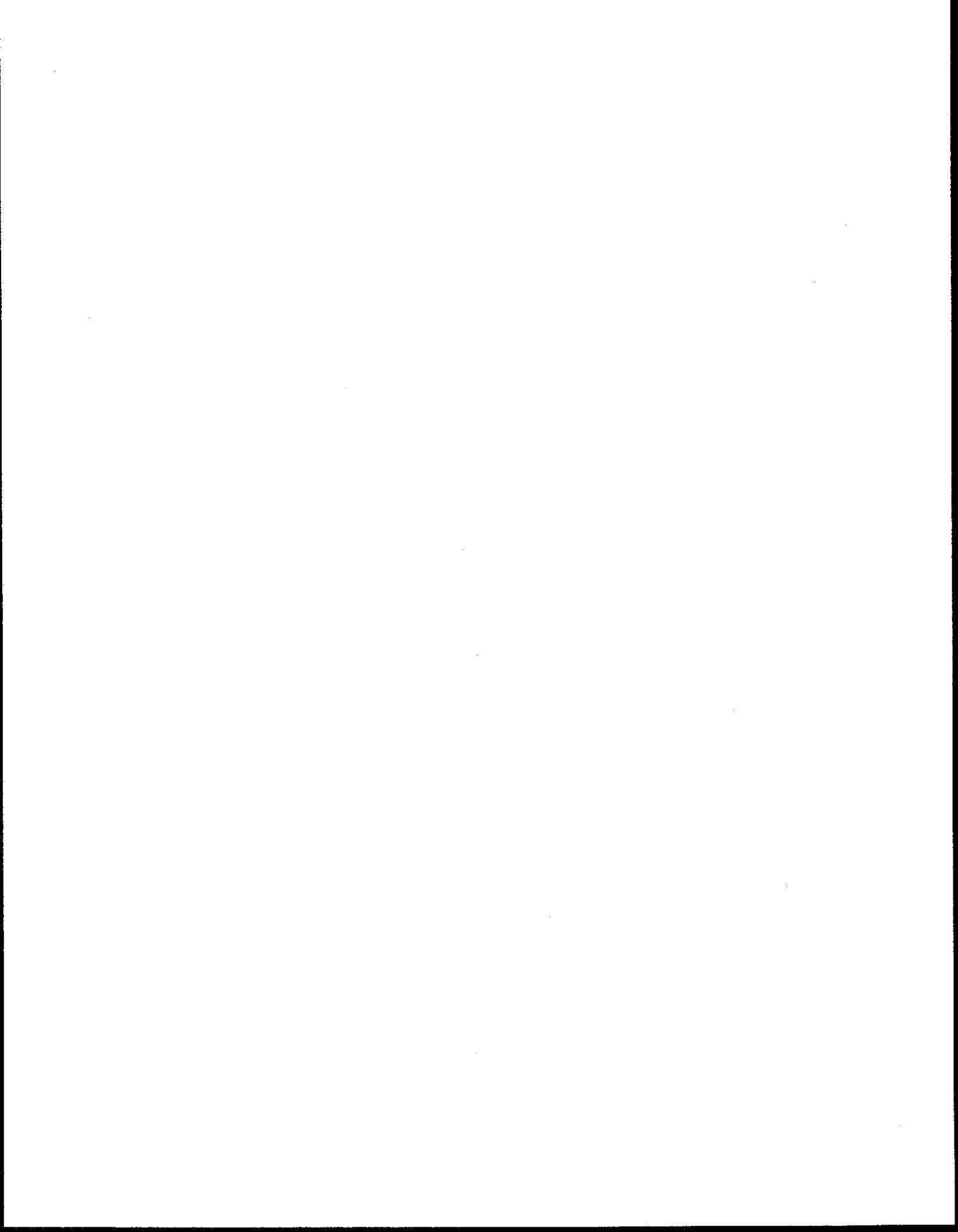
Consulting Engineers and Scientists

Job No. 89-614

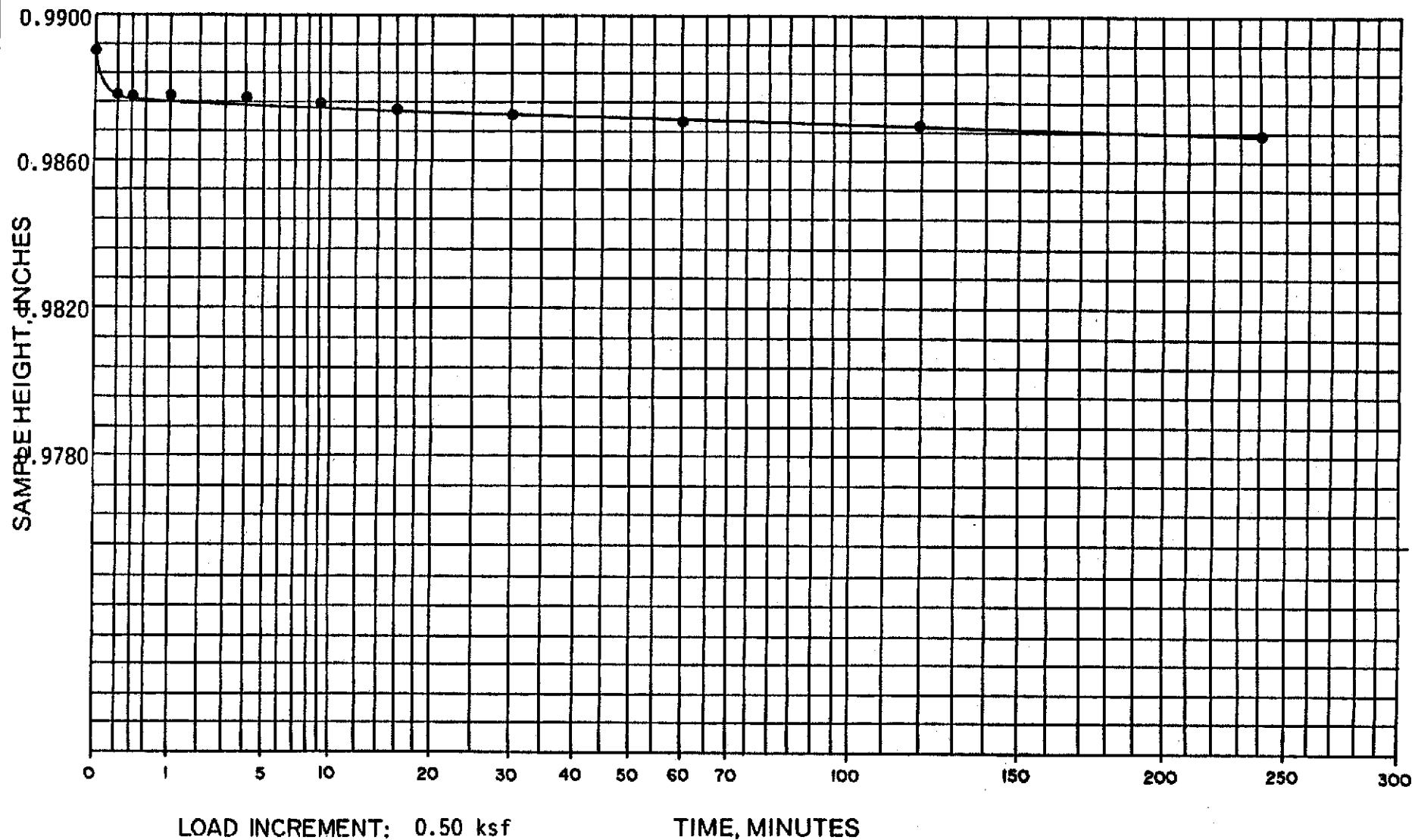
Plate No.

TSHEET 7 AEQ1



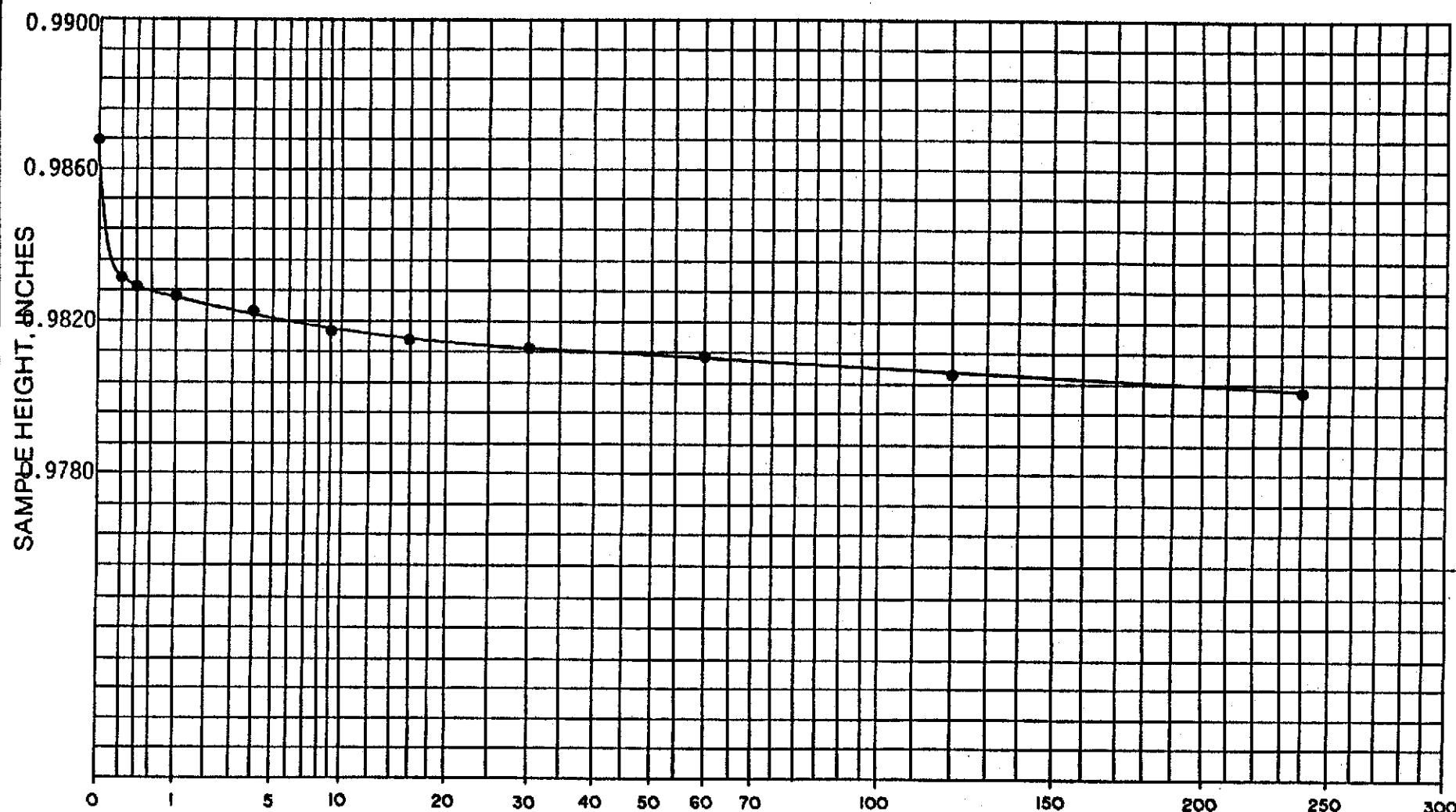


TIME RATE CONSOLIDATION TEST NO. 1



	ITEM NO. 4	MOIST UNIT WEIGHT	Chen Northern, Inc. Consulting Engineers and Scientists
	DRILL HOLE	DRY UNIT WEIGHT	
	DEPTH	CLASSIFICATION:	
		INITIAL MOISTURE CONTENT	Job No. 89-614
		FINAL MOISTURE CONTENT	Plate No.

