TVA 64 (OS-9-65)

UNITED STATES GOVERNMENT

Memorandum

CSB '77 1122 051

TENNESSEE VALLEY AUTHORITY

TO : G. L. Buchanan, Chief, Civil Engineering and Design Branch, W3C126 C-K (2)

FROM : Gene Farmer, Chief, Construction Services Branch, E6B39 C-K

DATE : November 22, 1977

SUBJECT: JOHNSONVILLE STEAM PLANT - ASH DISPOSAL AREA NO. 2 DIKE RAISING - SOIL EXPLORATION AND TESTING

We are transmitting herewith a report on a soil investigation program conducted by SME Laboratory.

This work was authorized May 16, 1977, (CDB 770517 004) and is presently listed under EN DES Soil Schedule No. 71.1.

Original signed by
Gene Farmer

Gene Farmer

ROL:ASH
Attachments
cc (Attachments):
R. O. Lane, SME-K
H. H. Mull, E7B24 C-K (w/text only)
MEDS, E4B37 C-K

CDB '771123 002

11/23/77 - GLB:NCH
cc: W. M. Bivens, 5100 MIB-K
Roy H. Dunham, W11A9 C-K
xc: MEDS, E4B37 C-K

JOHNSONVILLE STEAM PLANT

ASH DISPOSAL AREA NO. 2 DIKE RAISING

SOIL EXPLORATION AND TESTING

EN DES SOILS SCHEDULE NO. 71.1

Sampling and in-situ testing of soils in the ash disposal area No. 2 dike raising at Johnsonville Steam Plant were conducted between August 17 and September 14, 1977. In the investigation, two trailer-mounted drill rigs, hollow-stem and solid-core augers, 2-inch o.d. split spoons, and a 5-inch-diameter tube sampler were used.

Foundation

As shown on drawing 604A860, 11 standard penetration and 3 undisturbed borings were drilled around the perimeter of the No. 2 ash disposal area. Borings were discontinued after penetrating into the foundation to a depth equivalent to half the embankment height. The water table within the existing dike was variable but generally established between el. 355 and el. 360. See drawings 604K861R1 and 604K862R0. However, a water level of 372 was found for boring SS-8 in a zone of clayey gravel, indicating possible percolation through the zone.

The profile determined within the existing dike is composed primarily of lean clay, CL, with layers of clayey sand, SC; silty sand, SM; and gravelly soils, G-CL, G-SC, G-SM, and GC; scattered throughout. Angular gravel contents as high as 66 percent with a fines content as low as 21 percent were determined in the clayey gravel, GC.

In boring SS-6, at el. 364, a layer of clean sand was encountered. Since this material had a fines content of only 11 percent, 6 additional

borings were drilled to determine the extent of the sand stratum. See drawing 604K881R0. Gradation curves are included in the attachments for the sandy soils encountered in these 6 borings.

Overall, soil consistency of the cohesive fill is of medium to stiff range as indicated by penetration resistance. However, the sands present around borings SS-6 were found to be relatively loose with "N" values in the 4 to 6 range.

Foundation soils are primarily lean clays, CL. Over much of the dike area, topsoil marks the contact between fill and original ground. In-situ standard penetration tests reveal quite variable foundation consistency with soft zones established in borings 7, 8, and 9. Particularly, the weak zone between el. 343 and el. 357 in boring SS-8 may require special consideration. Over the remainder of the dike area, foundation soils are of medium to stiff consistency.

Undisturbed samples were obtained from borings 1, 7, and 8 for detailed testing. Strength determinations under triaxial compression unconsolidated-undrained and consolidated-undrained test conditions reveal a wide range of shear strengths. See table 1. Samples from borings 1 and 7 generally exhibit medium to medium-high shear strength under both Q and R test conditions. However, weak foundation soils in boring US-8 disclose essentially zero friction angle and low cohesion in the triaxial Q test. Under consolidated R test conditions, moderately high friction angles with low cohesion were indicated for these soils.

Bottom Ash

In-place density determinations were made around the perimeter of the existing dike in traffic-compacted bottom ash. Sand cone densities

indicate a range of densities varying from 121.7 pcf to 125.3 pcf. The gradation of a composite ash sample classifies it as a gravelly poorly graded silty sand, G-SP-SM, according to the Unified Soil Classification System. After scalping particles larger than 3/4 inch, specimens were remolded for shear testing to an average density of 123.8 pcf. Test results are summarized in table 2. Relatively high shear strength was determined under all test conditions. After completion of the shear tests, gradation testing disclosed little breakage of ash particles. See the attached plot. The well-graded and fairly dense ash had a coefficient of permeability of 1×10^{-5} cm/sec. All ash testing was performed on the largest size test specimens as allowed by equipment size. Triaxial specimens were 4 inches in diameter, direct shear specimens were 6 inches thick by 12 inches square, and the permeability specimen had a 6-inch diameter.

Borrow

As shown on drawings 604K886 and 604B887, two areas designated A and B were explored as potential sources of borrow soil. In area A, 37 auger borings were sunk to obtain samples and determine the quantity of suitable fill material available.

Drawing 604K882 indicates that in area A, along lines S12+00 and S14+00 cherty gravel, GC, dominates the profile. Lean clay, CL, and gravelly lean clay, G-CL, are also present but are scattered throughout. This portion of area A should not be considered a prime borrow source. South of S14+00, as shown on drawings 604K883 and 604K884, the profile typically consists of 7 to 15 feet of lean to medium clay, CL, which overlies clayey gravel, GC. Bedrock was not encountered to the depths drilled.

In area B (suitable lean clay, CL, or clayey sand, SC) borrow soils are available to depths of 3 to 10 feet.

Overall, area A could supply the 390,000 cubic yards of fill required for the dike construction. This area can probably be expanded to the south or southeast if necessary. Because of the clearing involved and the relatively shallow extent of suitable borrow, area B is considered a secondary borrow area.

Soils from borrow areas A and B were grouped according to their grain-size distribution and index properties and subjected to standard compaction testing. Gravelly soils, which contained over 40 percent gravel were not tested. Compaction characteristics limited soils to two classes of fine-grained and one class of gravelly borrow. These soils are equally distributed in both areas, having natural moisture contents within 2 percent of optimum and exhibiting similar plasticity.

The fine-grained borrow soils were tested for shear strength as requested. See table 2. The gravelly borrow class was not tested for shear strength since it is assumed to be as strong or stronger than the fine-grained soils.

Summary

This investigation has shown the existing Colbert ash dike and underlying foundation soils to consist primarily of the medium clay, CL, type. Interspersed throughout the dike and foundation are zones of gravelly clays, G-CL, clayey gravel, and occasionally within the dike soils, clayey sand, SC, and silty sand, SM.

A significant area of clayey gravel, GC, was established in boring SS-8 while semipervious to pervious sands were encountered in the vicinity of boring SS-6. Soil consistency in the dike is generally of medium to stiff range. Softer conditions exist in the foundation soils, particularly in borings SS-7, 8, and 9, and may require special attention.

The traffic-compacted ash is of relatively high density, and high shear strength under all shear test conditions.

Adequate quantities of lean to medium clay, CL, are available as borrow. Many of these clays contain chert gravel and will require close inspection to prevent use of soils with excessively high gravel contents.

Recommended design values are as follows:

		Triaxial Q		Triaxial R	
	γ_w	ϕ	c	ϕ	c
	pcf	deg	tsf	deg	tsf
New dike	125	7	0.8	16	.05
Existing dike	125	19	0.7	20	.35
Foundation	120	1	0.3	19	0.7
Bottom ash	134	40	1.8	42	1.3

Table 1

JOHNSONVILLE STEAM PLANT

ASH DIKE NO. 2

SUMMARY OF LABORATORY TEST DATA

EXISTING DIKE AND FOUNDATION

Elevation	Soil Symbol	Natural Moisture %	Natural Moisture % Sat.	Std. Penetr.	Grain-Size Analysis Gravel %	Sand %	Silt %	Clay %	D_{10} mm	Atterb. Limits Liq. Limit %	Plastic. Index %	Dry Dens. pcf	Void Ratio	Triaxial Q Undisturbed ϕ deg.	c tsf	Natural Moisture Triaxial R ϕ deg.	c tsf	Saturated Triaxial R Apparent ϕ deg.	Apparent c tsf	Effective ϕ deg.	Effective c tsf
Boring No. US-1, S-10+00, W-33+08, Surface Elevation 378.9																					
377.4-375.2	CL	20.3	95.0	20	0	6	54	40	--	43.6	23.6	107.3	.582	10.5	2.11			19.6	0.68	30.0	0.00
374.4-372.4	CL	21.6	96.1	18	0	12	54	34	--	38.2	16.6	105.1	.610								
371.4-369.9	CL	20.1	92.8	22	0	7	53	40	--	40.5	17.7	106.8	.590	10.5	2.23			22.0	1.30	29.5	0.12
368.4-366.9	CL	24.8	90.4	14	0	12	48	40	--	42.3	18.7	97.4	.750	5.1	0.60	17.0	0.70				
365.5-363.4	CL	22.7	96.6	10	0	11	45	44	--	42.4	20.8	103.4	.636								
362.9-360.5	CL	23.7	96.9	16	0	11	49	40	--	41.0	17.5	101.4	.657	3.1	1.06	17.5	0.78				
359.9-358.6	ML	25.6	94.3	14	0	7	53	40	--	43.0	16.4	97.4	.737								
Boring No. US-7, N-14+00, W-17+53, Surface Elevation 378.1																					
376.6-374.2	CL	17.7	81.3	13	10	19	47	24	--	30.1	11.2	105.5	.580								
373.6-372.3	CL	17.9	81.4	7	8	15	53	24	--	34.8	13.3	104.6	.582	19.1	0.65						
370.6-369.2	G-SM-SC	16.7	75.0	7	19	45	25	11	.0043	24.8	6.4	106.2	.610								
367.6-365.2	G-SM-SC	17.2	82.7	9	24	29	32	15	--	21.9	5.3	107.6	.561								
364.6-363.6	SM	22.0	81.1	7	9	48	33	10	.0053	NP	NP	96.0	.716								
Boring No. US-8, N-4+00, W-16+90, Surface Elevation 377.4																					
358.4-356.6	CL	28.1	97.9	4	0	7	37	56	--	40.3	18.1	95.4	.780	1.1	0.36	20.0	0.25				
354.4-352.4	G-SM	19.4		2	22	50	14	14	--	--	--	--									
351.4-350.4	CL	28.5	100.0	4	5	19	37	39	--	37.6	16.9	96.8	.760								
345.4-344.4	CL	27.6	98.0	3	2	14	50	34	--	40.1	16.6	95.8	.761	0.5	0.29	20.5	0.38				
342.4-340.3	MH	35.2	83.2	10	0	2	38	60	--	50.8	21.9	78.0	1.121								
339.4-337.8	CL	28.9	96.4	7	0	1	54	45	--	37.4	16.3	92.7	.799	0.0	0.25	25.0	0.15				

Table 2

JOHNSONVILLE STEAM PLANT

ASH DIKE NO. 2

BOTTOM ASH

SUMMARY OF LABORATORY TEST DATA

BORROW SOIL CLASSES

Class	I
Symbol	G-SW-SM
Mechanical and Hydrometer Analysis	
Gravel, percent	34
Sand, percent	57
Silt, percent	9
Atterberg Limits	
Liquid limit, percent	NP
Plastic limit, percent	NP
Plasticity index, percent	NP
Shear Strength at	
Triaxial Q: ϕ degrees	40.0
c tsf	2.00
Triaxial Q: ϕ degrees	39.0
c tsf	2.00
Triaxial R: ϕ degrees	42.0
c tsf	1.50
Direct Shear S: ϕ degrees	43.5
c tsf	0.72
Direct Shear S: ϕ degrees	45.5
c tsf	0.55
Coefficient of Permeability, cm/sec	1.04×10^{-5}