TIME RATE CONSOLIDATION TEST NO. 1

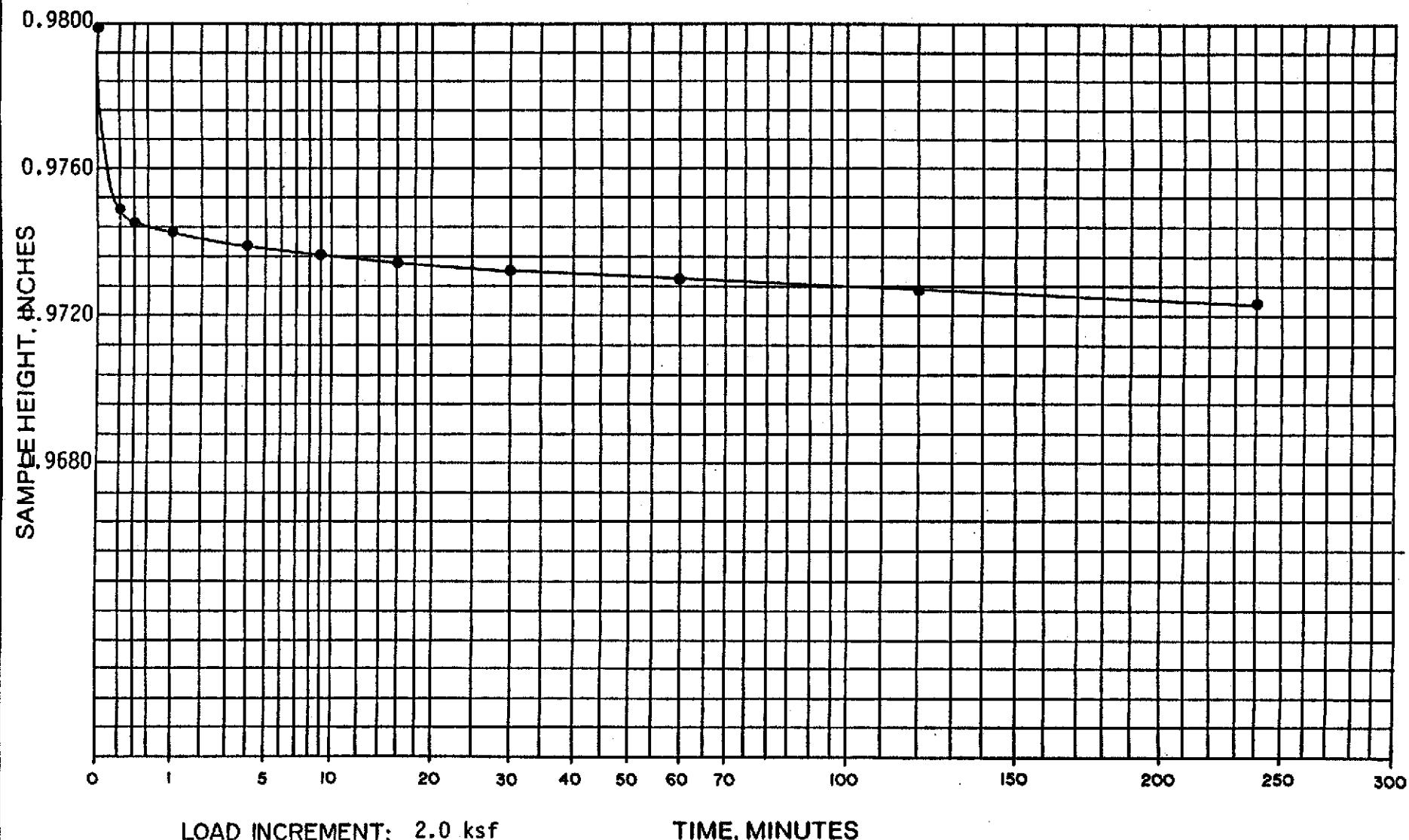


LOAD INCREMENT: 1.0 ksf

TIME, MINUTES

ITEM NO. 4	DRILL HOLE _____	MOIST UNIT WEIGHT _____	Chen Northern, Inc. Consulting Engineers and Scientists
	DEPTH _____	DRY UNIT WEIGHT _____	
	CLASSIFICATION: _____	INITIAL MOISTURE CONTENT _____	
		FINAL MOISTURE CONTENT _____	Job No. 89-614 Plate No.

TIME RATE CONSOLIDATION TEST NO. 1



LOAD INCREMENT: 2.0 ksf

TIME, MINUTES

ITEM NO. 4	MOIST UNIT WEIGHT
DRILL HOLE _____	DRY UNIT WEIGHT _____
DEPTH _____	INITIAL MOISTURE CONTENT _____
CLASSIFICATION: _____	FINAL MOISTURE CONTENT _____

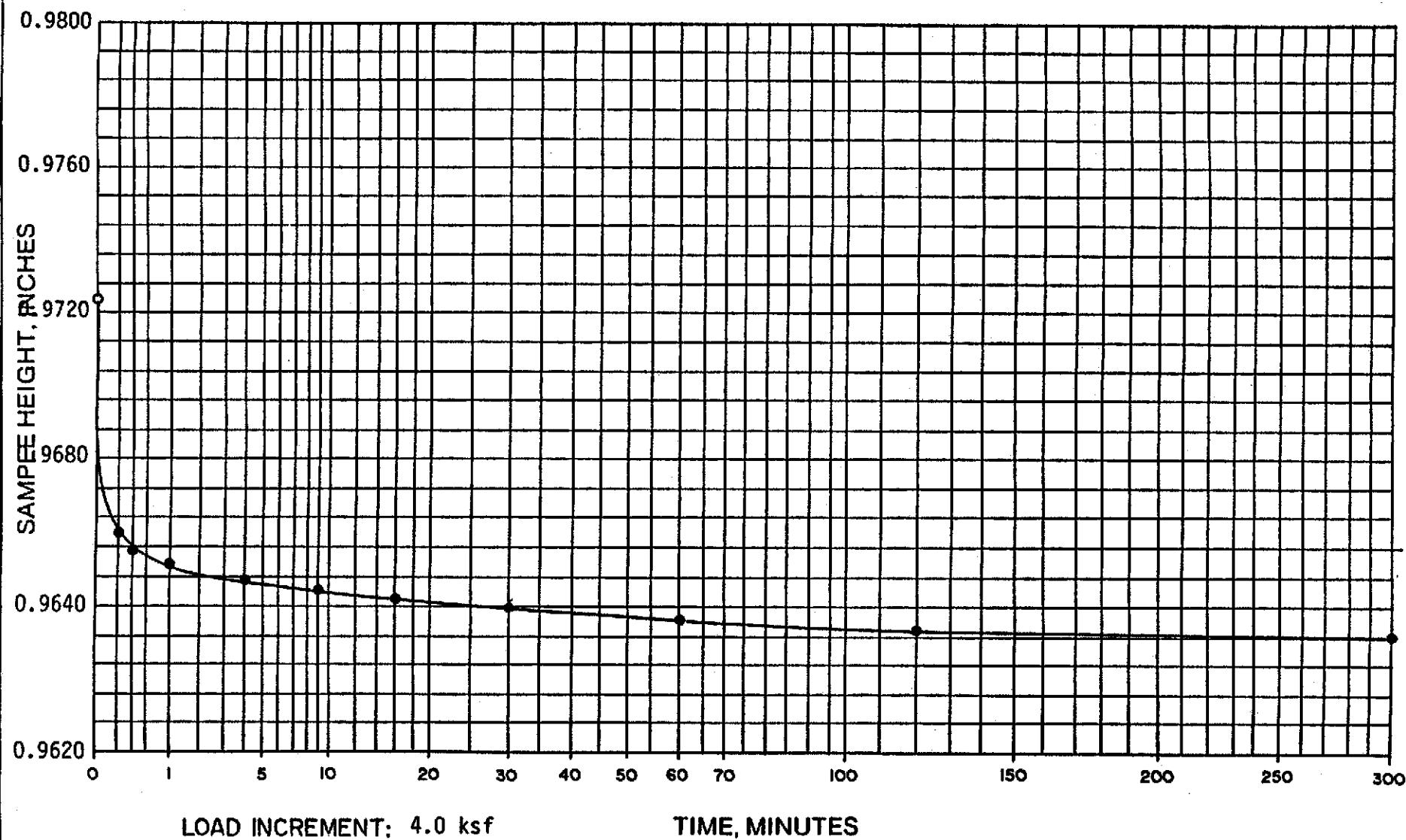
Chen Northern, Inc.

Consulting Engineers and Scientists

Job No. 89-614 Plate No.

(CHEN NORTHERN INC.)

TIME RATE CONSOLIDATION TEST NO. 1



LOAD INCREMENT: 4.0 ksf

TIME, MINUTES

ITEM NO. 4	DRILL HOLE _____	MOIST UNIT WEIGHT _____
	DEPTH _____	DRY UNIT WEIGHT _____
	CLASSIFICATION: _____	INITIAL MOISTURE CONTENT _____
		FINAL MOISTURE CONTENT _____

Chen Northern, Inc.

Consulting Engineers and Scientists

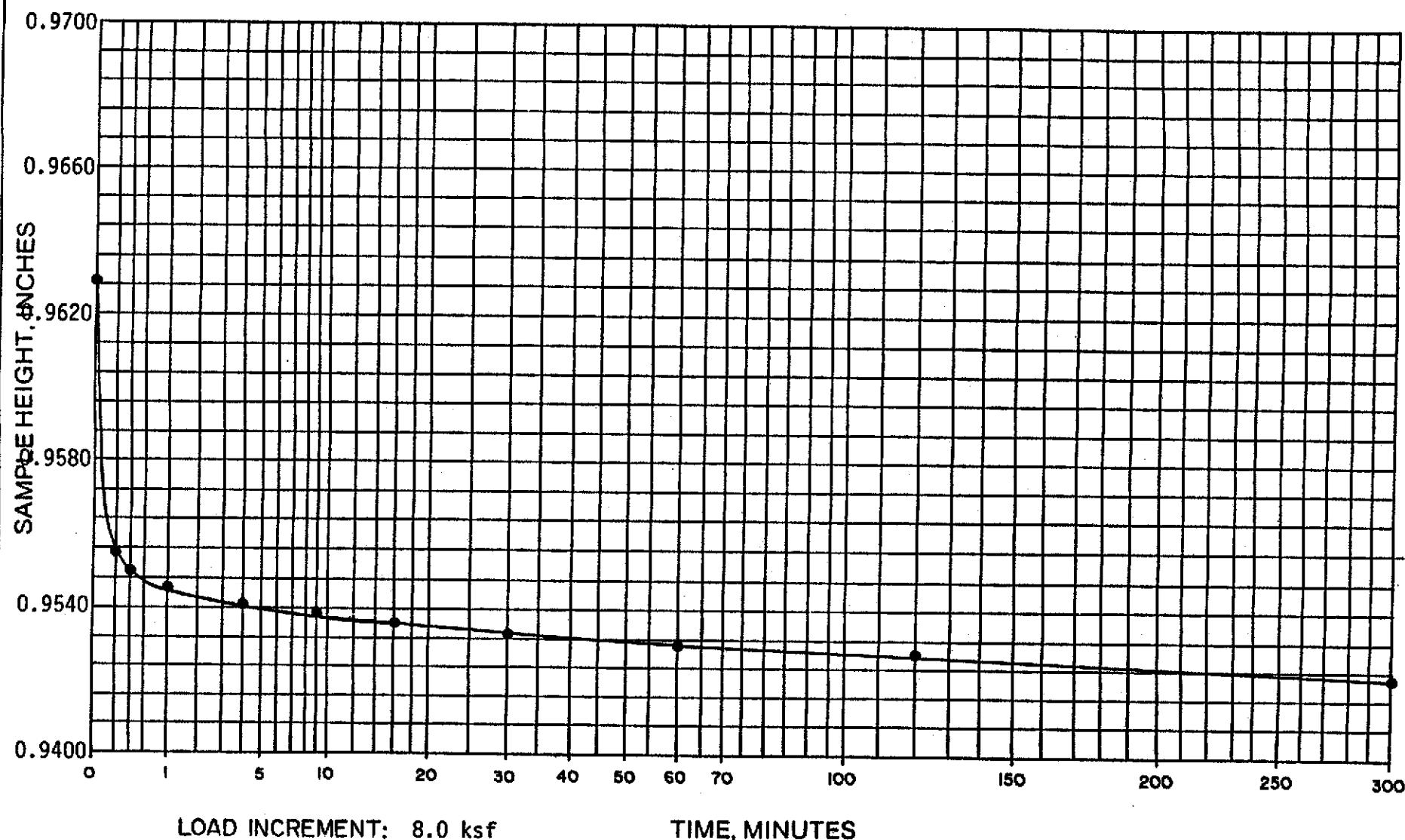
Job No. 89-614

Plate No.

(SHEET 6 OF 8)

NET 161

TIME RATE CONSOLIDATION TEST NO. 1



	ITEM NO. 4	MOIST UNIT WEIGHT _____
	DRILL HOLE _____	DRY UNIT WEIGHT _____
	DEPTH _____	CLASSIFICATION: _____
		FINAL MOISTURE CONTENT _____

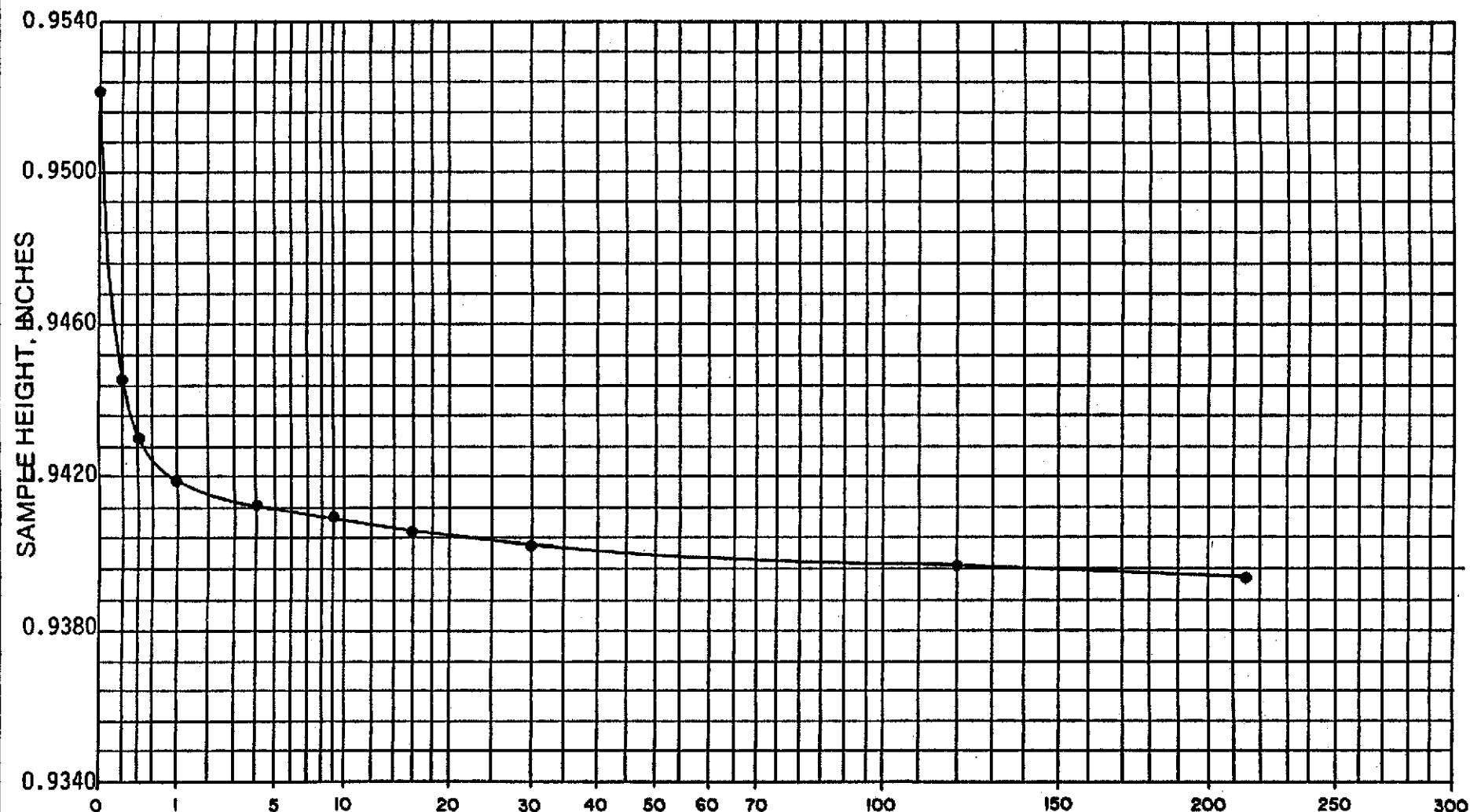
Chen Northern, Inc.

Consulting Engineers and Scientists

Job No. 89-614

Plate No.

TIME RATE CONSOLIDATION TEST NO. 1



LOAD INCREMENT: 16.0 ksf

TIME, MINUTES

ITEM NO. 4	DRILL HOLE _____	MOIST UNIT WEIGHT _____
	DEPTH _____	DRY UNIT WEIGHT _____
	CLASSIFICATION: _____	INITIAL MOISTURE CONTENT _____
		FINAL MOISTURE CONTENT _____

Chen Northern, Inc.

Consulting Engineers and Scientists

Job No. 89-614 Plate No.

(SHEET 8 OF 8)

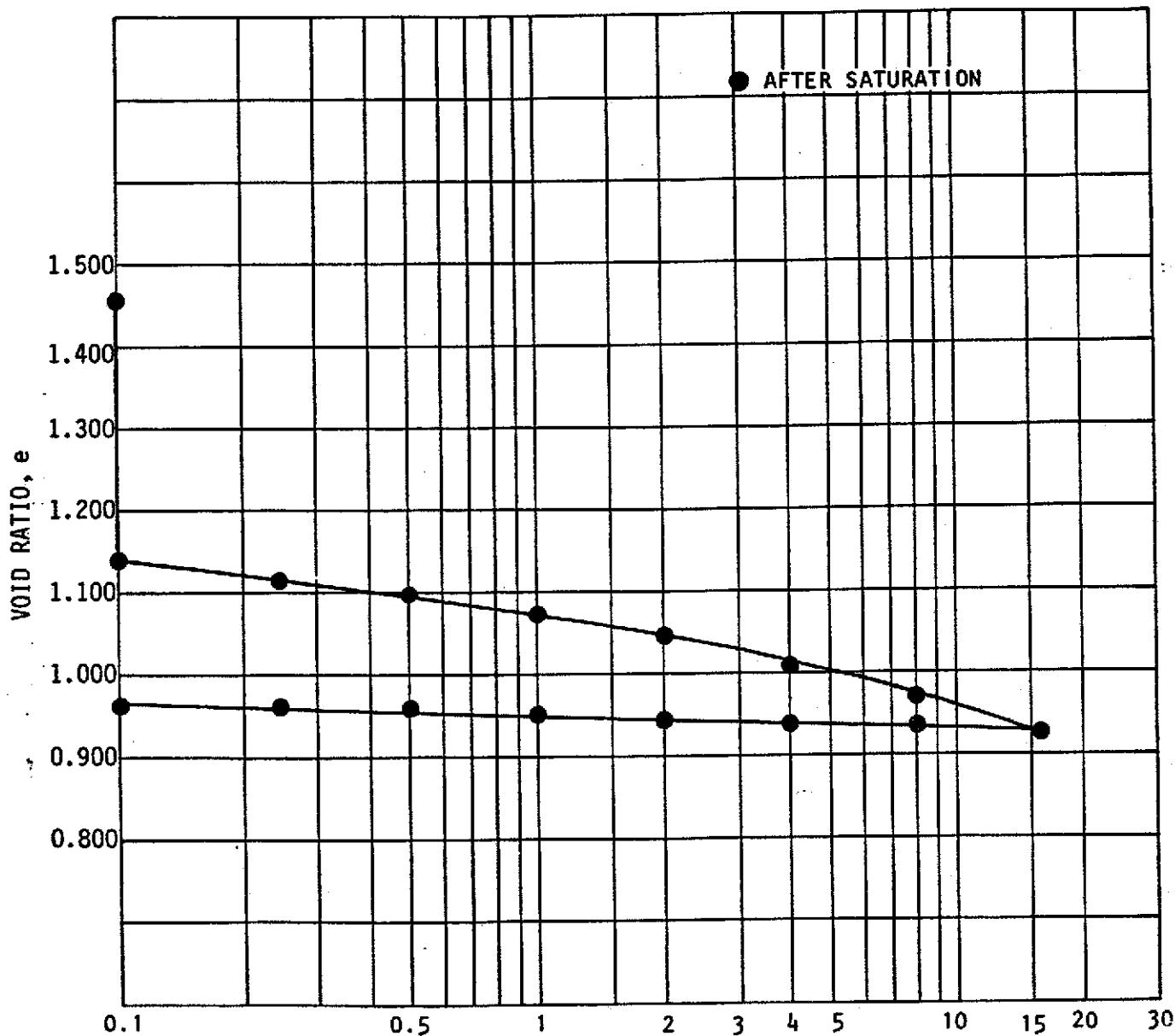
NET 161

CONSOLIDATION TEST NO. 2

CONSOLIDATION TEST NO. 2

DRILL HOLE Item No. 4
 DEPTH
 SAMPLE NO.

MOIST UNIT WEIGHT :
 DRY UNIT WEIGHT : 68.7
 INITIAL MOISTURE CONTENT:
 FINAL MOISTURE CONTENT : 37.7
 CLASSIFICATION : Mine tailing
 Initial sample height: 0.997"
 Initial sample diameter: 2.50"



NORMAL PRESSURE, KIPS PER SQUARE FOOT

SHEET 1 OF 8

SLIMES - OVERFLOW

MORRISON-KNUDSEN ENGINEERS, INC.
 SAN FRANCISCO, CA

Chen-Northern, Inc.