Table 3

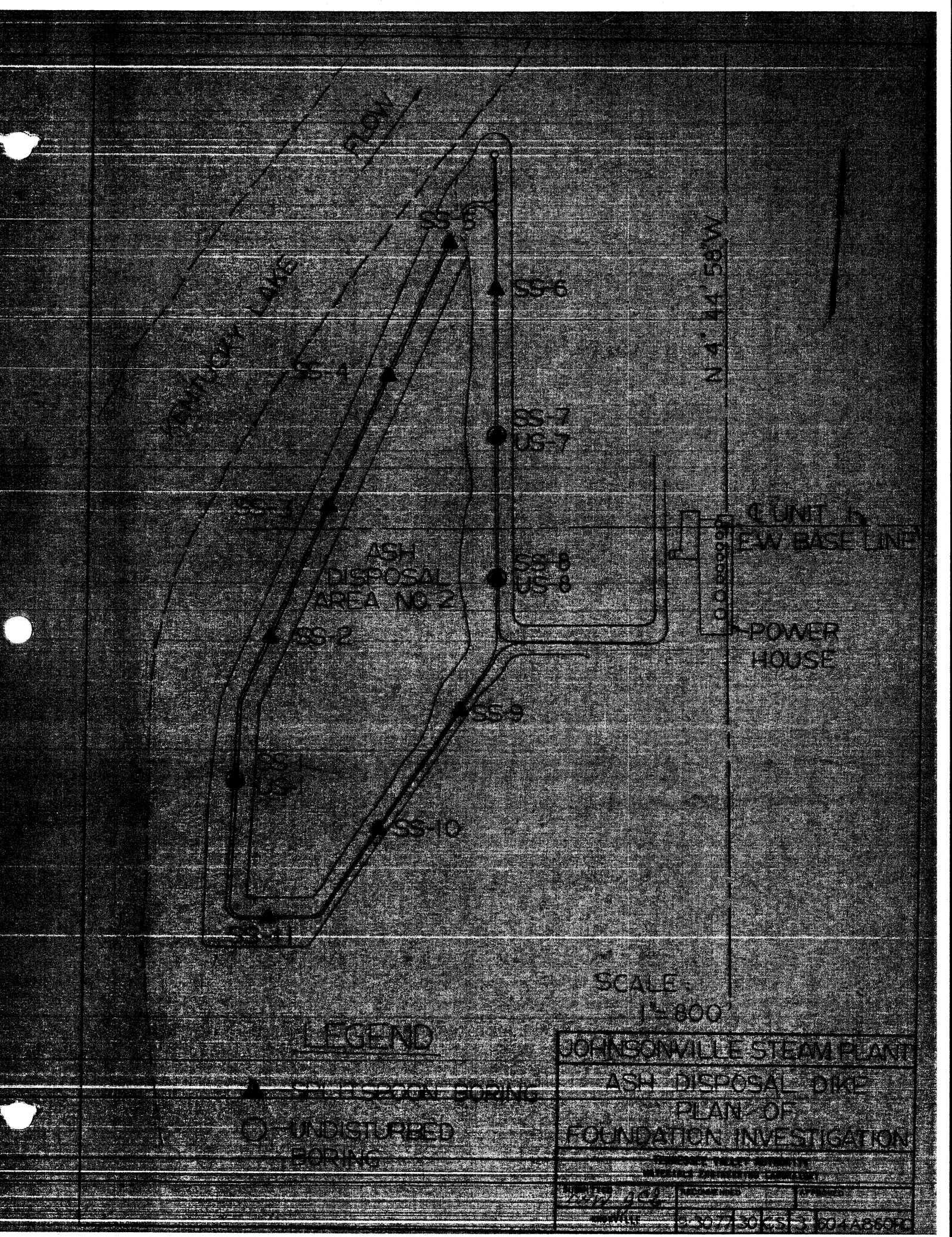
JOHNSONVILLE STEAM PLANT

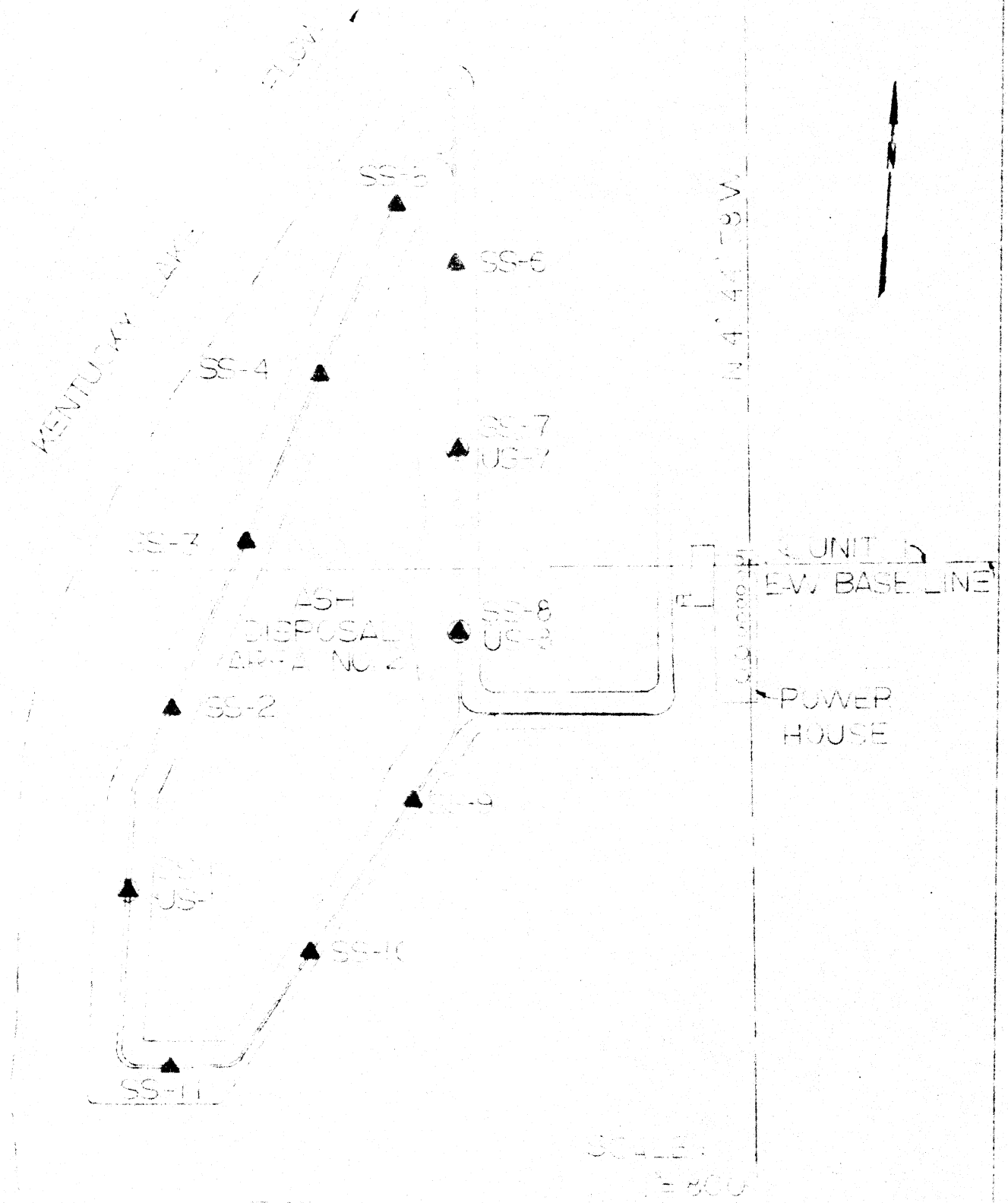
BORROW AREAS A & B

SUMMARY OF LABORATORY TEST DATA

BORROW SOIL CLASSES

Class	I	II
Symbol	CL	CL
Mechanical and Hydrometer Analysis		
Gravel, percent	0	0
Sand, percent	21	11
Silt, percent	42	47
Clay, percent	37	42
Atterberg Limits		
Liquid limit, percent	42.1	46.7
Plastic limit, percent	18.5	18.5
Plasticity index, percent	23.6	28.2
Shrinkage limit, percent	--	--
Standard Proctor Compaction		
Optimum moisture, percent	16.9	18.0
Maximum density, pcf	109.2	106.8
Penetration resistance, psi	790	765
Shear strength at 3 percent wet of optimum moisture and at 95 percent of standard maximum dry density		
Triaxial Q: ϕ degrees	6.0	7.5
c tsf	1.05	0.82
Shear strength at 3 percent dry of optimum moisture and at 95 percent of standard maximum dry density		
Triaxial Q: ϕ degrees	32.0	30.0
c tsf	1.30	0.75
Triaxial R: ϕ degrees	16.5	18.0
c tsf	0.06	0.05


FLOW
FRANKLIN LAKE
SS-5
SS-6
SS-4
SS-7
US-7
SS-3
ASH
DISPOSAL
AREA NO. 2
SS-8
US-8
SS-2
SS-9
SS-1
US-1
SS-10
SS-11
N 4° 44' 58" W
℄ UNIT 1
EW BASE LINE
POWER
HOUSE
SCALE:
1" = 800'
LEGEND
SPLITSPOON BORING
UNDISTURBED
BORING
JOHNSONVILLE STEAM PLANT
ASH DISPOSAL DIKE
PLAN OF
FOUNDATION INVESTIGATION
TENNESSEE VALLEY AUTHORITY
WATERSHED DEVELOPMENT DEPARTMENT
DRAWN
CHECKED
APPROVED
SCALE
1-30-7 30-S-3 60-A8607D

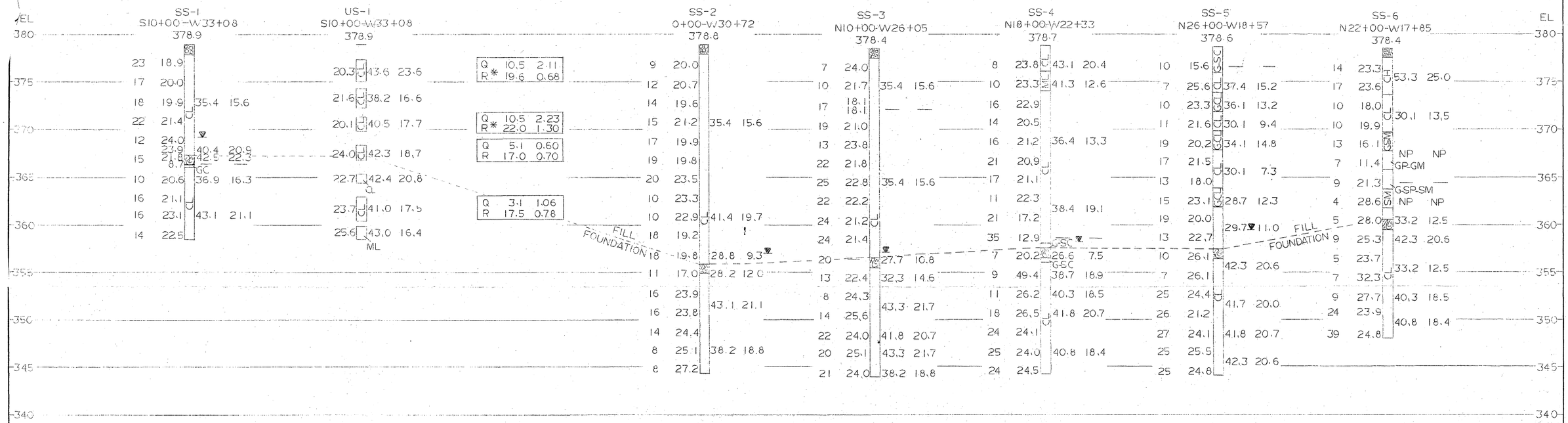


LEGEND

▲ - SPLIT SPOON BORING

○ - UNDISTURBED BORING

JOHNSONVILLE STEAM PLANT				
ASH DISPOSAL DIKE PLAN OF FOUNDATION INVESTIGATION				
TENNESSEE VALLEY AUTHORITY MATERIALS ENGINEERING LABORATORY				
SUBMITTED	RECOMMENDED		APPROVED	
KNOXVILLE			J	



SYMBOLS

- TOPSOIL
- ASH AND GRAVEL
- WATER TABLE
- Q — UNCONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST
- R — CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST AT NATURAL MOISTURE
- R* — CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST SATURATED

LEGEND

BORING NO
COORDINATES
ELEVATION

BLOWS | NATURAL MOISTURE CONTENT | CLASSIFICATION | LIQUID LIMIT | PLASTICITY INDEX

TYPE TEST	FRICTION ANGLE (DEGREES)	COHESION (TSF)

NOTE: BLOWS PER FOOT WITH A 140 LB HAMMER AND A 30 INCH DROP ON A 2 INCH OD SPLITSPOON SAMPLER

SCALE 1"=5'

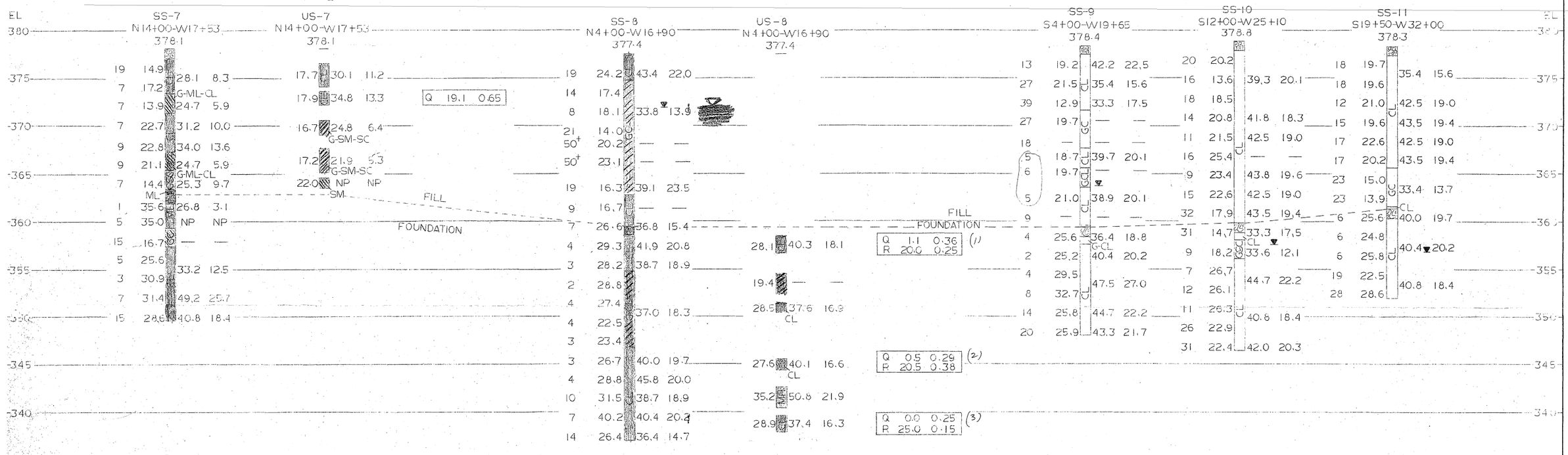
JOHNSONVILLE STEAM PLANT

ASH DISPOSAL DIKE
FOUNDATION INVESTIGATION
BORINGS SS-1 THROUGH SS-6

TENNESSEE VALLEY AUTHORITY
MATERIALS ENGINEERING LABORATORY

SUBMITTED	RECOMMENDED	APPROVED
gcs		RDR

KNOXVILLE	9-30-77	30	CS	3	604K861R1



5/30/78

SYMBOLS

- TOPSOIL
- ASH AND GRAVEL
- WATER TABLE
- Q — UNCONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST
- R — CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST AT NATURAL MOISTURE

LEGEND

BORING NO
COORDINATES
ELEVATION

BLOWS | NATURAL MOISTURE CONTENT | CLASSIFICATION | LIQUID LIMIT | PLASTICITY INDEX

TYPE TEST	FRICTION ANGLE (DEGREES)	COHESION (TSF)