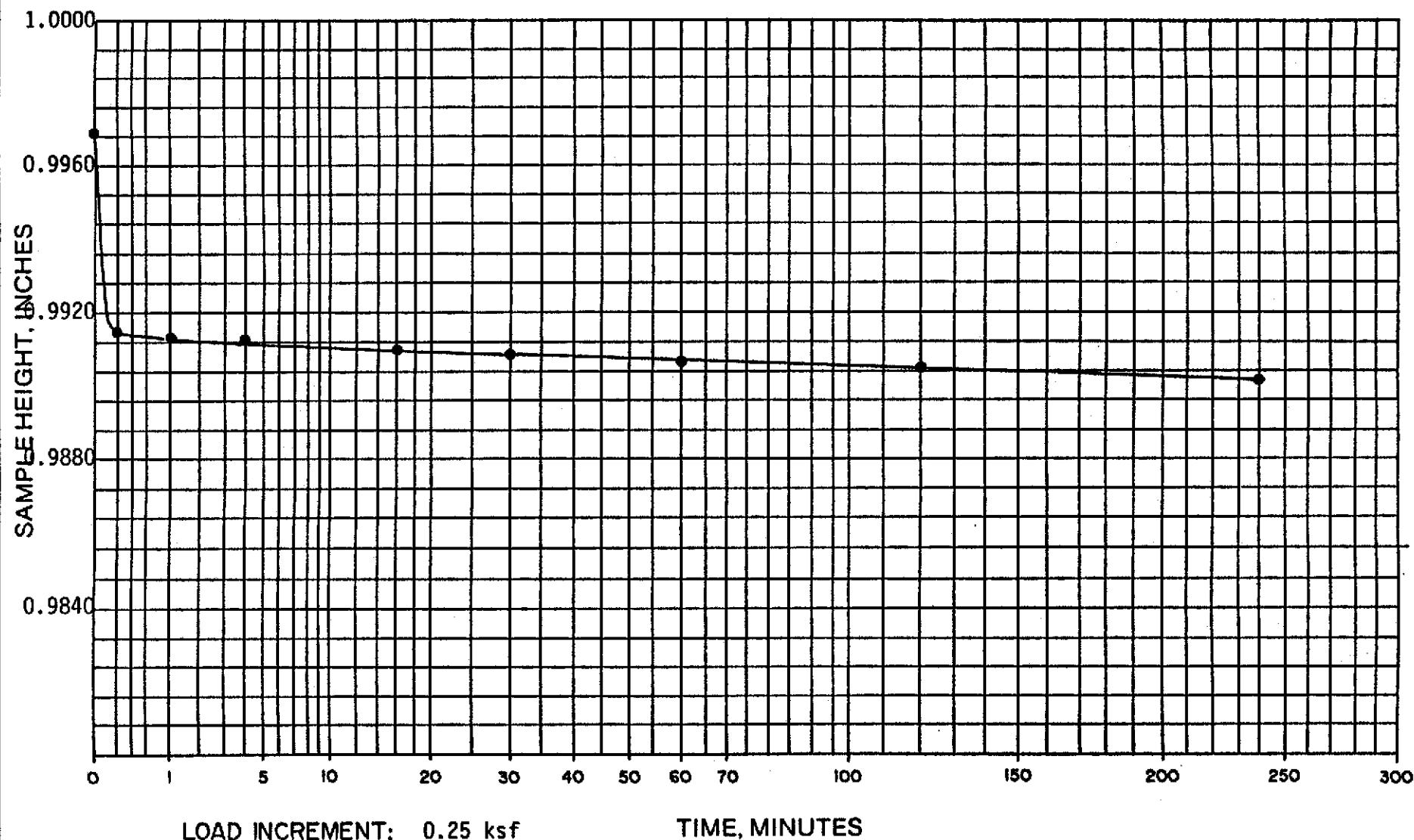
A member of the GROUP OF COMPANIES

MONTANORE

JOB NO. 89-614

PLATE NO.

TIME RATE CONSOLIDATION TEST NO. 2



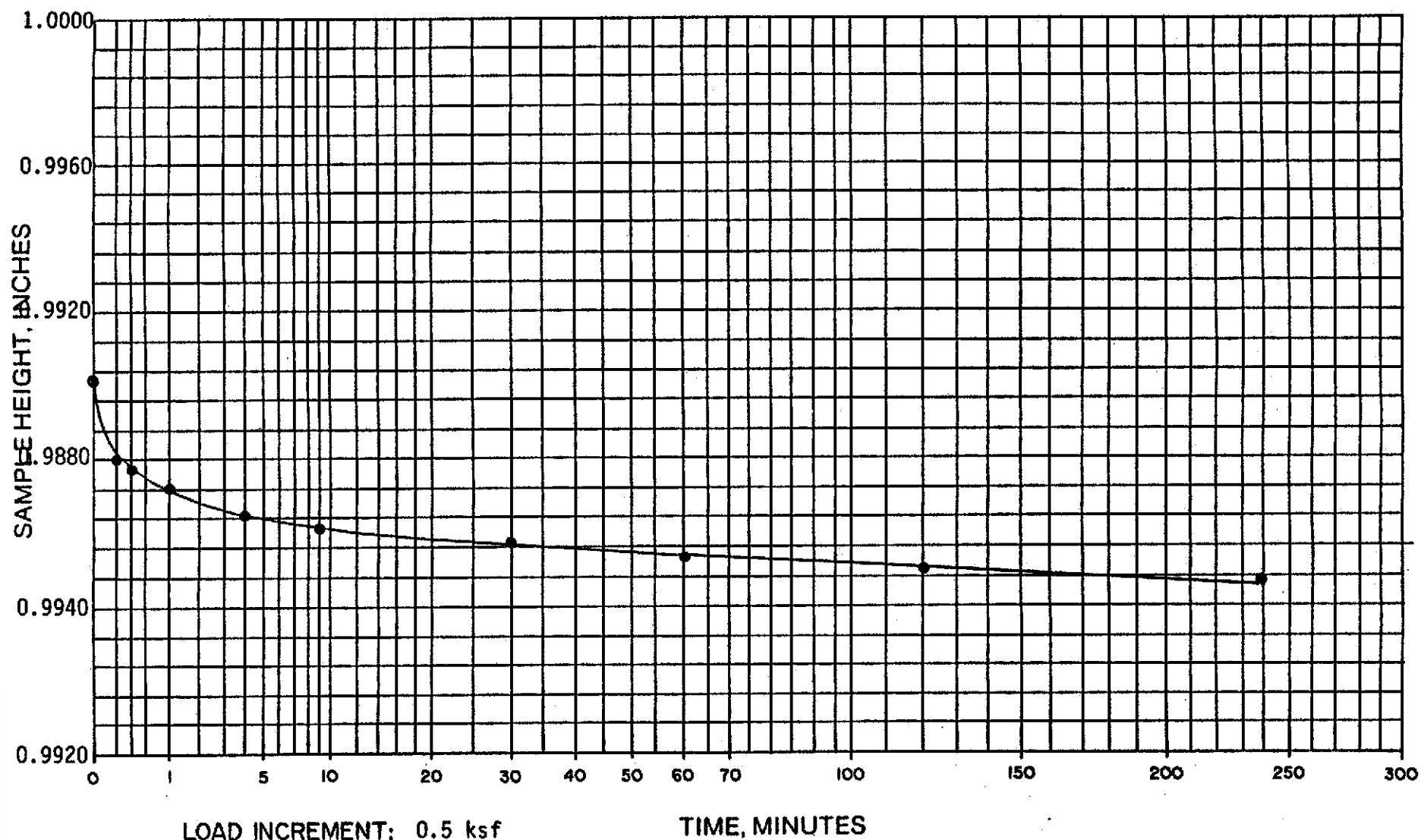
LOAD INCREMENT: 0.25 ksf

TIME, MINUTES

	DRILL HOLE _____	MOIST UNIT WEIGHT _____	Chen Northern, Inc. Consulting Engineers and Scientists
	DEPTH _____	DRY UNIT WEIGHT _____	
	CLASSIFICATION: _____	INITIAL MOISTURE CONTENT _____	
		FINAL MOISTURE CONTENT _____	
			Job No. 89-614
			Plate No. _____

(SHEET 2 OF 8)

TIME RATE CONSOLIDATION TEST NO. 2



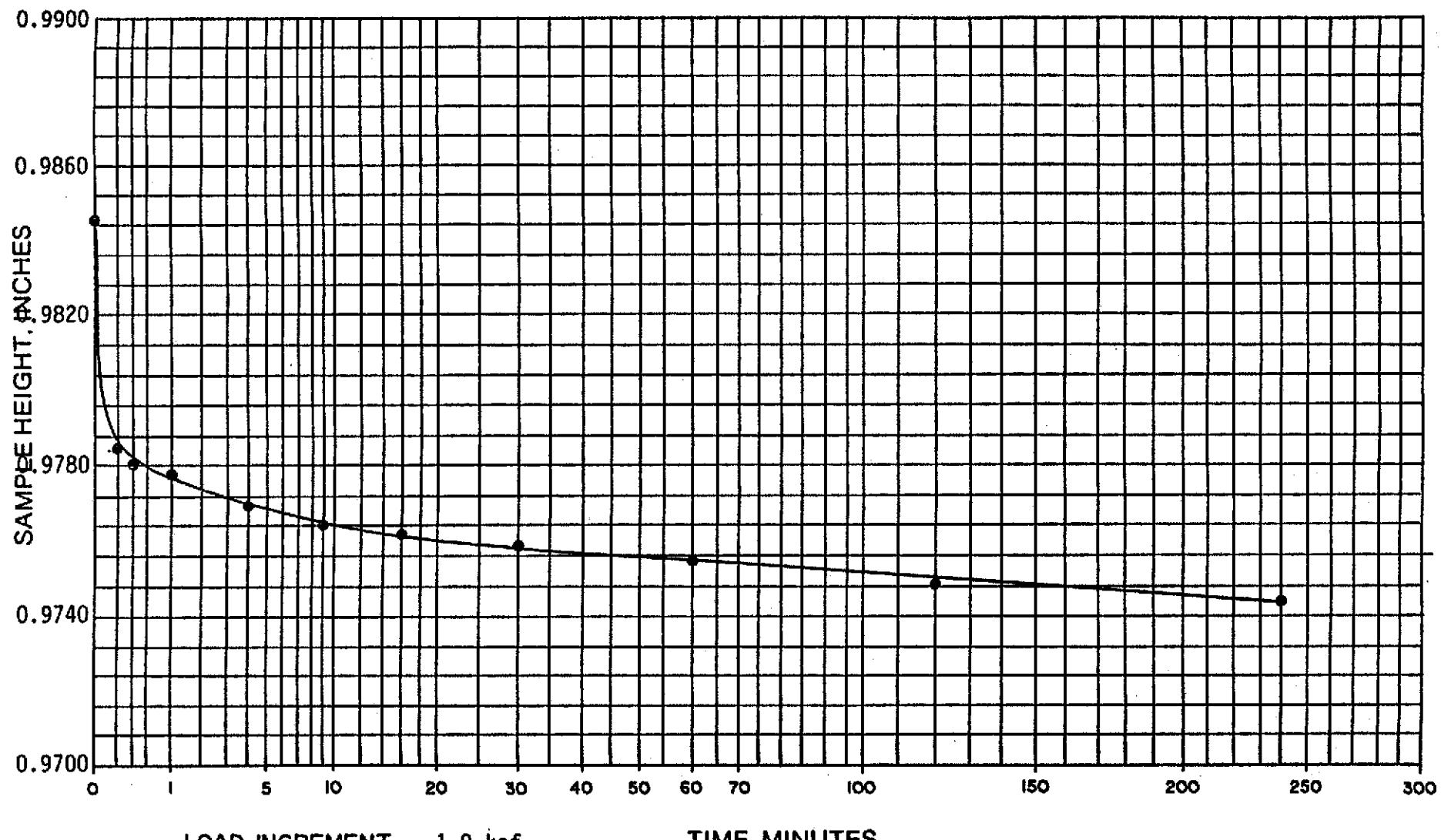
LOAD INCREMENT: 0.5 ksf

TIME, MINUTES

ITEM NO. 4	DRILL HOLE _____	MOIST UNIT WEIGHT _____	Chen Northern, Inc. Consulting Engineers and Scientists Job No. 89-614 Plate No. _____
	DEPTH _____	DRY UNIT WEIGHT _____	
	CLASSIFICATION: _____	INITIAL MOISTURE CONTENT _____ FINAL MOISTURE CONTENT _____	

(SHEET 3 OF 8)

TIME RATE CONSOLIDATION TEST NO. 2



LOAD INCREMENT: 1.0 ksf

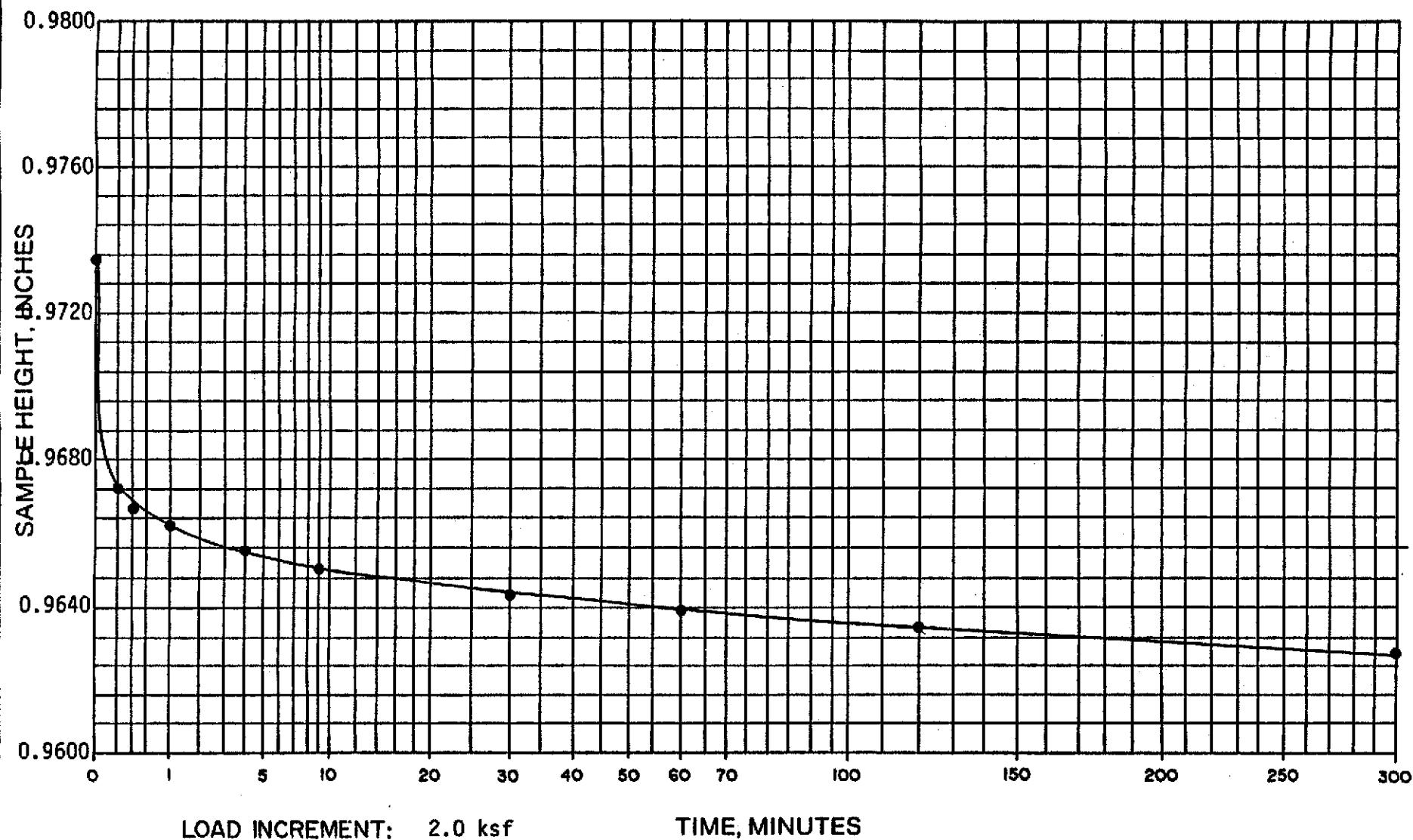
TIME, MINUTES

	ITEM NO. 4	MOIST UNIT WEIGHT	Chen Northern, Inc.
	DRILL HOLE _____	DRY UNIT WEIGHT _____	
	DEPTH _____	INITIAL MOISTURE CONTENT _____	Consulting Engineers and Scientists
	CLASSIFICATION: _____	FINAL MOISTURE CONTENT _____	Job No. 89-614 Plate No. _____

(SHEET 4 OF 8)

- NET 161

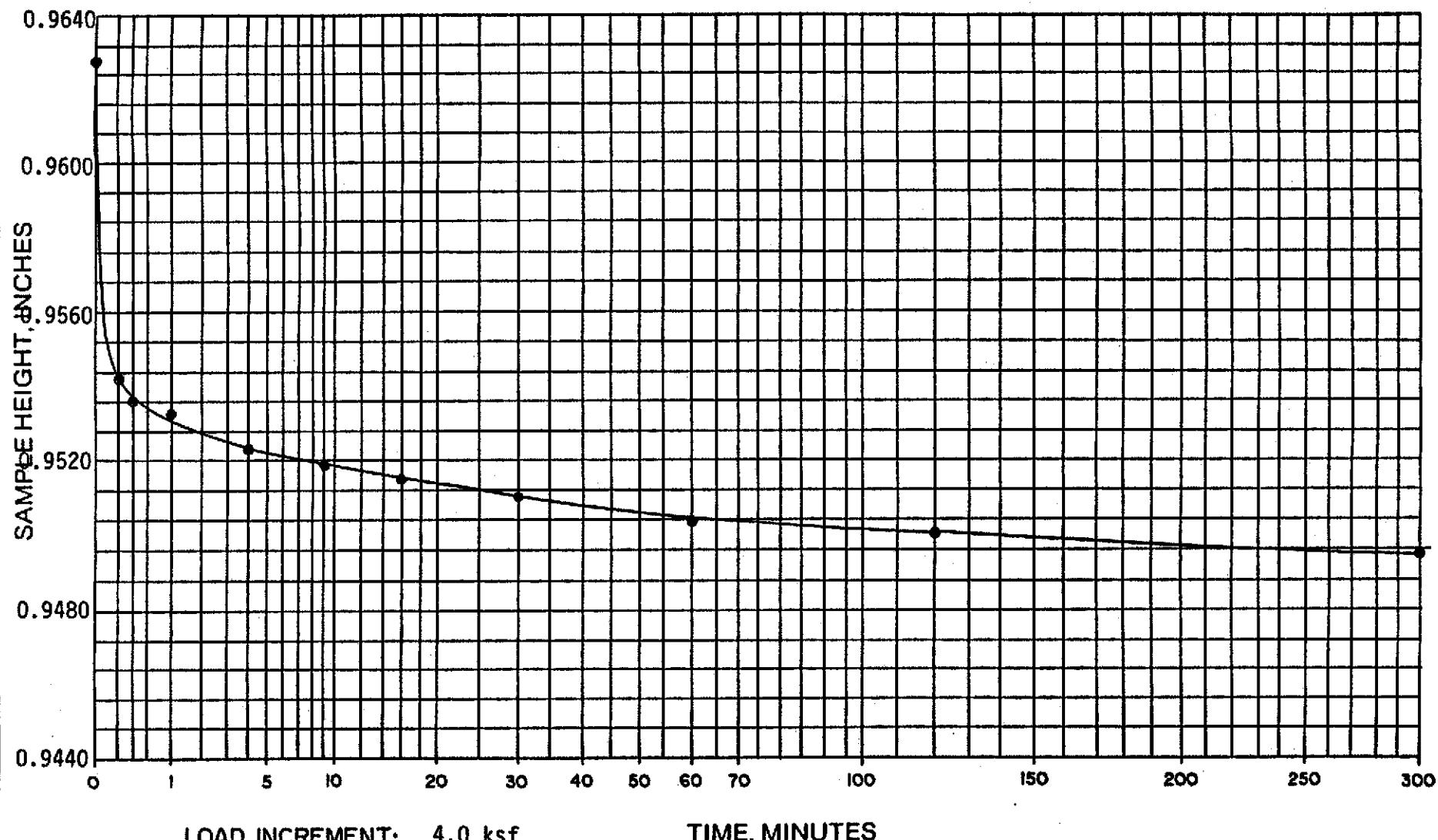
TIME RATE CONSOLIDATION TEST NO. 2



	ITEM NO. 4	MOIST UNIT WEIGHT	Chen Northern, Inc. Consulting Engineers and Scientists
	DRILL HOLE _____	DRY UNIT WEIGHT _____	
	DEPTH _____	INITIAL MOISTURE CONTENT _____	
	CLASSIFICATION: _____	FINAL MOISTURE CONTENT _____	Job No. 89-614 Plate No. _____

(SHEET 5 OF 8)