NOTE: BLOWS PER FOOT WITH A 140 LB HAMMER AND A 30 INCH DROP ON A 2 INCH OD SPILTSPOON SAMPLER

SCALE: 1"=5'

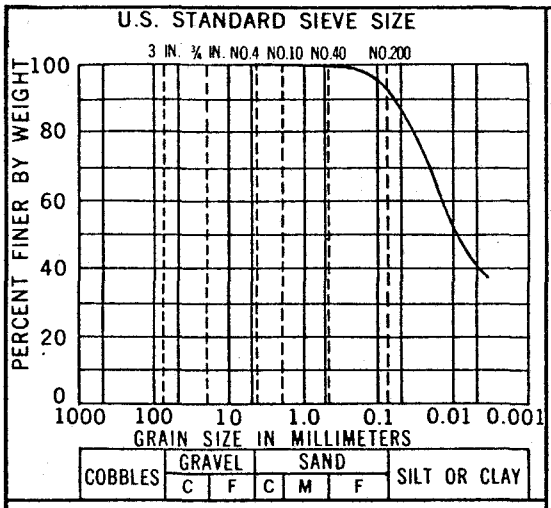
JOHNSONVILLE STEAM PLANT

ASH DISPOSAL DIKE
FOUNDATION INVESTIGATION
BORINGS SS-7 THROUGH SS-11

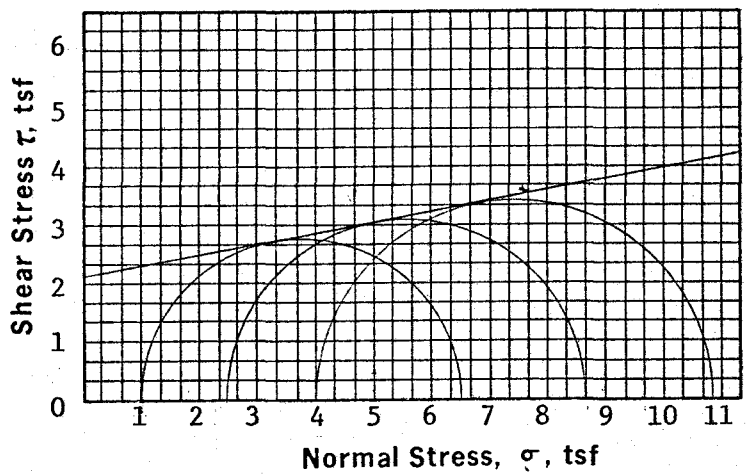
TENNESSEE VALLEY AUTHORITY
MATERIALS ENGINEERING LABORATORY

SUBMITTED	RECOMMENDED	APPROVED
DWW	WAB	Rar

KNOXVILLE	9-30-77	30	CS	3	604K862R0

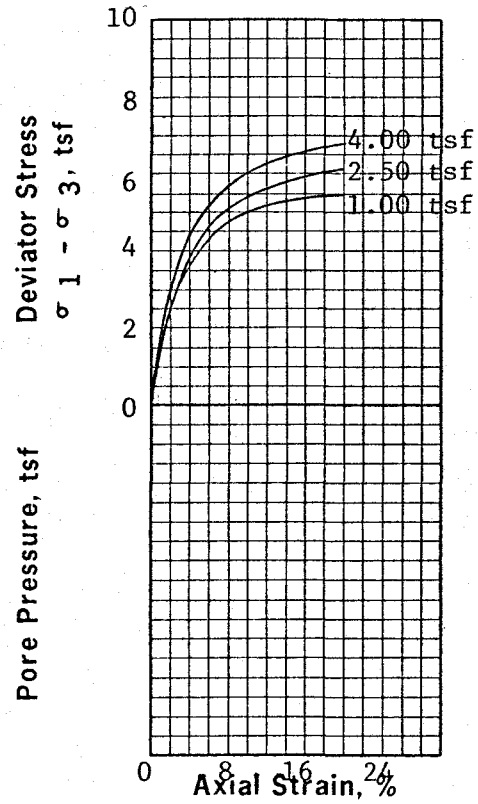


Type of Specimen Undisturbed	
Classification CL	
LL. 43.6	**G** 2.72
PI. 23.6	**D_{10}** --



Shear Strength	ø Deg.	Tan ø	C, tsf
Apparent	10.5	.19	2.11
Effective	--	--	--

Specimen Number		1	2	3	4
Initial	Moisture Content, %	19.4	19.3	19.8	
	Dry Density, pcf	106.9	109.3	108.2	
	Void Ratio	.588	.553	.570	
	Saturation, %	90.0	94.9	94.3	
Before Shearing	Moisture Content after Saturation, %	--	--	--	
	Saturation, %	--	--	--	
	Moisture Content after Consolidation, %	--	--	--	
	Void Ratio after Consolidation	--	--	--	
Final Moisture Content ,%		19.3	19.3	19.7	
Minor Principal Stress, σ_3, tsf		1.00	2.50	4.00	
Major Principal Stress, σ_1, tsf		6.49	8.62	10.81	
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		--	--	--	
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		--	--	--	
Time to Failure, min.		19	20	20	
Rate of strain, %/min.		1.00	1.00	1.00	
Specimen Height, in.		3.15	3.15	3.15	
Specimen Diameter, in.		1.40	1.40	1.40	



Remarks:

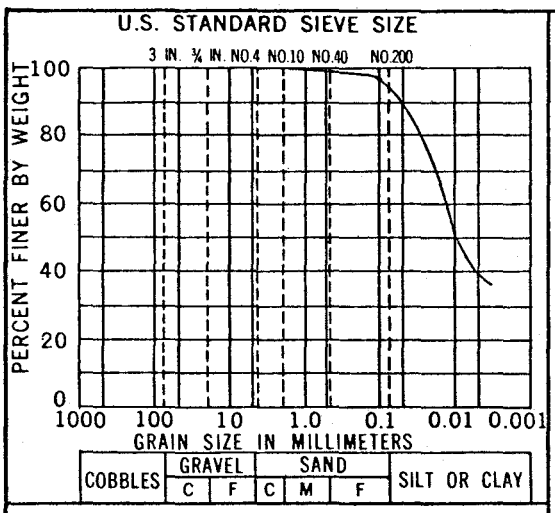
Project: Johnsonville Steam Plant

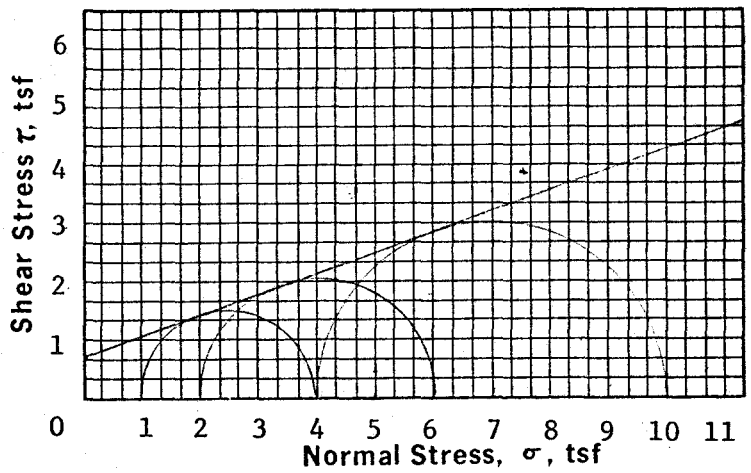
Feature Ash Dike 2

Boring No. US-1	**Sample No.** 1
Station S-10+00	Range W-33+08
Date 9-26-77	**Elev.** 377.4-375.9

TRIAXIAL COMPRESSION TEST (Q)

Tested by: GMD & RLV Reviewed by: JCS

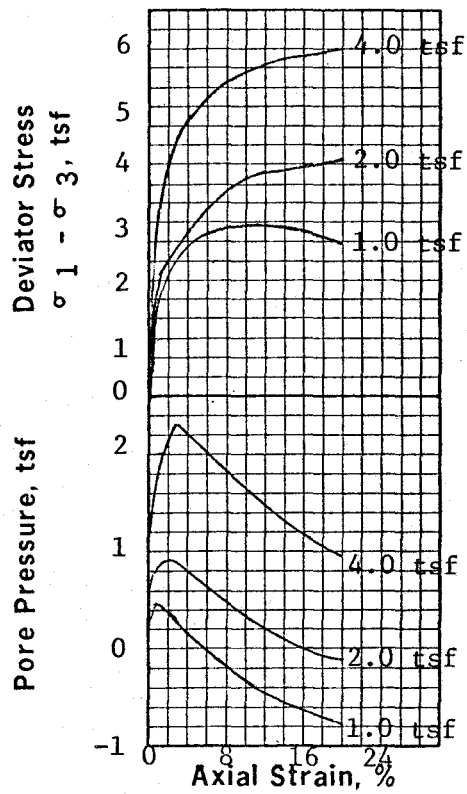




Type of Specimen	Undisturbed		
Classification	CL		
LL.	43.6	**G**	2.72
PI.	23.6	**D_{10}**	--

Shear Strength	ø Deg.	Tan ø	C, tsf
Apparent	19.6	.36	0.68
Effective	30.0	.58	0.00

	Specimen Number	1	2	3	4
Initial	Moisture Content, %	20.4	20.9	20.7	
	Dry Density, pcf	107.9	105.6	107.5	
	Void Ratio	.573	.607	.580	
	Saturation, %	96.9	93.8	97.1	
Before Shearing	Moisture Content after Saturation, %	21.1	22.3	21.3	
	Saturation, %	100.0	100.0	100.0	
	Moisture Content after Consolidation, %	18.9	20.5	18.8	
	Void Ratio after Consolidation	.538	.556	.510	
Final Moisture Content ,%		18.9	20.5	18.8	
Minor Principal Stress, σ_3, tsf		1.00	2.00	4.00	
Major Principal Stress, σ_1, tsf		3.97	6.06	10.00	
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		1.42	2.08	3.01	
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		4.32	6.14	9.01	
Time to Failure, min.		60	97	100	
Rate of strain, %/min.		0.20	0.20	0.20	
Specimen Height, in.		3.15	3.15	3.15	
Specimen Diameter, in.		1.40	1.40	1.40	



Remarks:

Project: Johnsonville Steam Plant

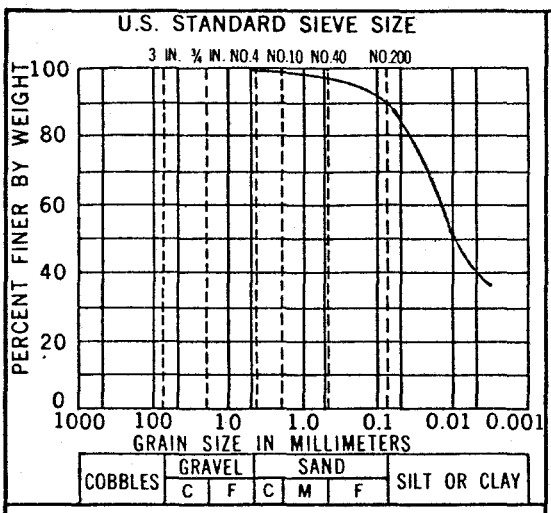
Feature Ash Dike 2

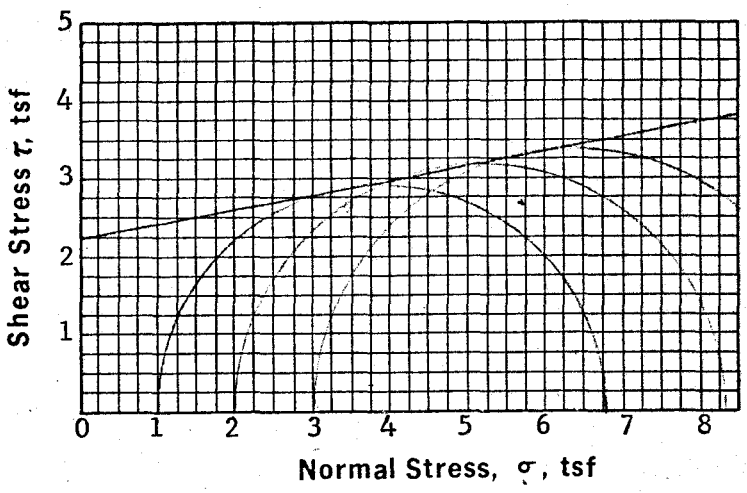
Boring No. US-1	**Sample No.** 1
Station S-10+00	Range W-33+08
Date 9-23-77	**Elev.** 375.9-375.4

TRIAXIAL COMPRESSION TEST (R)

Tested by: E.L.