TIME RATE CONSOLIDATION TEST NO. 2



LOAD INCREMENT: 4.0 ksf

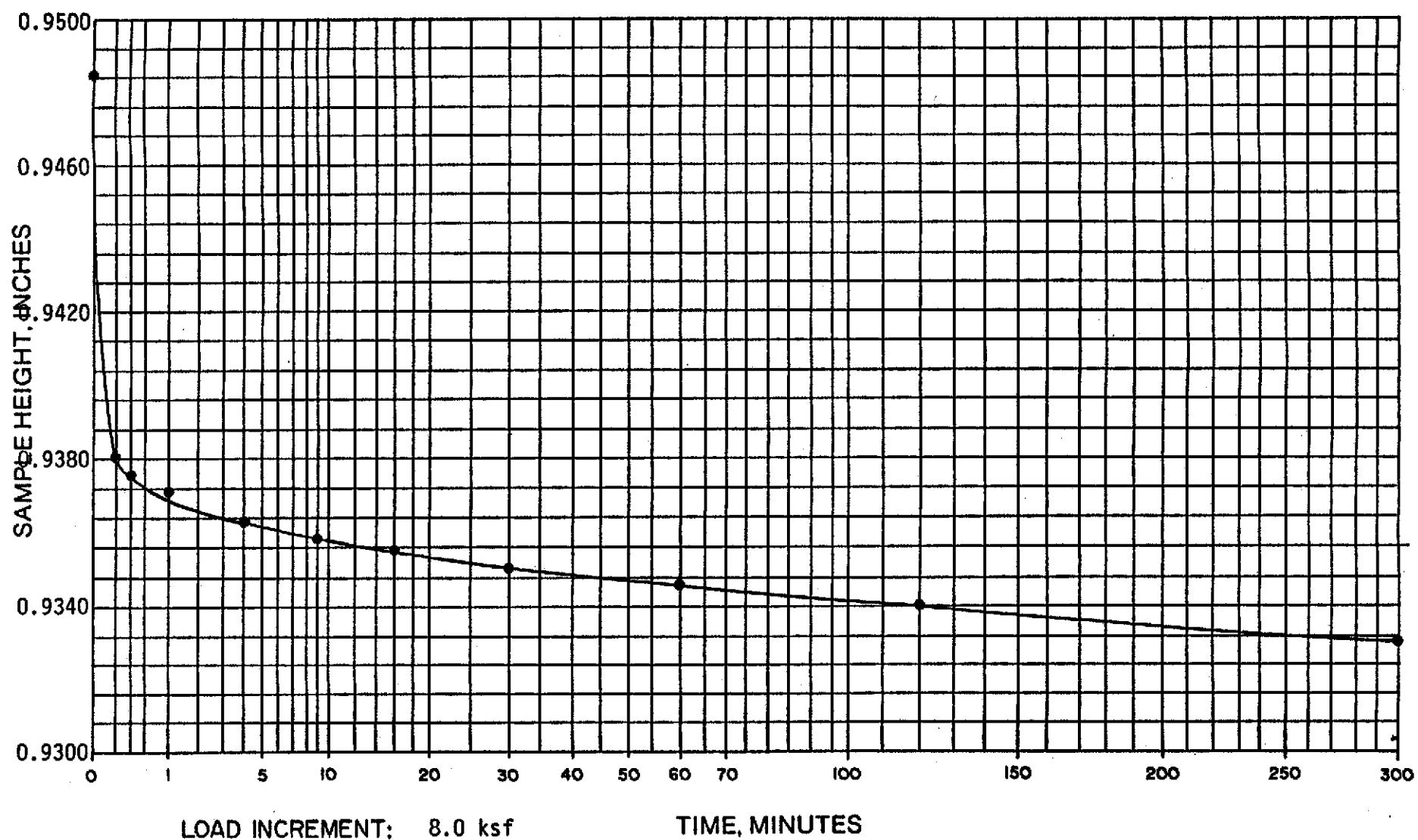
TIME, MINUTES

	ITEM NO. 4		Chen Northern, Inc.
	DRILL HOLE _____	MOIST UNIT WEIGHT _____	
	DEPTH _____	DRY UNIT WEIGHT _____	Consulting Engineers and Scientists
	CLASSIFICATION: _____	INITIAL MOISTURE CONTENT _____	Job No. 89-614
		FINAL MOISTURE CONTENT _____	Plate No. _____

(SHEET 6 OF 8)

NET 161

TIME RATE CONSOLIDATION TEST NO. 2

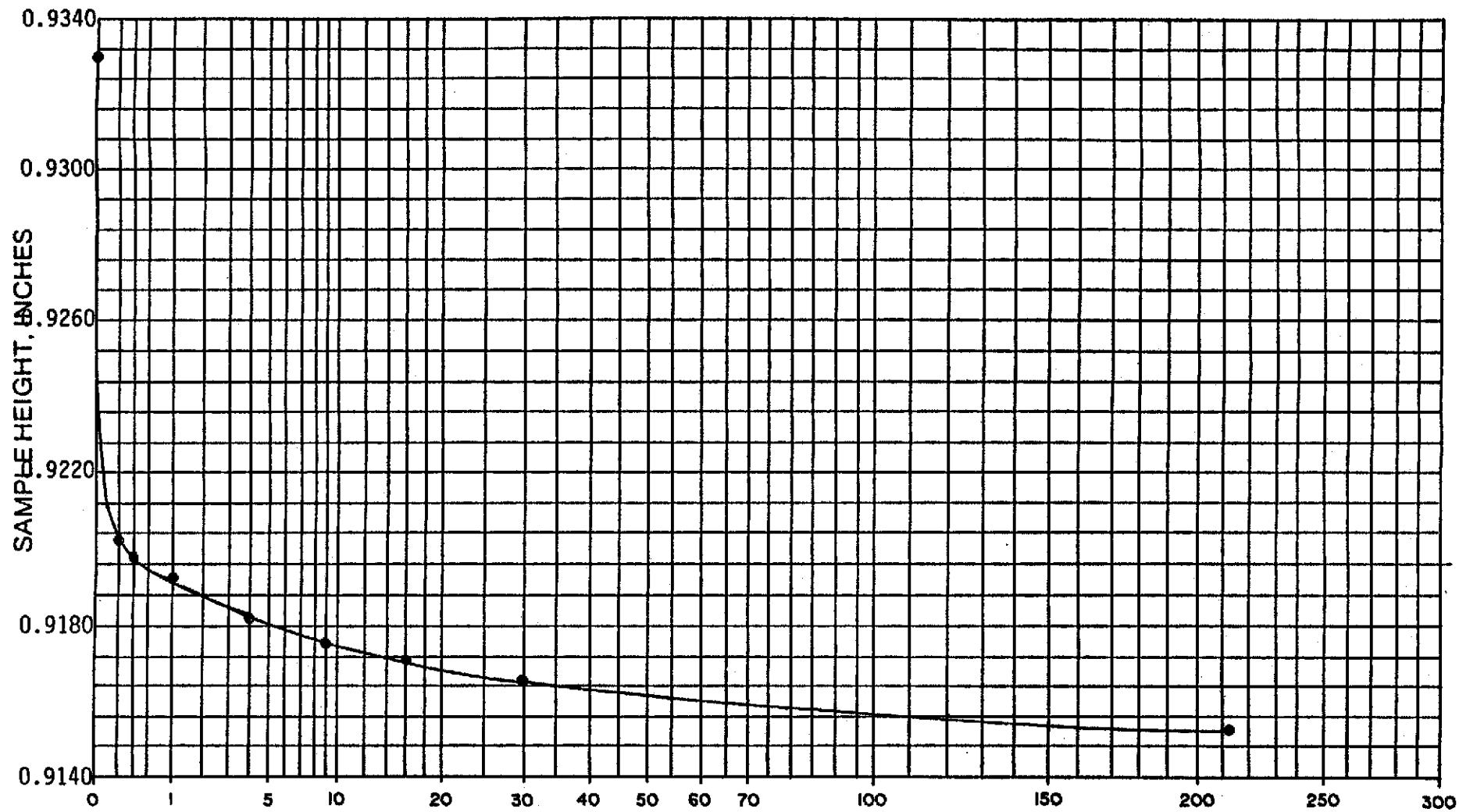


LOAD INCREMENT: 8.0 ksf

TIME, MINUTES

ITEM NO. 4	DRILL HOLE	MOIST UNIT WEIGHT	Chen Northern, Inc. Consulting Engineers and Scientists Job No. 89-614
	DEPTH	DRY UNIT WEIGHT	
	CLASSIFICATION:	INITIAL MOISTURE CONTENT FINAL MOISTURE CONTENT	

TIME RATE CONSOLIDATION TEST NO. 2



LOAD INCREMENT: 16.0 ksf

TIME, MINUTES

ITEM NO. 4 DRILL HOLE _____ DEPTH _____ CLASSIFICATION: _____	MOIST UNIT WEIGHT _____	Chen Northern, Inc. Consulting Engineers and Scientists Job No. 89-614
	DRY UNIT WEIGHT _____	
	INITIAL MOISTURE CONTENT _____	
	FINAL MOISTURE CONTENT _____	

(SHEET 8 OF 8)

NET 161

MOISTURE - DENSITY RELATIONSHIP DATA

MOISTURE-DENSITY RELATIONSHIP DATA SHEET

BILLINGS
600 SOUTH 25TH STREET
P. O. BOX 30615
BILLINGS, MT 59107
(406) 248-9161
FAX (406) 248-9282

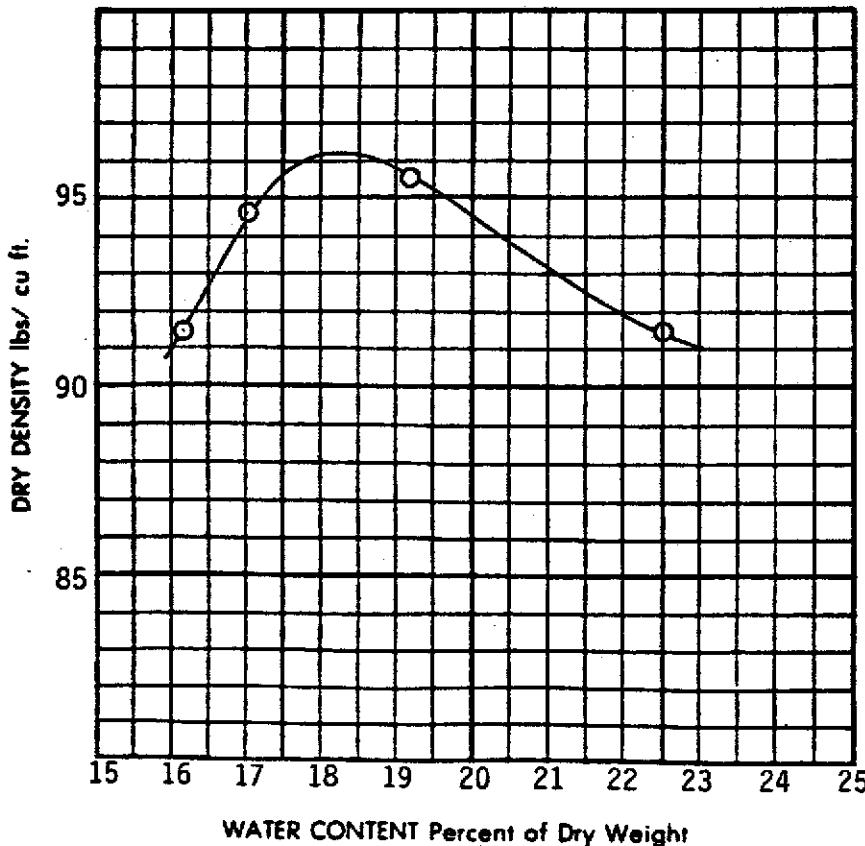
REPORT TO: M-K Environmental Services
180 Howard Street
San Francisco, CA 84105

DATE: July 3, 1990
JOB NUMBER: 89-614
SHEET: 1 OF 1
INVOICE NO.: 095937
LAB NO.:
DATE SAMPLED:
DATE RECEIVED: 5/22/90
SAMPLED BY: Brenda

PROJECT:
CONTRACTOR:
SAMPLE LOCATION: Item 2 - Tailings Testing Program
MATERIAL USE: UNDERFLOW NO. 5

SIZE	MECHANICAL ANALYSIS
	% PASS SPECS.