Reviewed by: JCB

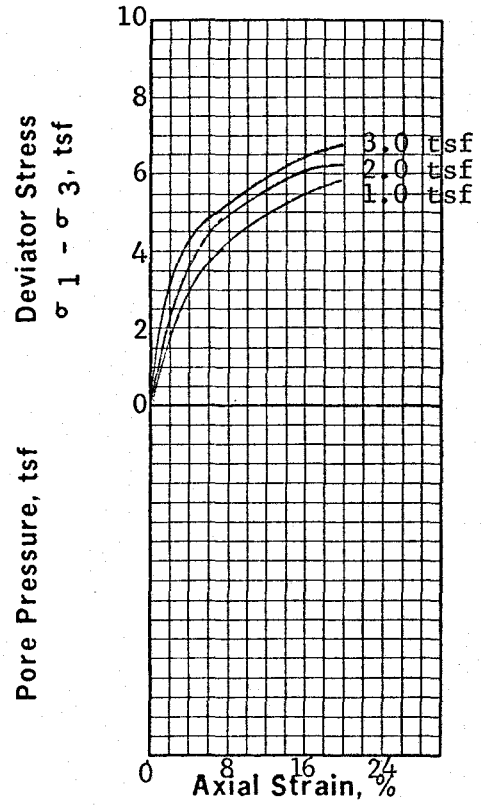




Type of Specimen	Undisturbed		
Classification	CL		
LL.	40.5	G	2.72
PI.	17.7	D_{10}	--

Shear Strength	ø Deg.	Tan ø	C, tsf
Apparent	10.5	.19	2.23
Effective	--	--	--

	Specimen Number	1	2	3	4
Initial	Moisture Content, %	19.8	19.6	19.3	
	Dry Density, pcf	106.8	107.5	107.9	
	Void Ratio	.590	.579	.574	
	Saturation, %	91.2	92.1	91.2	
Before Shearing	Moisture Content after Saturation, %	--	--	--	
	Saturation, %	--	--	--	
	Moisture Content after Consolidation, %	--	--	--	
	Void Ratio after Consolidation	--	--	--	
Final Moisture Content ,%		19.7	19.5	19.2	
Minor Principal Stress, σ_3, tsf		1.00	2.00	3.00	
Major Principal Stress, σ_1, tsf		6.78	8.33	9.69	
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		--	--	--	
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		--	--	--	
Time to Failure, min.		20	18	20	
Rate of strain, %/min.		1.0	1.0	1.0	
Specimen Height, in.		3.15	3.15	3.15	
Specimen Diameter, in.		1.40	1.40	1.40	



Remarks:

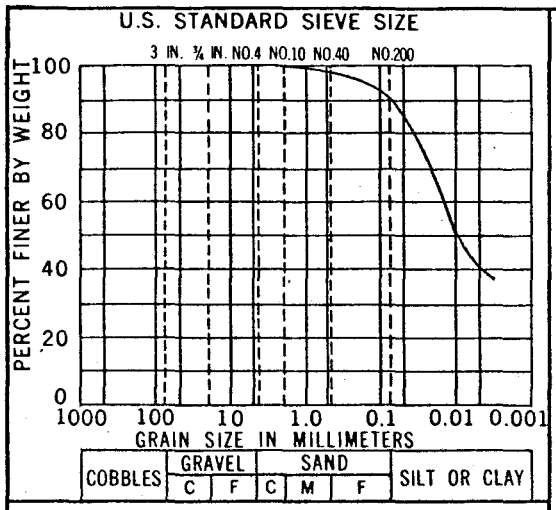
Project: Johnsonville S. P.

Feature Ash Dike 2

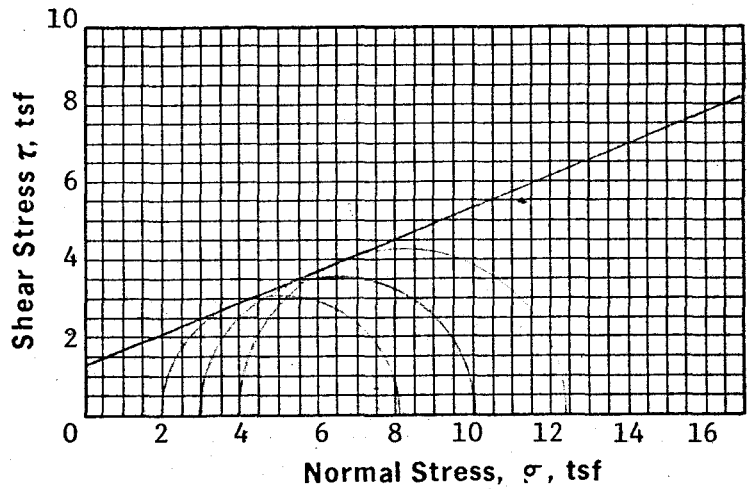
Boring No. US-1	Sample No. 3
Station S-10+00	Range W-33+08
Date 7-19-77	Elev. 370.9-370.4

TRIAXIAL COMPRESSION TEST (Q)

Tested by: CEC Reviewed by: JCS

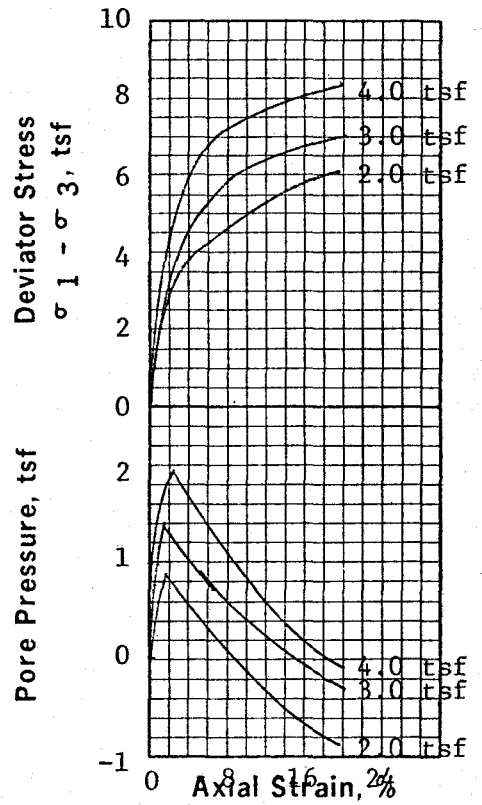


Type of Specimen	Undisturbed
Classification	CL
LL. 40.5	**G** 2.72
PI. 17.7	**D_{10}** --



Shear Strength	ø Deg.	Tan ø	C, tsf
Apparent	22.0	.40	1.30
Effective	29.5	.57	0.12

	Specimen Number	1	2	3	4
Initial	Moisture Content, %	20.4	20.4	20.4	
	Dry Density, pcf	106.2	106.4	106.3	
	Void Ratio	.600	.596	.597	
	Saturation, %	92.6	93.3	92.8	
Before Shearing	Moisture Content after Saturation, %	22.0	21.9	22.0	
	Saturation, %	100	100	100	
	Moisture Content after Consolidation, %	20.6	20.4	20.9	
	Void Ratio after Consolidation	.539	.489	.571	
Final Moisture Content ,%		20.6	20.4	20.9	
Minor Principal Stress, σ_3, tsf		2.00	3.00	4.00	
Major Principal Stress, σ_1, tsf		8.13	10.03	12.40	
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		2.89	3.29	4.09	
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		9.02	10.32	12.49	
Time to Failure, min.		97	97	104	
Rate of strain, %/min.		0.20	0.20	0.20	
Specimen Height, in.		3.15	3.15	3.15	
Specimen Diameter, in.		1.40	1.40	1.40	



Remarks:

Project: Johnsonville Steam Plant

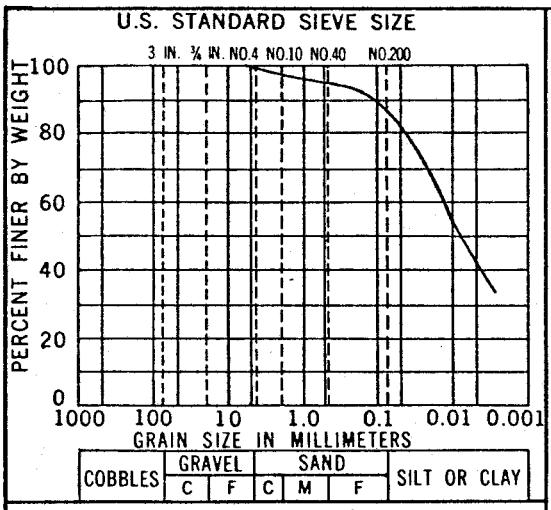
Feature Ash Dike 2

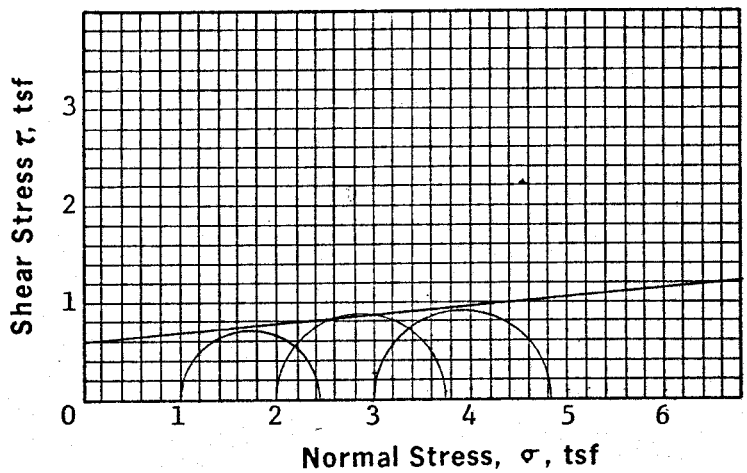
Boring No. US-1	**Sample No.** 3
Station S-10+00	**Range** W-33+08
Date 9-23-77	**Elev.** 370.4-369.9

TRIAXIAL COMPRESSION TEST (R)

Tested by: CEC

Reviewed by: JCS

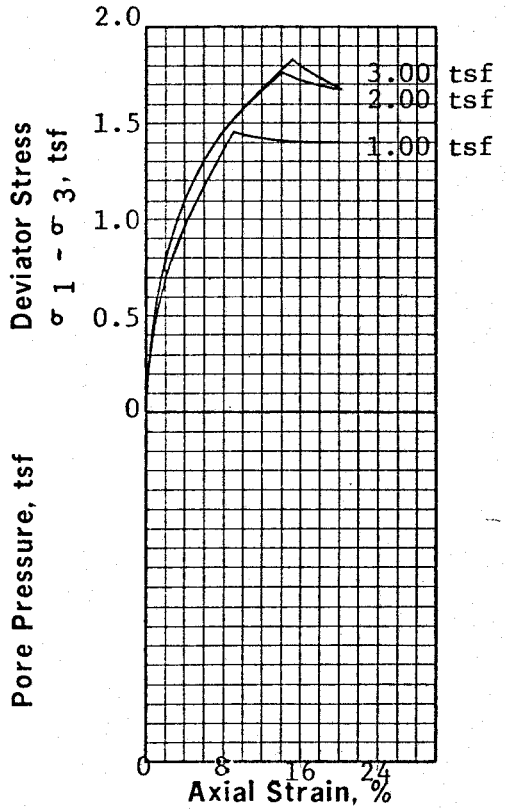




Type of Specimen	Undisturbed		
Classification	CL		
LL.	42.3	G	2.73
PI.	18.7	D_{10}	--

Shear Strength	ø Deg.	Tan ø	C, tsf
Apparent	5.1	.09	0.60
Effective	--	--	--

	Specimen Number	1	2	3	4
Initial	Moisture Content, %	24.3	23.8	24.5	
	Dry Density, pcf	97.5	99.2	98.0	
	Void Ratio	.748	.718	.739	
	Saturation, %	88.6	90.3	90.3	
Before Shearing	Moisture Content after Saturation, %	--	--	--	
	Saturation, %	--	--	--	
	Moisture Content after Consolidation, %	--	--	--	
	Void Ratio after Consolidation	--	--	--	
Final Moisture Content ,%		24.0	23.6	24.1	
Minor Principal Stress, σ_3, tsf		1.00	2.00	3.00	
Major Principal Stress, σ_1, tsf		2.45	3.77	4.82	
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		--	--	--	
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		--	--	--	
Time to Failure, min.		9	14	15	
Rate of strain, %/min.		1.00	1.00	1.00	
Specimen Height, in.		3.15	3.15	3.15	
Specimen Diameter, in.		1.40	1.40	1.40	

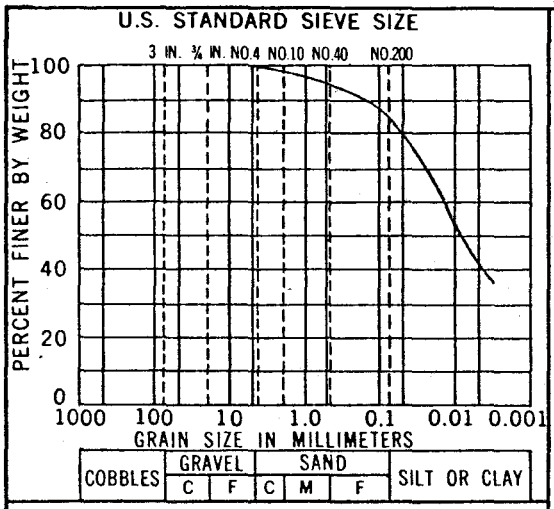


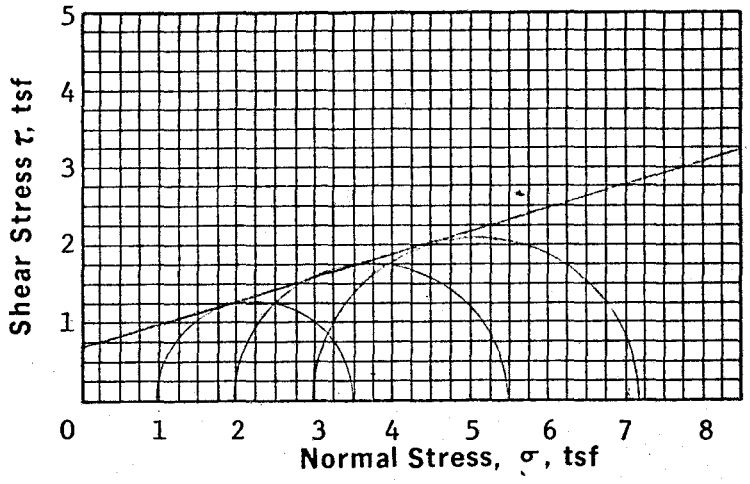
Remarks:

Project: Johnsonville Steam Plant	
Feature Ash Dike 2	
Boring No. US-1	Sample No. 4
Station S-10+00	Range W-33+-8
Date 9-25-77	Elev. 367.9-367.4

TRIAXIAL COMPRESSION TEST (Q)