MOISTURE-DENSITY RELATIONSHIP



REMARKS:

UNIFIED CLASSIFICATION (ASTM D2487)

SPECIFIC GRAVITY:
LIQUID LIMIT:
PLASTICITY INDEX:

TEST PROCEDURE ASTM D698 Method A
MAX. DENSITY: 96.3
OPT. MOIST.: 18.3
RAMMER TYPE: Manual
PREPARATION PROCEDURE: Wet
PENETRATION RESIS.: Not Performed

DISTRIBUTION:

Reviewed By:

c1z

R. Klemm

MOISTURE-DENSITY RELATIONSHIP DATA SHEET

BILLINGS
600 SOUTH 25TH STREET
P. O. BOX 30615
BILLINGS, MT 59107
(406) 248-9181
FAX (406) 248-9282

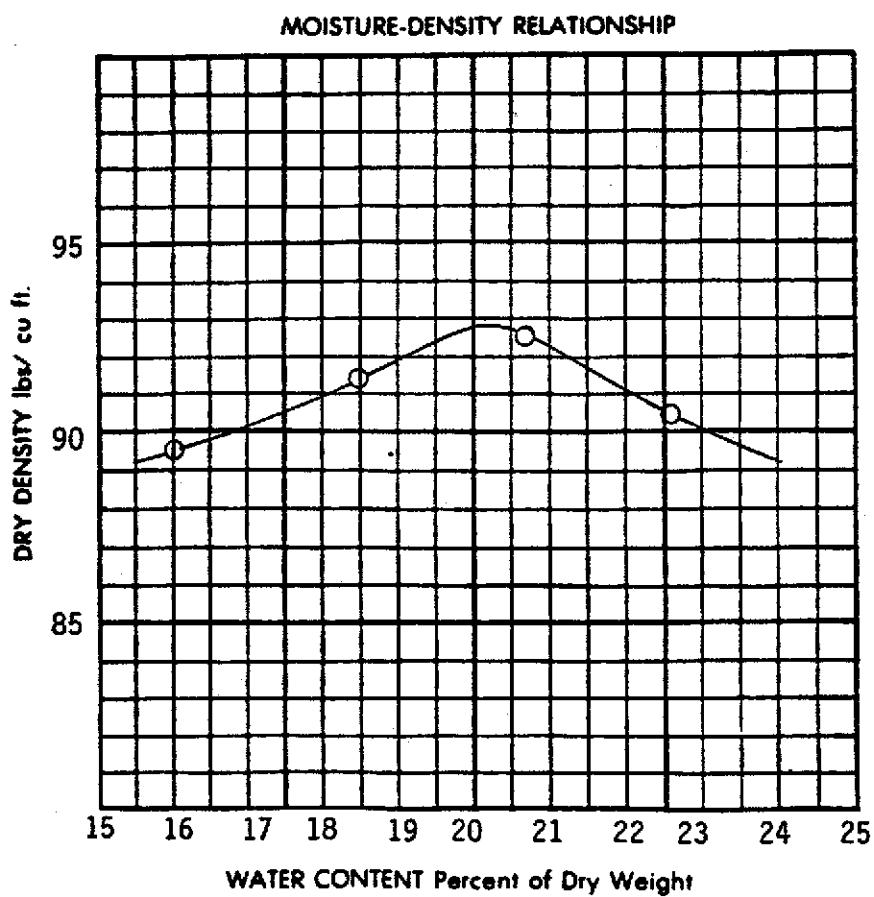
REPORT TO: MK-ENVIRONMENTAL SERVICES
180 HOWARD STREET
SAN FRANCISCO, CA 84105

DATE: July 3, 1990
JOB NUMBER: 89-614
SHEET: 1 OF 1
INVOICE NO.: 095937
LAB NO.:
DATE SAMPLED:
DATE RECEIVED: 5/22/90
SAMPLED BY: Brenda

PROJECT: Montanore
CONTRACTOR:
SAMPLE LOCATION:

MATERIAL USE: Item No. 3 - TAILINGS TESTING PROGRAM
UNDERFLOW NO. 7

SIZE	MECHANICAL ANALYSIS	% PASS	SPECs.
------	---------------------	--------	--------



UNIFIED CLASSIFICATION (ASTM D2487)

SPECIFIC GRAVITY:
LIQUID LIMIT:
PLASTICITY INDEX:

TEST PROCEDURE: ASTM D698 Meth
MAX. DENSITY: 92.8
OPT. MOIST.: 20.2
RAMMER TYPE: Manual
PREPARATION PROCEDURE: Wet
PENETRATION RESIS.: Not performed

REMARKS:

DISTRIBUTION:

Reviewed By: _____

MOISTURE-DENSITY RELATIONSHIP DATA SHEET

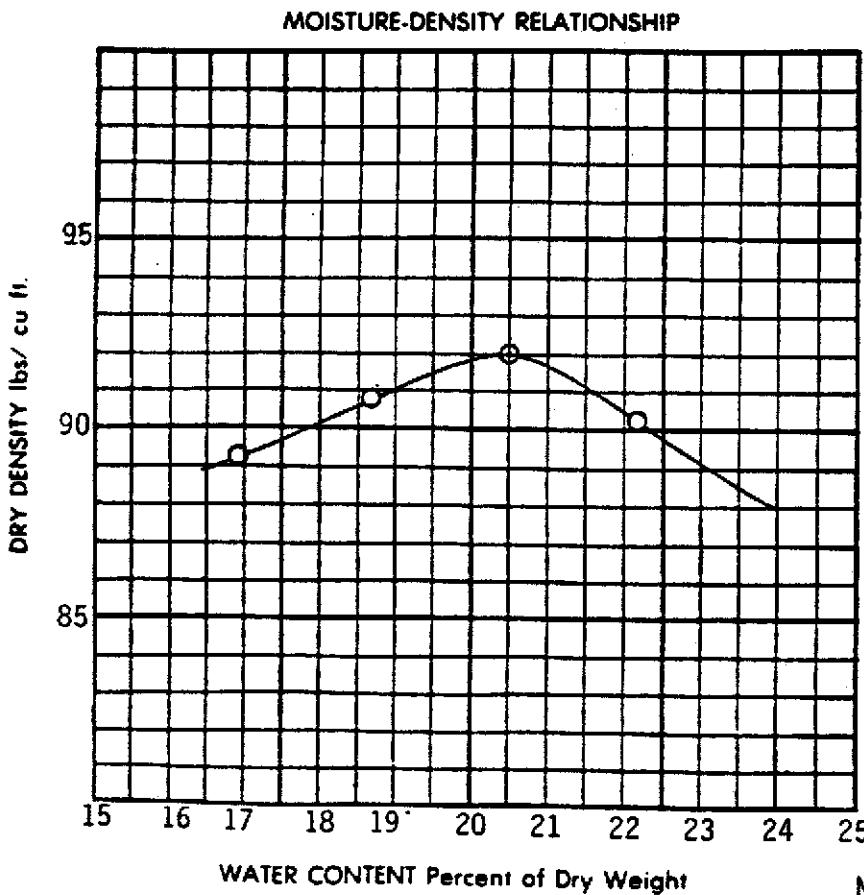
BILLINGS
600 SOUTH 25TH STREET
P. O. BOX 30615
BILLINGS, MT 59107
(406) 248-9161
FAX (406) 248-9282

REPORT TO: MK - ENVIRONMENTAL SERVICES
180 HOWARD STREET
SAN FRANCISCO, CA 84105

DATE: August 14, 1990
JOB NUMBER: 89-614
SHEET: 2 OF 2
INVOICE NO.: 99803
LAB NO.:
DATE SAMPLED:
DATE RECEIVED:
SAMPLED BY:

PROJECT: Montanore Tailings Testing Program
CONTRACTOR:
SAMPLE LOCATION:

MATERIAL USE: UNDERFLOW NO. 9



Sieve Size	MECHANICAL ANALYSIS	
	% PASS As Prepared	% Pass After MD Curve
30	100	100
65	99.8	99.0
100	77.5	84.0
150	32.5	45.4
200	8.3	15.8
270	1.6	5.5
400	0.4	2.6

UNIFIED CLASSIFICATION (ASTM D2487)

Silty sand

SPECIFIC GRAVITY: Not Performed

LIQUID LIMIT: Not Performed

PLASTICITY INDEX: Not Performed

TEST PROCEDURE ASTM D698 METHOD A
MAX. DENSITY: 92.0 Pcf

OPT. MOIST.: 20.5%

RAMMER TYPE: Manual

PREPARATION PROCEDURE: Wet

PENETRATION RESIS.: Not Performed

REMARKS: Maximum-minimum
Density Test ASTM D4253 and 42

Minimum Index Density Method A - 75.5 pc
Maximim Index Density Method 1A - 99.8 pc

DISTRIBUTION:

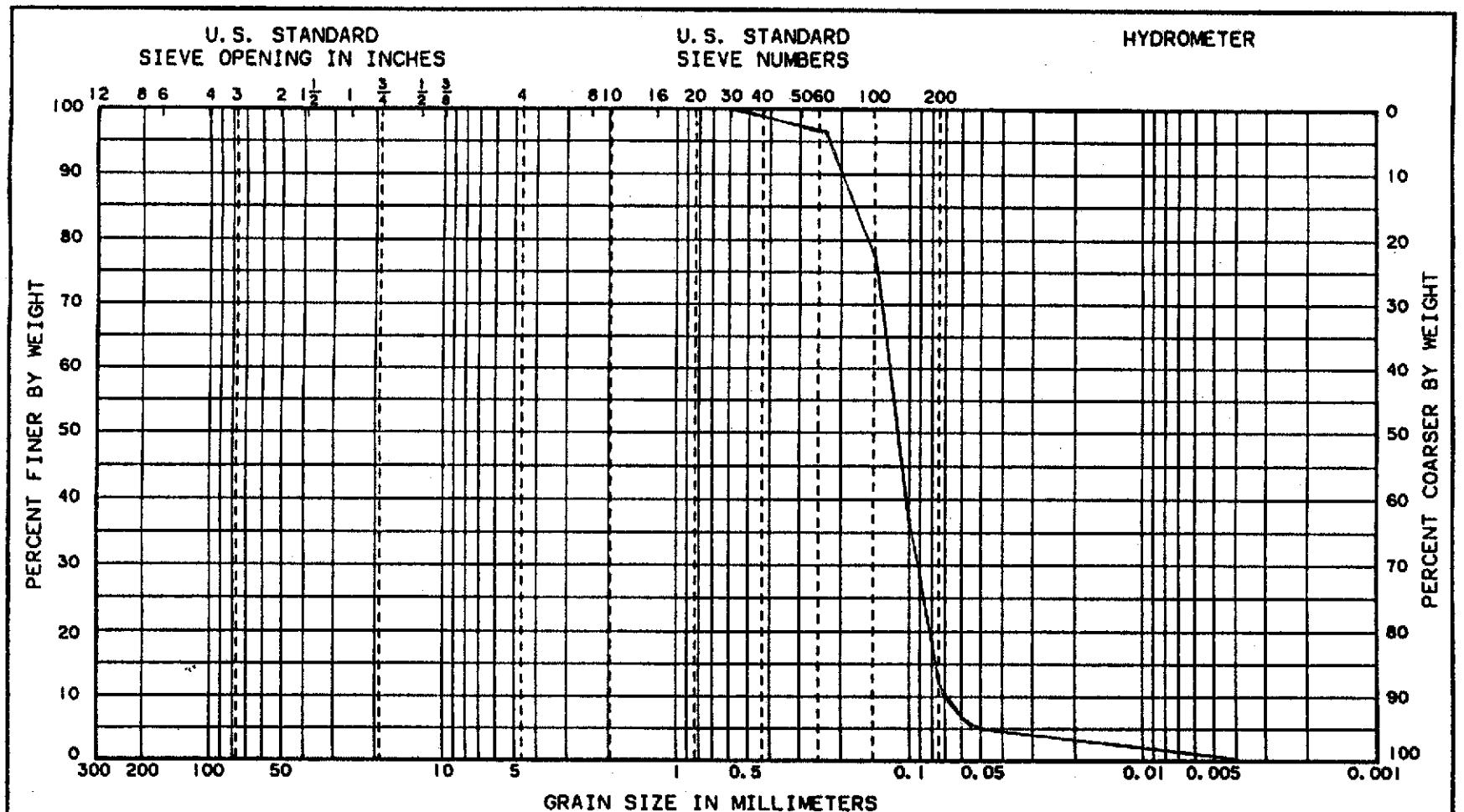
c1z

Reviewed By:

W. J. Fennell

TAILINGS SAND GRAIN SIZE CURVES

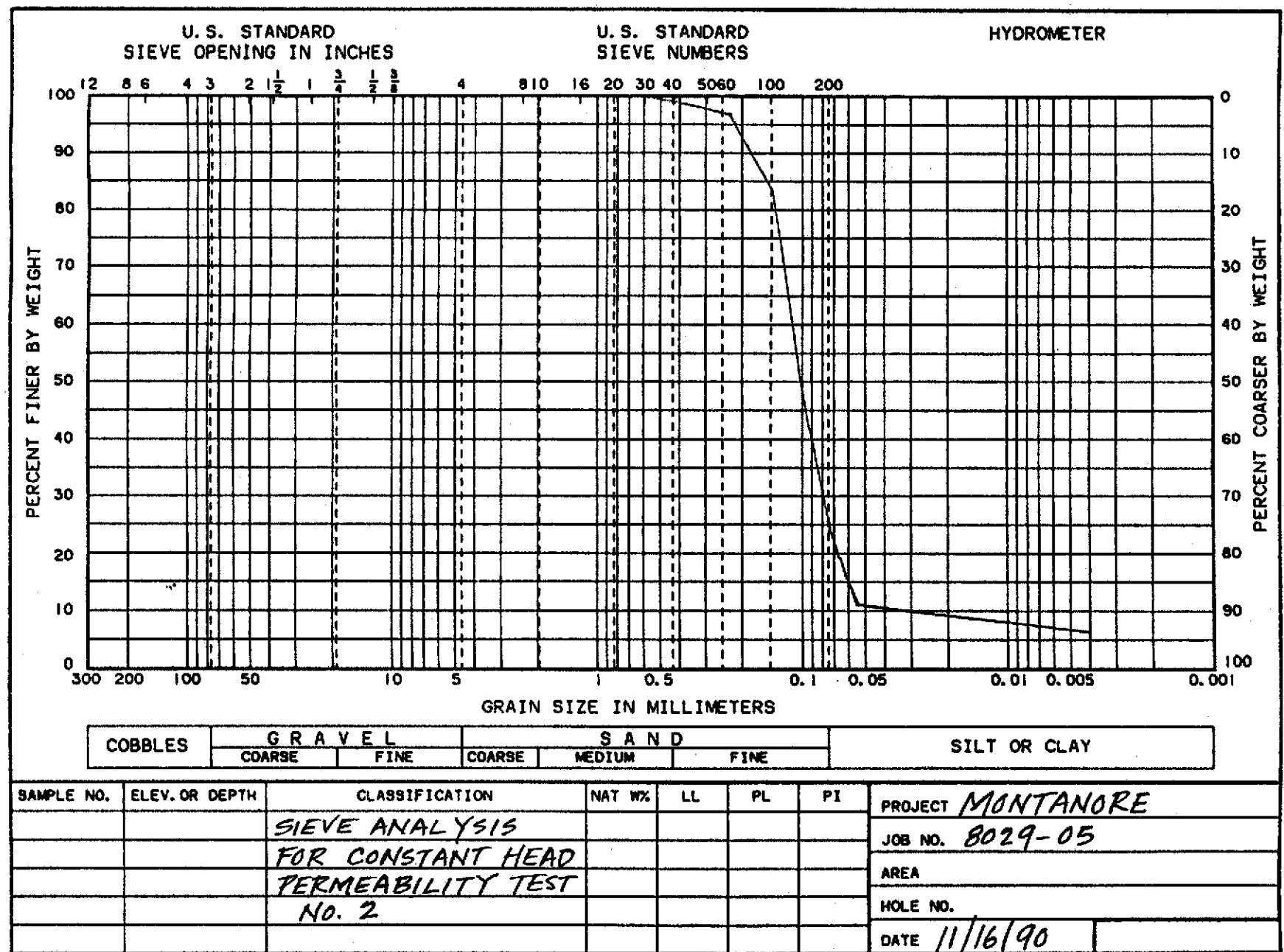
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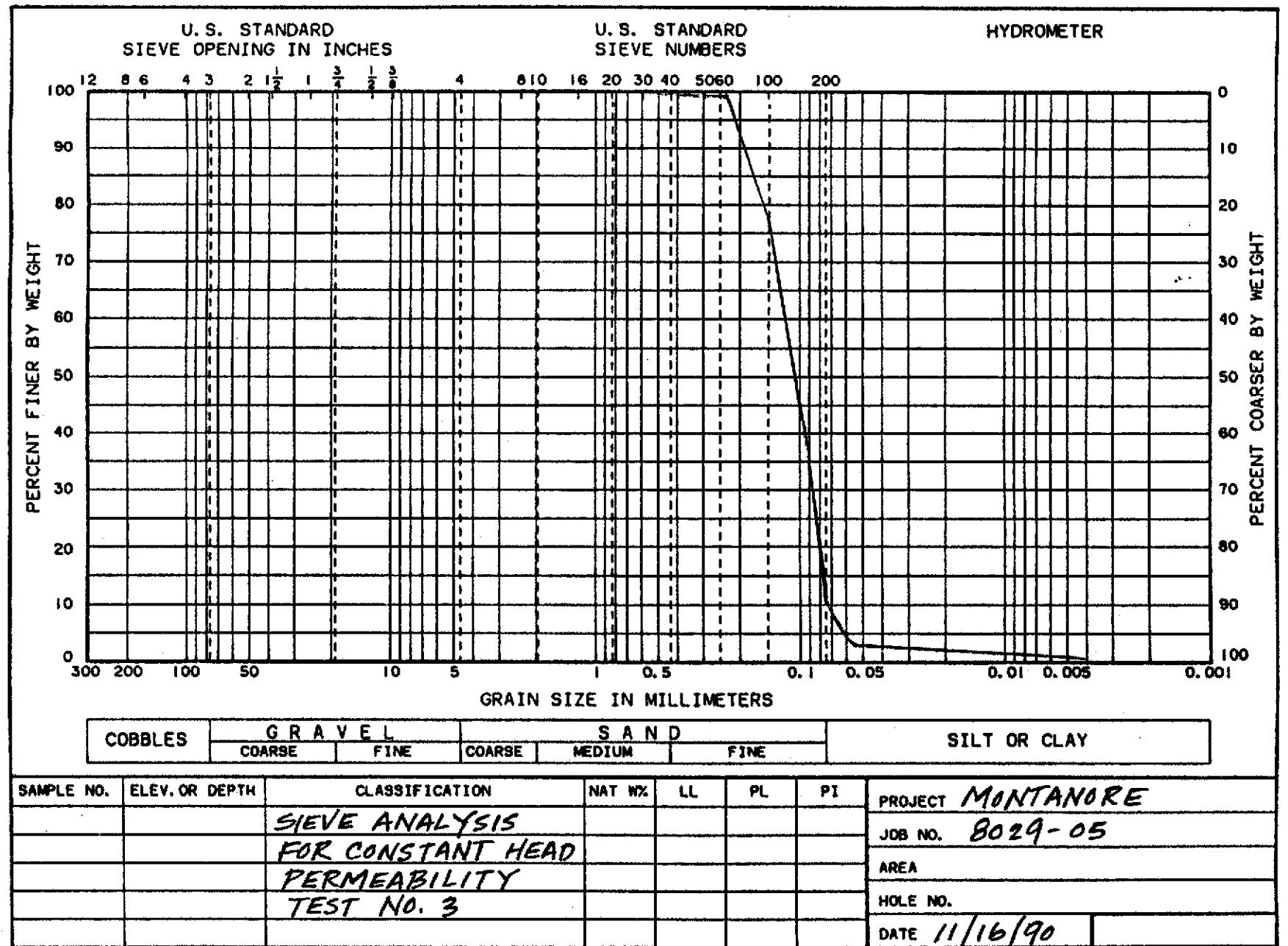
COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

CAB110

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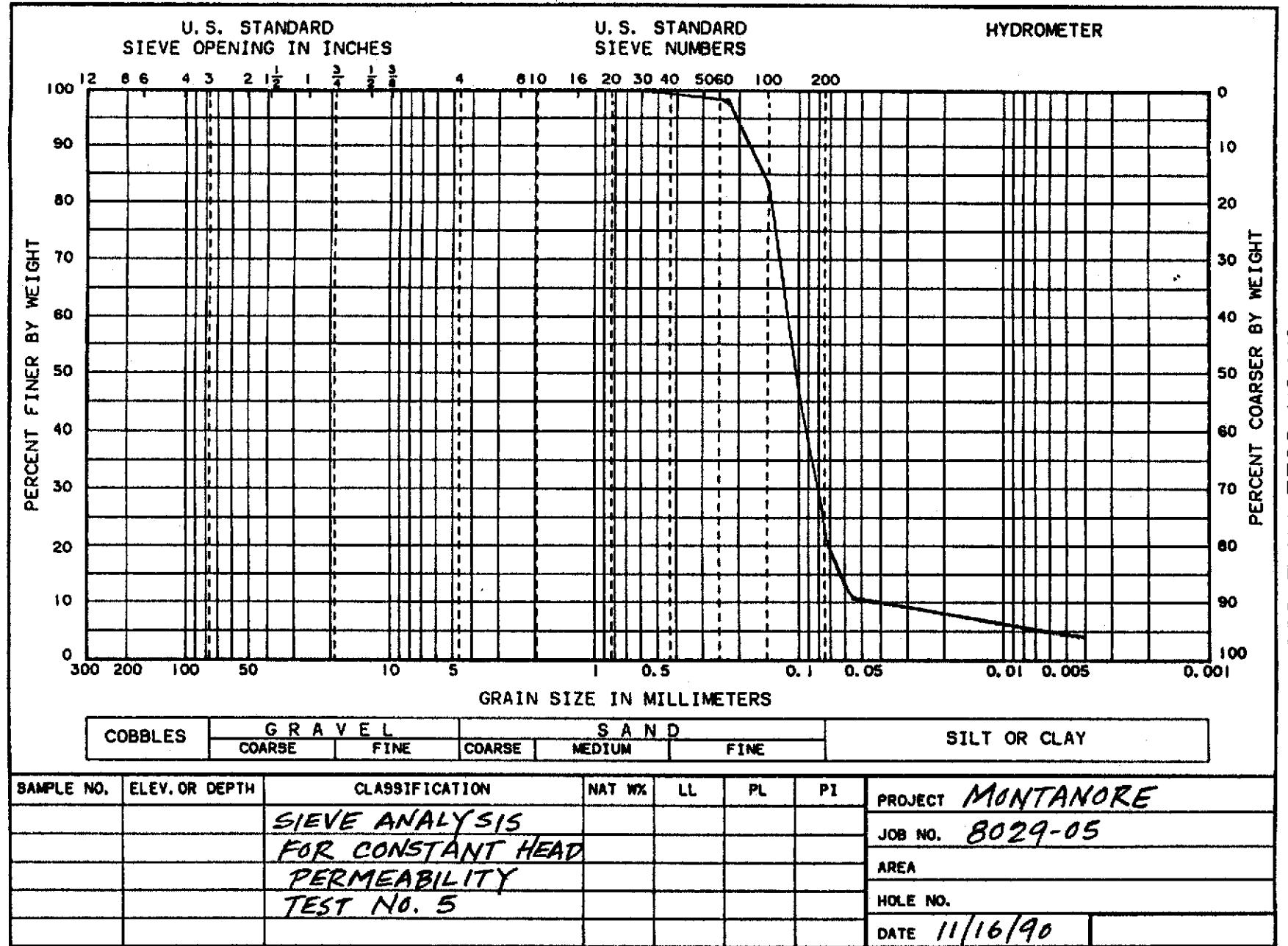


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