Tested by: GMD & PLK Reviewed by: JCB

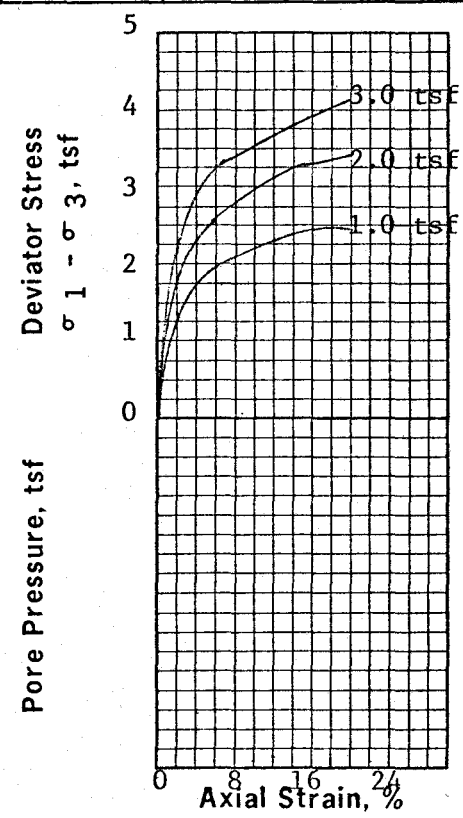




Type of Specimen	Undisturbed
Classification	CL
LL. 42.3	**G** 2.73
PI. 18.7	**D_{10}** --

Shear Strength	ø Deg.	Tan ø	C, tsf
Apparent	17.0	.31	0.70
Effective	--	--	--

Specimen Number		1	2	3	4
Initial	Moisture Content, %	25.3	25.8	26.7	
	Dry Density, pcf	97.6	96.4	94.3	
	Void Ratio	.746	.768	.807	
	Saturation, %	92.7	91.7	90.4	
Before Shearing	Moisture Content after Saturation, %	--	--	--	
	Saturation, %	--	--	--	
	Moisture Content after Consolidation, %	24.3	23.5	23.1	
	Void Ratio after Consolidation	.742	.728	.727	
Final Moisture Content ,%		24.3	23.5	23.1	
Minor Principal Stress, σ_3, tsf		1.00	2.00	3.00	
Major Principal Stress, σ_1, tsf		3.47	5.46	7.17	
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		--	--	--	
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		--	--	--	
Time to Failure, min.		90	100	100	
Rate of strain, %/min.		0.2	0.2	0.2	
Specimen Height, in.		3.15	3.15	3.15	
Specimen Diameter, in.		1.40	1.40	1.40	



Remarks:

Project: Johnsonville Steam Plant

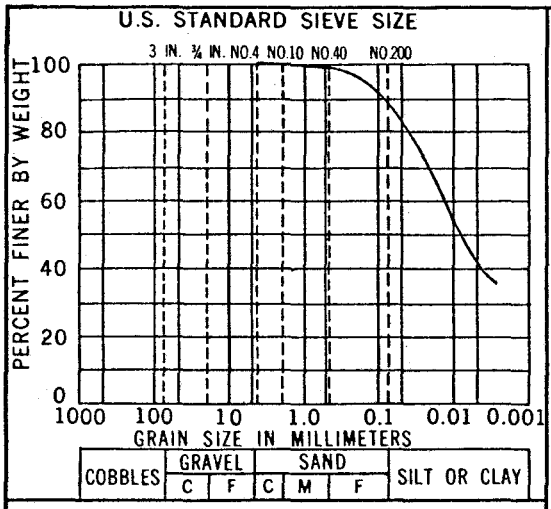
Feature Ash Dike 2

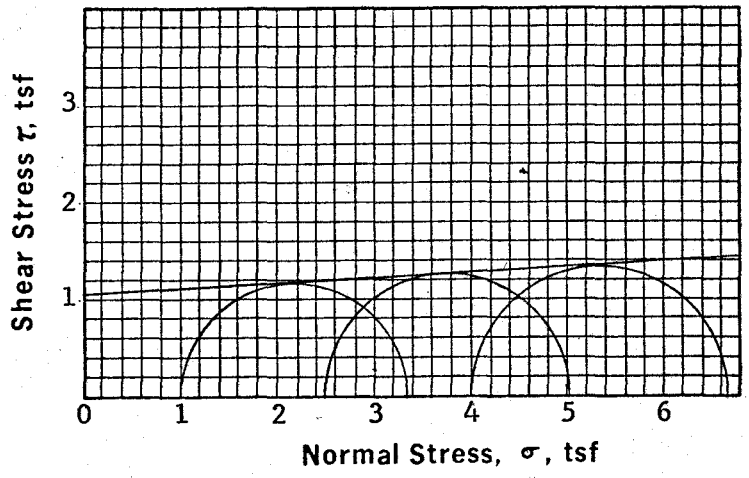
Boring No. US-1	**Sample No.** 4
Station S-10+00	Range W-33+08
Date 7-21-77	**Elev** 367.4-366.9

TRIAXIAL COMPRESSION TEST(R)

Tested by: CEC

Reviewed by: JCB

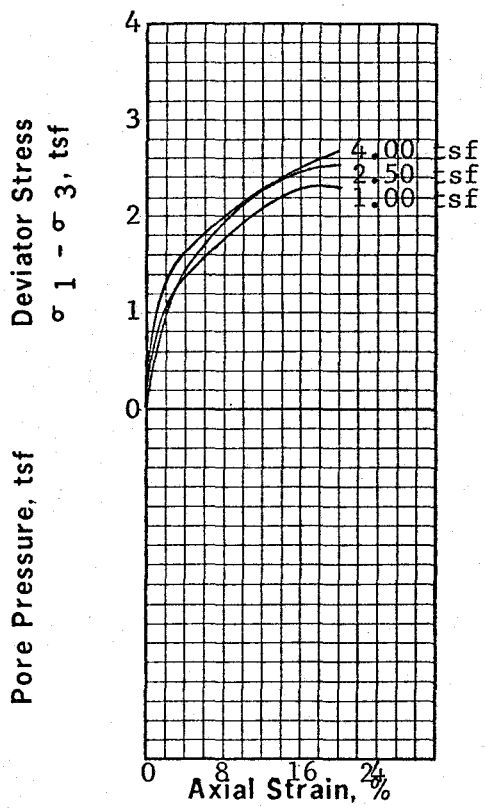




Type of Specimen	Undisturbed		
Classification	CL		
LL.	41.0	G	2.69
PI.	17.5	D_{10}	--

Shear Strength	ø Deg.	Tan ø	C, tsf
Apparent	3.1	.05	1.06
Effective	--	--	--

Specimen Number		1	2	3	4
Initial	Moisture Content, %	23.4	23.8	22.4	
	Dry Density, pcf	102.5	101.7	103.9	
	Void Ratio	.639	.651	.617	
	Saturation, %	98.4	98.4	97.7	
Before Shearing	Moisture Content after Saturation, %	--	--	--	
	Saturation, %	--	--	--	
	Moisture Content after Consolidation, %	--	--	--	
	Void Ratio after Consolidation	--	--	--	
Final Moisture Content ,%		23.3	23.7	22.3	
Minor Principal Stress, σ_3, tsf		1.00	2.50	4.00	
Major Principal Stress, σ_1, tsf		3.34	5.03	6.69	
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		--	--	--	
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		--	--	--	
Time to Failure, min.		18	19	20	
Rate of strain, %/min.		1.00	1.00	1.00	
Specimen Height, in.		3.15	3.15	3.15	
Specimen Diameter, in.		1.40	1.40	1.40	



Remarks:

Project: Johnsonville S. P.

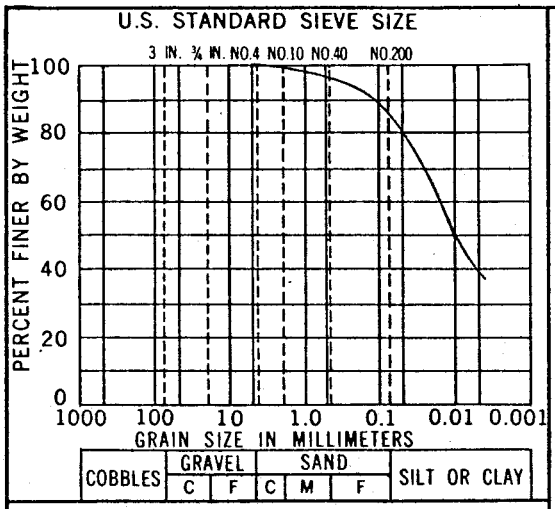
Feature Ash Dike 2

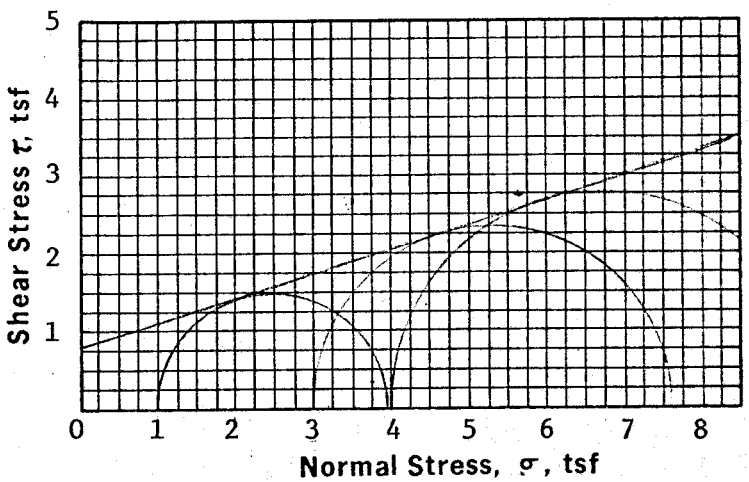
Boring No.	US-1	Sample No.	6
Station	S-10+00	Range	W-33+08
Date	9-20-77	Elev.	362.4-361.9

TRIAXIAL COMPRESSION TEST (Q)

Tested by: RW

Reviewed by: gcs

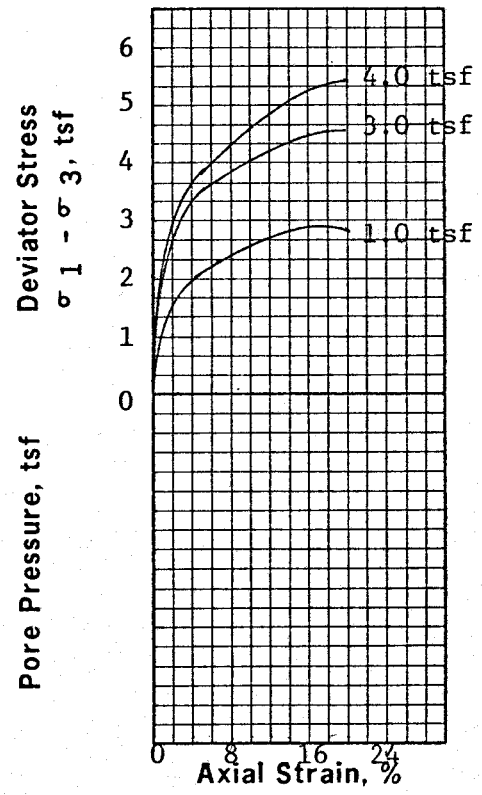




Type of Specimen	Undisturbed
Classification	CL
LL. 41.0	**G** 2.69
PI. 17.5	**D_{10}** --

Shear Strength	ø Deg.	Tan ø	C, tsf
Apparent	17.5	.32	0.78
Effective	--	--	--

	Specimen Number	1	2	3	4
Initial	Moisture Content, %	25.0	24.6	24.5	
	Dry Density, pcf	99.2	99.7	99.7	
	Void Ratio	.693	.685	.684	
	Saturation, %	97.0	96.8	96.3	
Before Shearing	Moisture Content after Saturation, %	--	--	--	
	Saturation, %	--	--	--	
	Moisture Content after Consolidation, %	24.4	22.8	22.3	
	Void Ratio after Consolidation	.663	.606	.625	
Final Moisture Content ,%		24.4	22.8	22.3	
Minor Principal Stress, σ_3, tsf		1.00	3.00	4.00	
Major Principal Stress, σ_1, tsf		3.96	7.62	9.47	
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		--	--	--	
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		--	--	--	
Time to Failure, min.		90	100	96	
Rate of strain, %/min.		0.20	0.20	0.20	
Specimen Height, in.		3.15	3.15	3.15	
Specimen Diameter, in.		1.40	1.40	1.40	



Remarks:

Project: Johnsonville Steam Plant

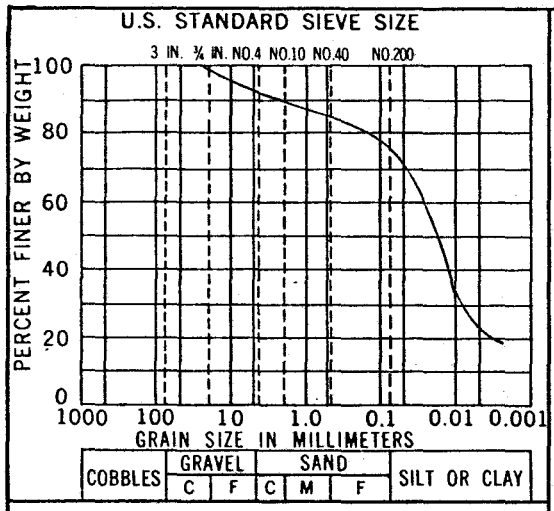
Feature Ash Dike 2

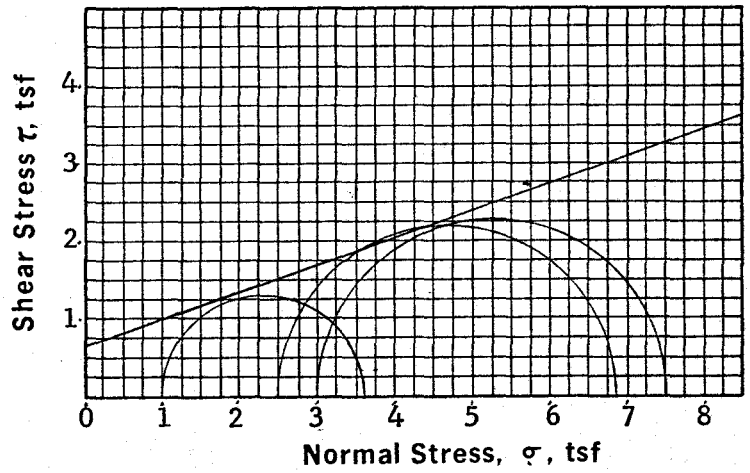
Boring No. US-1	**Sample No.** 6
Station S-10+00	Range W-33+08
Date 9-23-77	**Elev.** 361.9-361.5

TRIAXIAL COMPRESSION TEST (R)

Tested by: CEC

Reviewed by: JCS

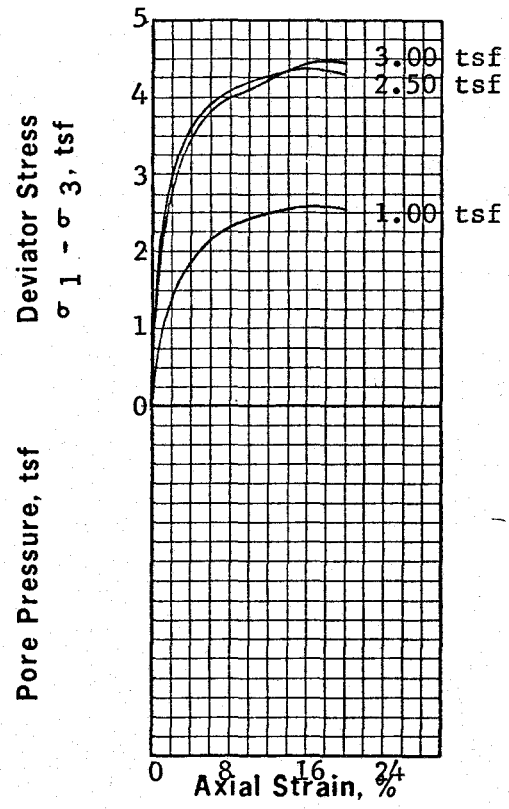




Type of Specimen	Undisturbed		
Classification	CL		
LL.	34.8	G	2.65
PI.	13.3	D_{10}	--

Shear Strength	ø Deg.	Tan ø	C, tsf
Apparent	19.1	.35	0.65
Effective	--	--	--

	Specimen Number	1	2	3	4
Initial	Moisture Content, %	18.4	16.9	15.5	
	Dry Density, pcf	103.4	103.3	107.3	
	Void Ratio	.600	.601	.542	
	Saturation, %	81.2	74.6	75.9	
Before Shearing	Moisture Content after Saturation, %	--	--	--	
	Saturation, %	--	--	--	
	Moisture Content after Consolidation, %	--	--	--	
	Void Ratio after Consolidation	--	--	--	
Final Moisture Content ,%		18.3	16.9	15.5	
Minor Principal Stress, σ_3, tsf		1.00	2.50	3.00	
Major Principal Stress, σ_1, tsf		3.60	6.88	7.48	
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		--	--	--	
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		--	--	--	
Time to Failure, min.		19	16	19	
Rate of strain, %/min.		1.00	1.00	1.00	
Specimen Height, in.		3.15	3.15	3.15	
Specimen Diameter, in.		1.40	1.40	1.40	



Remarks: Specimen nonuniform in moisture and density.

Project: Johnsonville S. P.

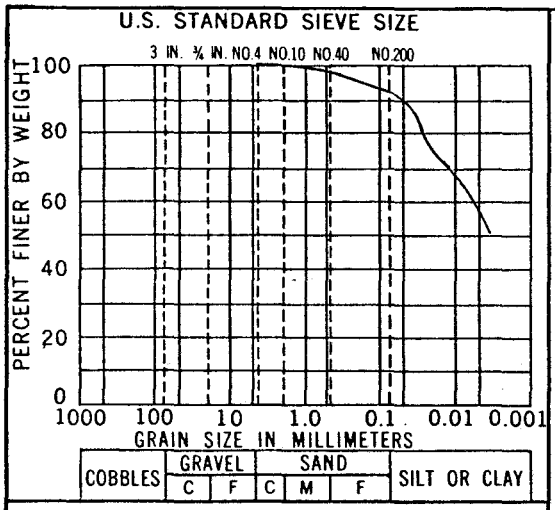
Feature Ash Dike 2

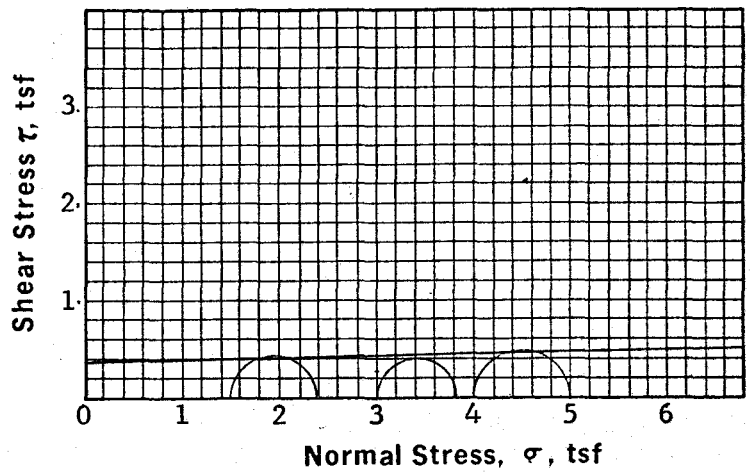
Boring No.	US-7	Sample No.	2
Station	N-14+00	Range	W-17+53
Date	9-21-77	Elev.	373.6-373.1

TRIAXIAL COMPRESSION TEST (Q)

Tested by: RW

Reviewed by: JCB

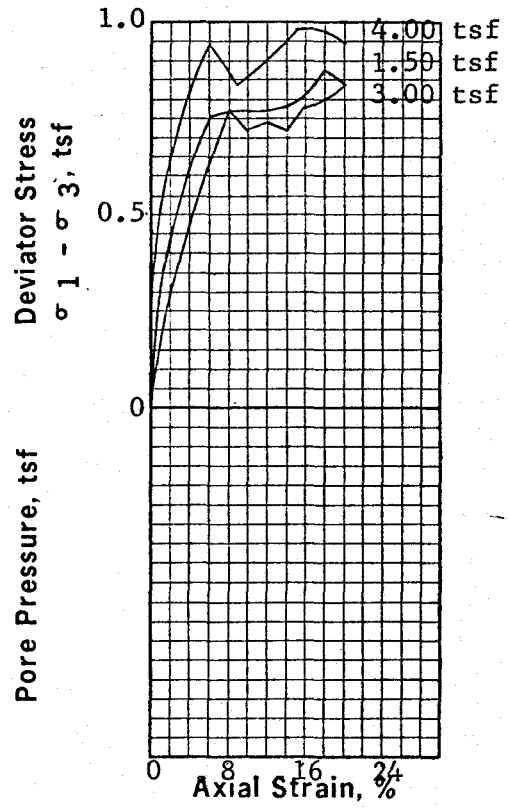




Type of Specimen	Undisturbed		
Classification	CL		
LL.	40.3	G	2.72
PI.	18.1	D_{10}	--

Shear Strength	ø Deg.	Tan ø	C, tsf
Apparent	1.1	.02	0.36
Effective	--	--	--

	Specimen Number	1	2	3	4
Initial	Moisture Content, %	27.0	27.2	27.7	
	Dry Density, pcf	97.4	96.5	96.8	
	Void Ratio	.744	.760	.754	
	Saturation, %	98.9	97.4	99.9	
Before Shearing	Moisture Content after Saturation, %	--	--	--	
	Saturation, %	--	--	--	
	Moisture Content after Consolidation, %	--	--	--	
	Void Ratio after Consolidation	--	--	--	
Final Moisture Content ,%		26.6	26.9	27.4	
Minor Principal Stress, σ_3, tsf		1.50	3.00	4.00	
Major Principal Stress, σ_1, tsf		2.37	3.84	4.99	
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		--	--	--	
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		--	--	--	
Time to Failure, min.		18	20	17	
Rate of strain, %/min.		1.00	1.00	1.00	
Specimen Height, in.		3.15	3.15	3.15	
Specimen Diameter, in.		1.40	1.40	1.40	



Remarks:

Project: Johnsonville S. P.

Feature Ash Dike 2

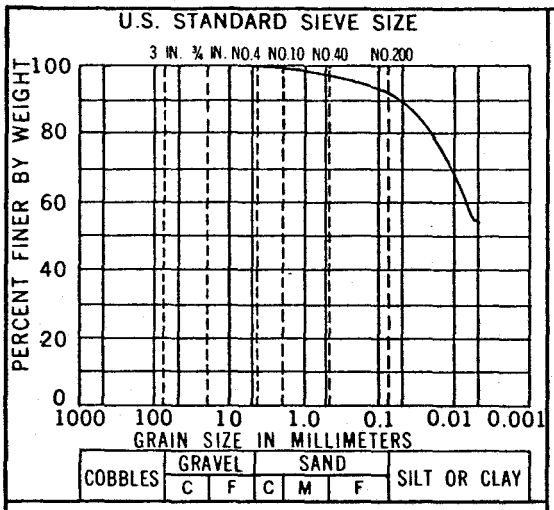
Boring No. US-8 | Sample No. 1

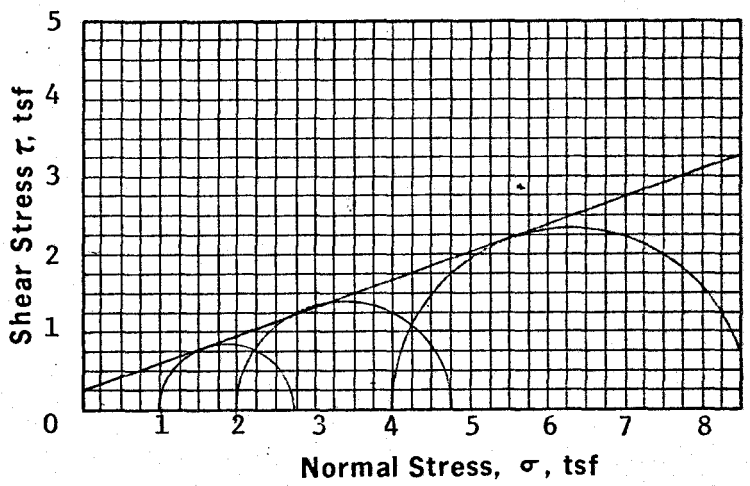
Station N-4+00 | Range W-16+90

Date 9-23-77 | Elev. 358.0-357.5

TRIAXIAL COMPRESSION TEST (Q)

Tested by: GMD & RLK Reviewed by: JCG

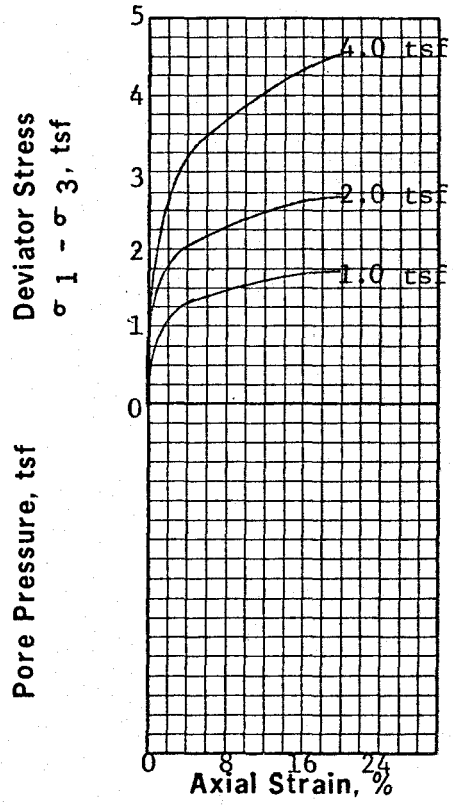




Type of Specimen Undisturbed			
Classification CL			
LL. 40.3		**G** 2.72	
PI. 18.1		**D_{10}** --	

Shear Strength	ø Deg.	Tan ø	C, tsf
Apparent	20.0	.36	0.25
Effective	--	--	--

	Specimen Number	1	2	3	4
Initial	Moisture Content, %	28.1	28.7	27.7	
	Dry Density, pcf	94.4	94.0	95.8	
	Void Ratio	.798	.807	.773	
	Saturation, %	95.7	96.8	97.5	
Before Shearing	Moisture Content after Saturation, %	--	--	--	
	Saturation, %	--	--	--	
	Moisture Content after Consolidation, %	25.2	25.0	23.0	
	Void Ratio after Consolidation	.788	.763	.712	
Final Moisture Content ,%		25.2	25.0	23.0	
Minor Principal Stress, σ_3, tsf		1.00	2.00	4.00	
Major Principal Stress, σ_1, tsf		2.75	4.75	8.55	
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		--	--	--	
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		--	--	--	
Time to Failure, min.		100	100	96	
Rate of strain, %/min.		0.20	0.20	0.20	
Specimen Height, in.		3.15	3.15	3.15	
Specimen Diameter, in.		1.40	1.40	1.40	



Remarks:

Project: Johnsonville Steam Plant

Feature Ash Dike 2

Boring No. US-8 | **Sample No.** 1

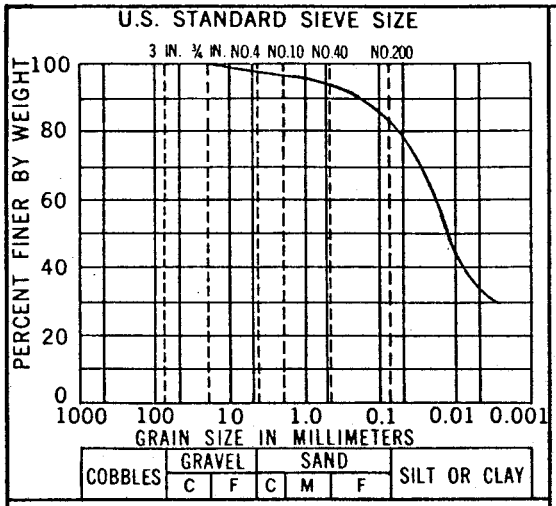
Station N. 4+00 | **Range** W.16+90

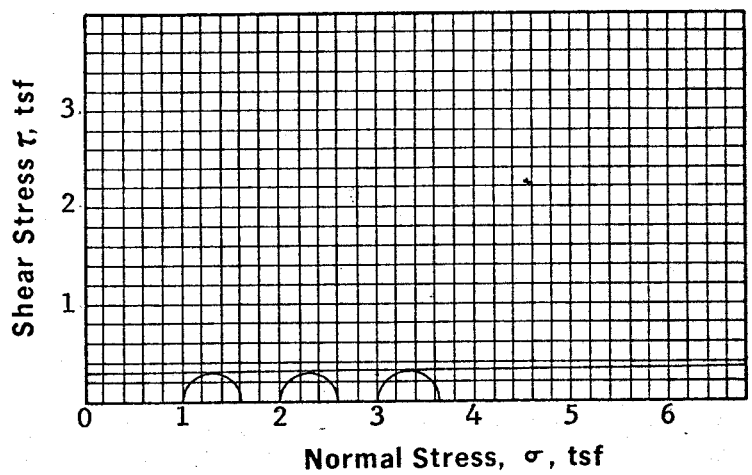
Date 7-23-77 | **Elev.** 357.5-357.0

TRIAXIAL COMPRESSION TEST (R)

Tested by: CEC

Reviewed by: [illegible]

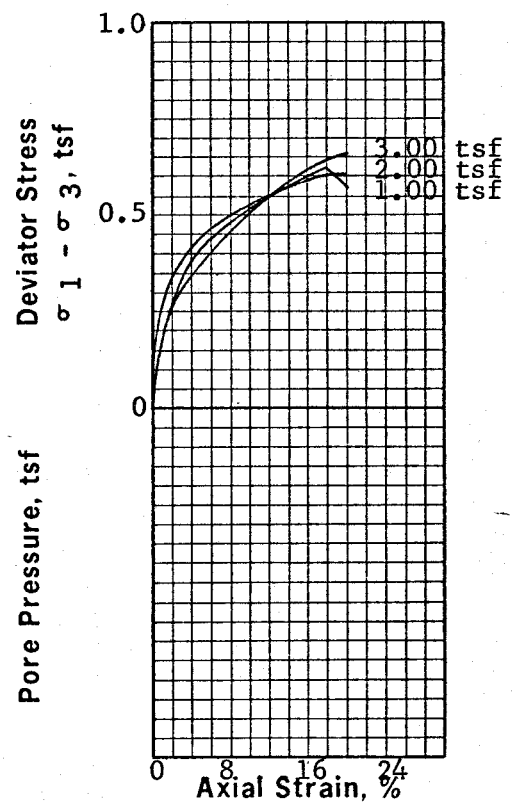




Type of Specimen	Undisturbed		
Classification	CL		
LL.	40.1	G	2.70
PI.	16.6	D_{10}	--

Shear Strength	ø Deg.	Tan ø	C, tsf
Apparent	0.5	.01	0.29
Effective	--	--	--

	Specimen Number	1	2	3	4
Initial	Moisture Content, %	27.7	27.5	28.1	
	Dry Density, pcf	96.5	97.1	96.1	
	Void Ratio	.747	.737	.754	
	Saturation, %	100.0	100.0	100.0	
Before Shearing	Moisture Content after Saturation, %	--	--	--	
	Saturation, %	--	--	--	
	Moisture Content after Consolidation, %	--	--	--	
	Void Ratio after Consolidation	--	--	--	
Final Moisture Content ,%		27.4	27.3	27.7	
Minor Principal Stress, σ_3, tsf		1.00	2.00	3.00	
Major Principal Stress, σ_1, tsf		1.62	2.61	3.66	
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		--	--	--	
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		--	--	--	
Time to Failure, min.		17	18	19	
Rate of strain, %/min.		1.00	1.00	1.00	
Specimen Height, in.		3.15	3.15	3.15	
Specimen Diameter, in.		1.40	1.40	1.40	



Remarks:

Project: Johnsonville S.P.

Feature Ash Dike 2

Boring No. US-8 | Sample No. 4

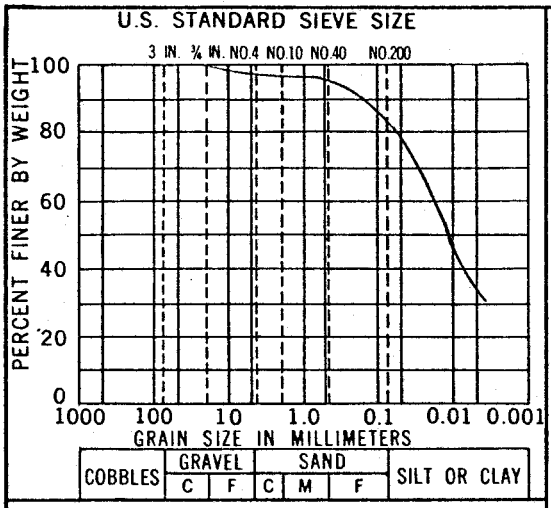
Station N-4+00 | Range W-16+90

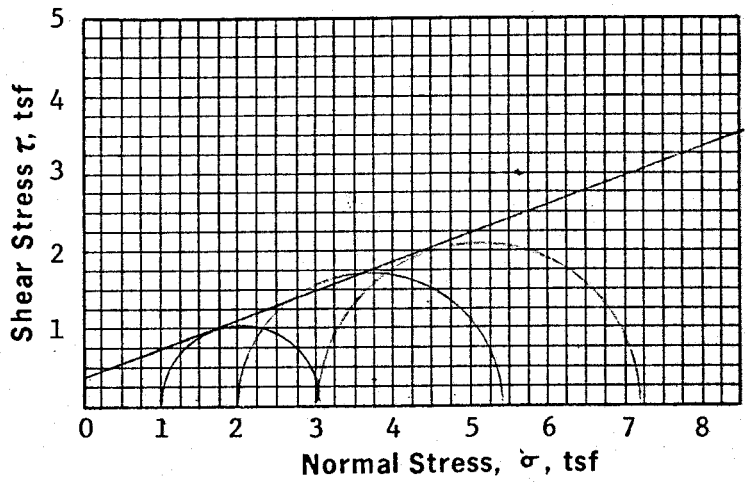
Date 9-21-77 | Elev. 345.4-344.9

TRIAXIAL COMPRESSION TEST (Q)

Tested by: RW

Reviewed by: JCB

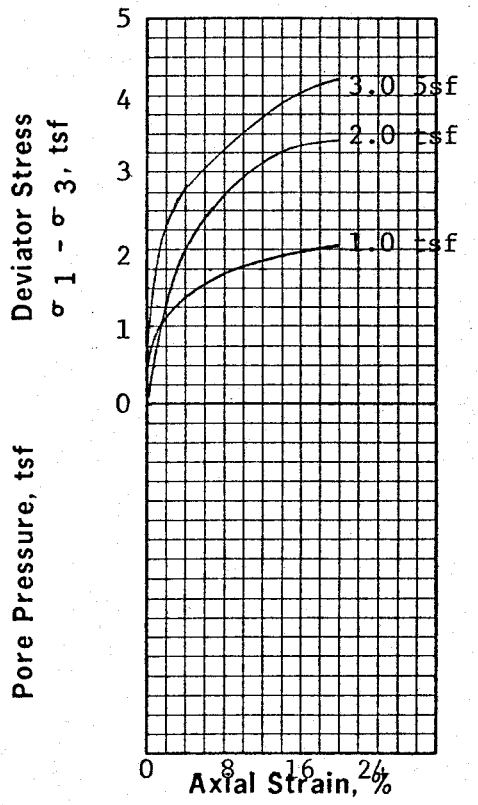




Type of Specimen Undisturbed	
Classification CL	
LL. 40.1	**G** 2.70
PI. 16.6	D_{10} --

Shear Strength	ø Deg.	Tan ø	C, tsf
Apparent	20.5	.37	0.38
Effective	--	--	--

Specimen Number		1	2	3	4
Initial	Moisture Content, %	28.6	26.7	27.8	
	Dry Density, pcf	93.9	97.2	95.9	
	Void Ratio	.795	.734	.757	
	Saturation, %	97.0	98.1	99.0	
Before Shearing	Moisture Content after Saturation, %	--	--	--	
	Saturation, %	--	--	--	
	Moisture Content after Consolidation, %	26.7	24.0	23.8	
	Void Ratio after Consolidation	.717	.621	.651	
Final Moisture Content ,%		26.7	24.0	23.8	
Minor Principal Stress, σ_3, tsf		1.00	2.00	3.00	
Major Principal Stress, σ_1, tsf		3.07	5.41	7.19	
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		--	--	--	
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		--	--	--	
Time to Failure, min.		99	99	99	
Rate of strain, %/min.		0.20	0.20	0.20	
Specimen Height, in.		3.15	3.15	3.15	
Specimen Diameter, in.		1.40	1.40	1.40	



Remarks:

Project: Johnsonville Steam Plant

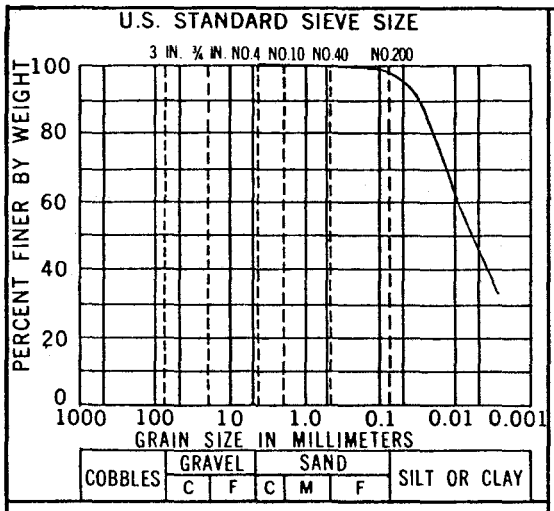
Feature Ash Dike 2

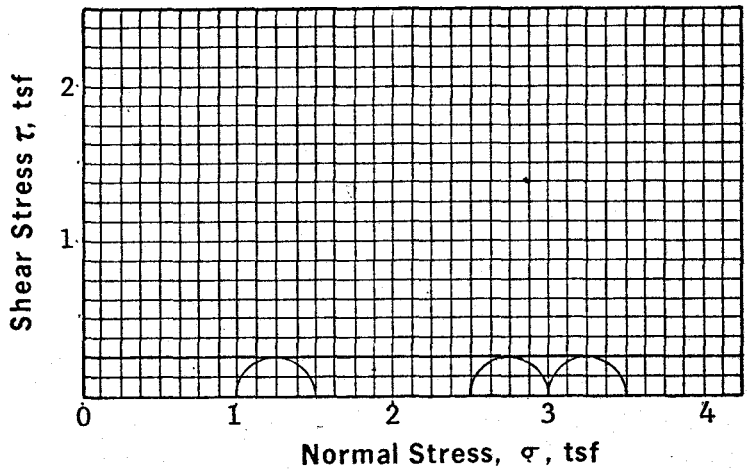
Boring No. US-8	**Sample No.** 4
Station N. 4+00	Range W-16+90
Date 9-24-77	**Elev.** 344.9-344.4

TRIAXIAL COMPRESSION TEST (R)

Tested by: E.L.

Reviewed by: JCS

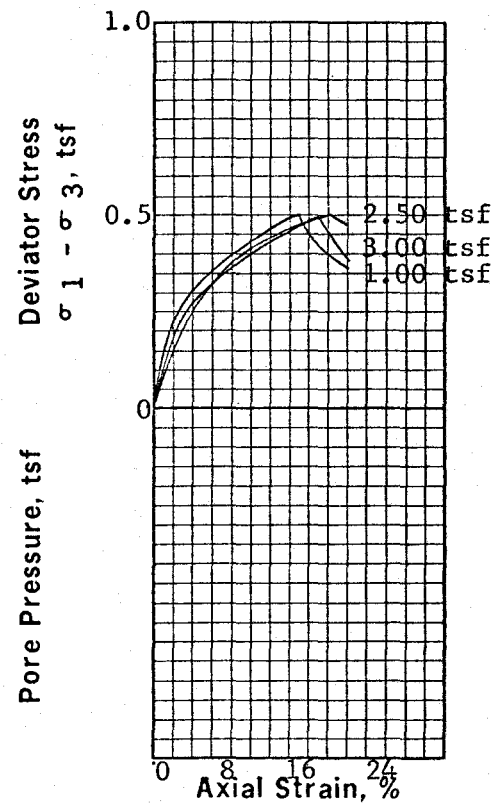




Type of Specimen	Undisturbed		
Classification	CL		
LL.	37.4	G	2.67
PI.	16.3	D_{10}	--

Shear Strength	ø Deg.	Tan ø	C, tsf
Apparent	0.0	.00	0.25
Effective	--	--	--

	Specimen Number	1	2	3	4
Initial	Moisture Content, %	29.5	30.4	29.6	
	Dry Density, pcf	90.8	89.7	91.4	
	Void Ratio	.835	.859	.824	
	Saturation, %	94.2	94.4	95.7	
Before Shearing	Moisture Content after Saturation, %	--	--	--	
	Saturation, %	--	--	--	
	Moisture Content after Consolidation, %	--	--	--	
	Void Ratio after Consolidation	--	--	--	
Final Moisture Content ,%		29.1	30.2	29.3	
Minor Principal Stress, σ_3, tsf		1.00	2.50	3.00	
Major Principal Stress, σ_1, tsf		1.50	3.00	3.49	
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		--	--	--	
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		--	--	--	
Time to Failure, min.		15	18	17	
Rate of strain, %/min.		1.00	1.00	1.00	
Specimen Height, in.		3.15	3.15	3.15	
Specimen Diameter, in.		1.40	1.40	1.40	



Remarks:

Project: Johnsonville S. P.

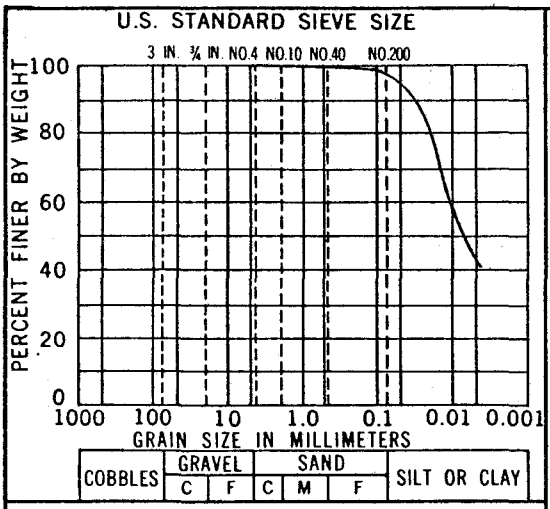
Feature Ash Dike 2

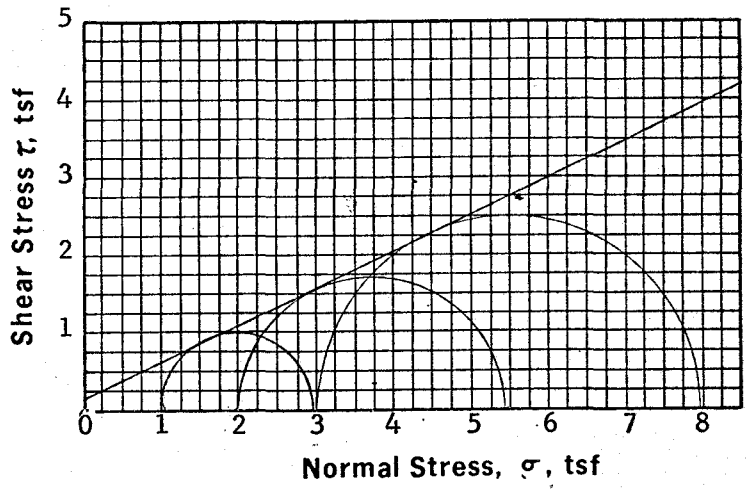
Boring No. US-8	Sample No. 6
Station N-4+00	Range W-16+90
Date 9-23-77	Elev. 338.9-338.4

TRIAXIAL COMPRESSION TEST (Q)

Tested by: RLV

Reviewed by: JCB

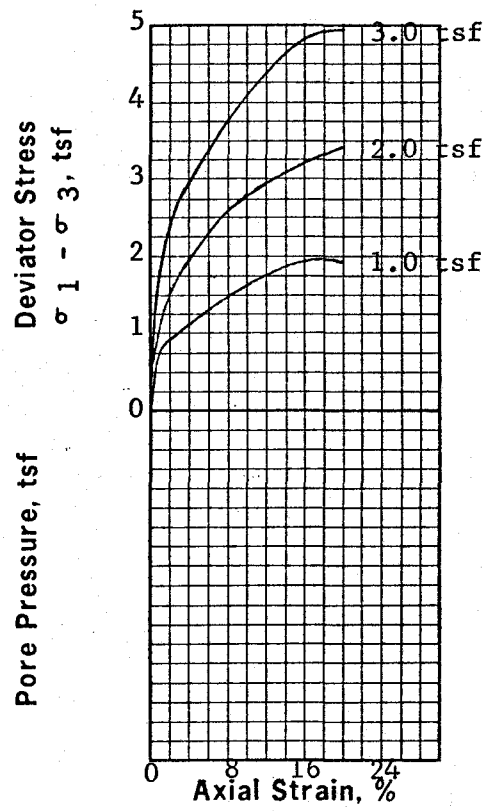




Type of Specimen	Undisturbed		
Classification	CL		
LL.	37.4	G	2.67
PI.	16.3	D_{10}	--

Shear Strength	ø Deg.	Tan ø	C, tsf
Apparent	25.0	.47	0.15
Effective	--	--	--

Specimen Number		1	2	3	4
Initial	Moisture Content, %	27.7	28.2	27.5	
	Dry Density, pcf	95.9	95.3	96.5	
	Void Ratio	.738	.749	.723	
	Saturation, %	100.0	100.0	100.0	
Before Shearing	Moisture Content after Saturation, %	--	--	--	
	Saturation, %	--	--	--	
	Moisture Content after Consolidation, %	25.0	23.6	22.5	
	Void Ratio after Consolidation	.664	.672	.630	
Final Moisture Content ,%		25.0	23.6	22.5	
Minor Principal Stress, σ_3, tsf		1.00	2.00	3.00	
Major Principal Stress, σ_1, tsf		2.94	5.42	7.98	
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		--	--	--	
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		--	--	--	
Time to Failure, min.		90	99	91	
Rate of strain, %/min.		0.20	0.20	0.20	
Specimen Height, in.		3.15	3.15	3.15	
Specimen Diameter, in.		1.40	1.40	1.40	



Remarks:

Project: Johnsonville Steam Plant

Feature Ash Dike 2

Boring No. US-8 | Sample No. 6

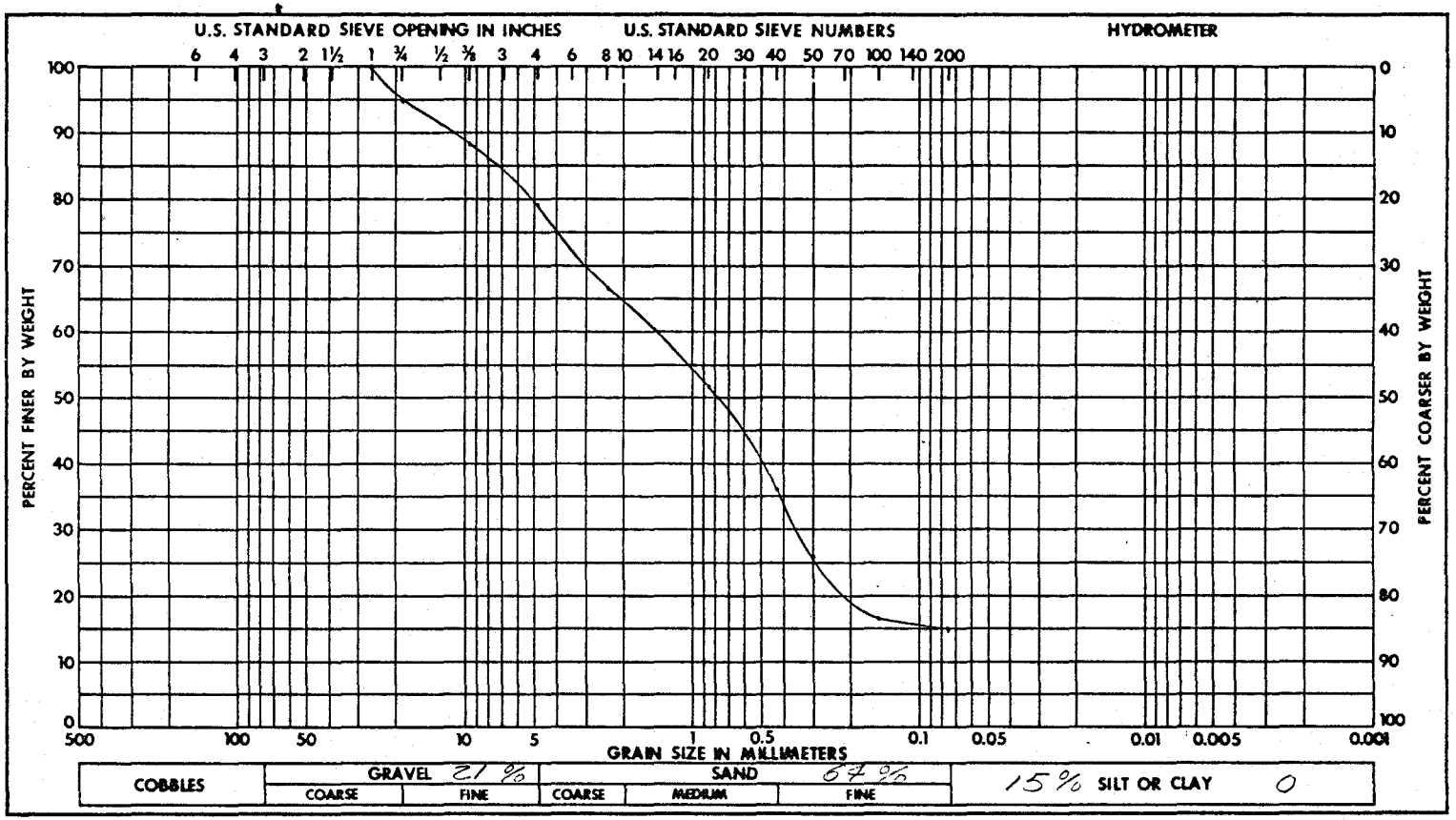
Station N 4+00 | Range W 16+90

Date 9-29-77 | Elev. 338.4-338.0

TRIAXIAL COMPRESSION TEST (R)

Tested by: E.L.

Reviewed by: JCS



Soil Symbol	G-SM	Liquid Limit, %	NP
Moisture Content, %	10.9	Plastic Limit, %	NP
Specific Gravity		Plasticity Index, %	NP
		Shrinkage Limit, %	

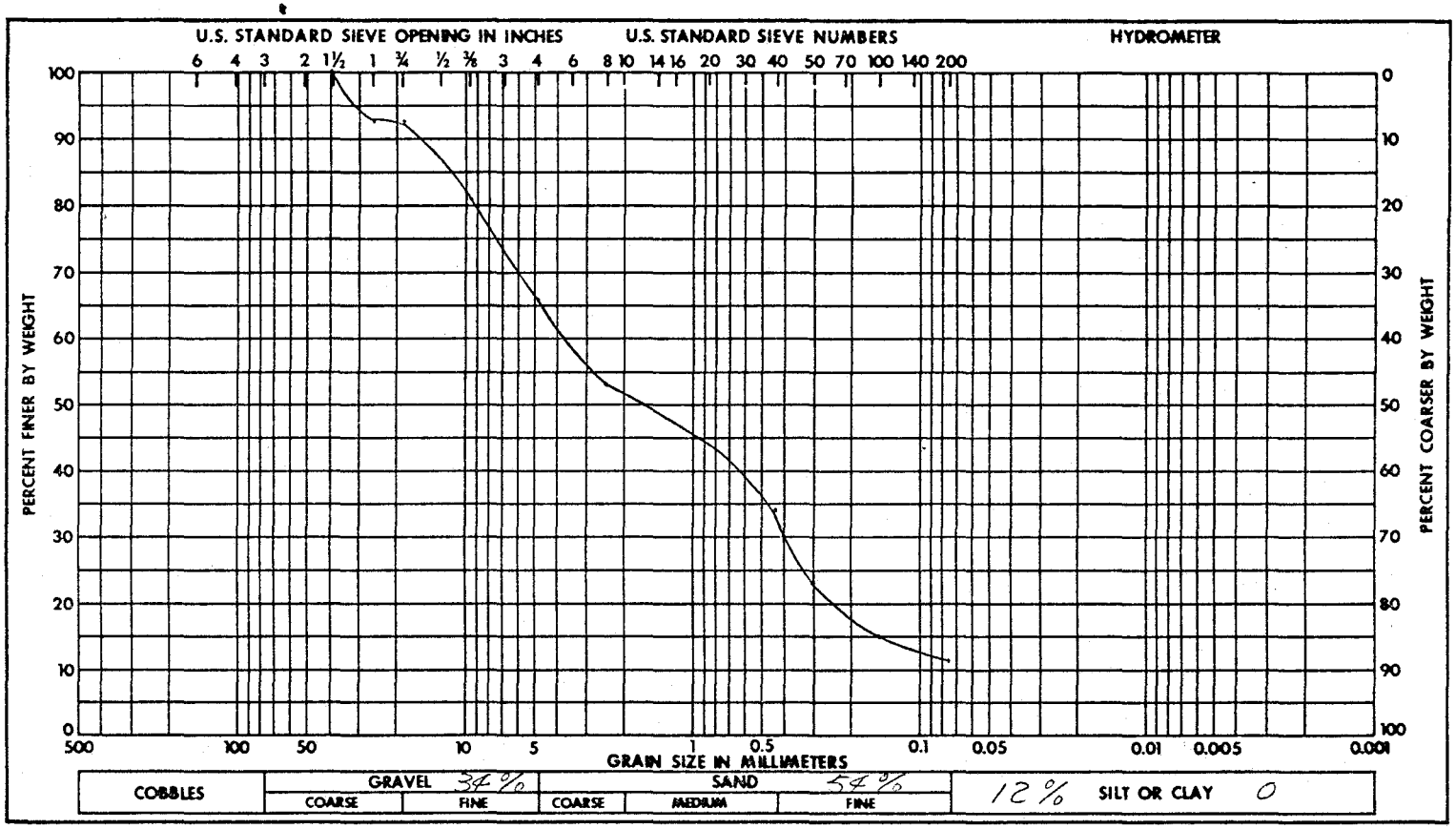
Remarks:

Project Johnsonville S. P.	
Feature	
Boring No. SS-6A	Sample No. 1A
Station	Range
Date 11-2-77	Elevation 367.9-366.9

GRAIN SIZE ANALYSIS

TVA 10199 (CONST-6-77)

Tested by: _____ Reviewed by: _____



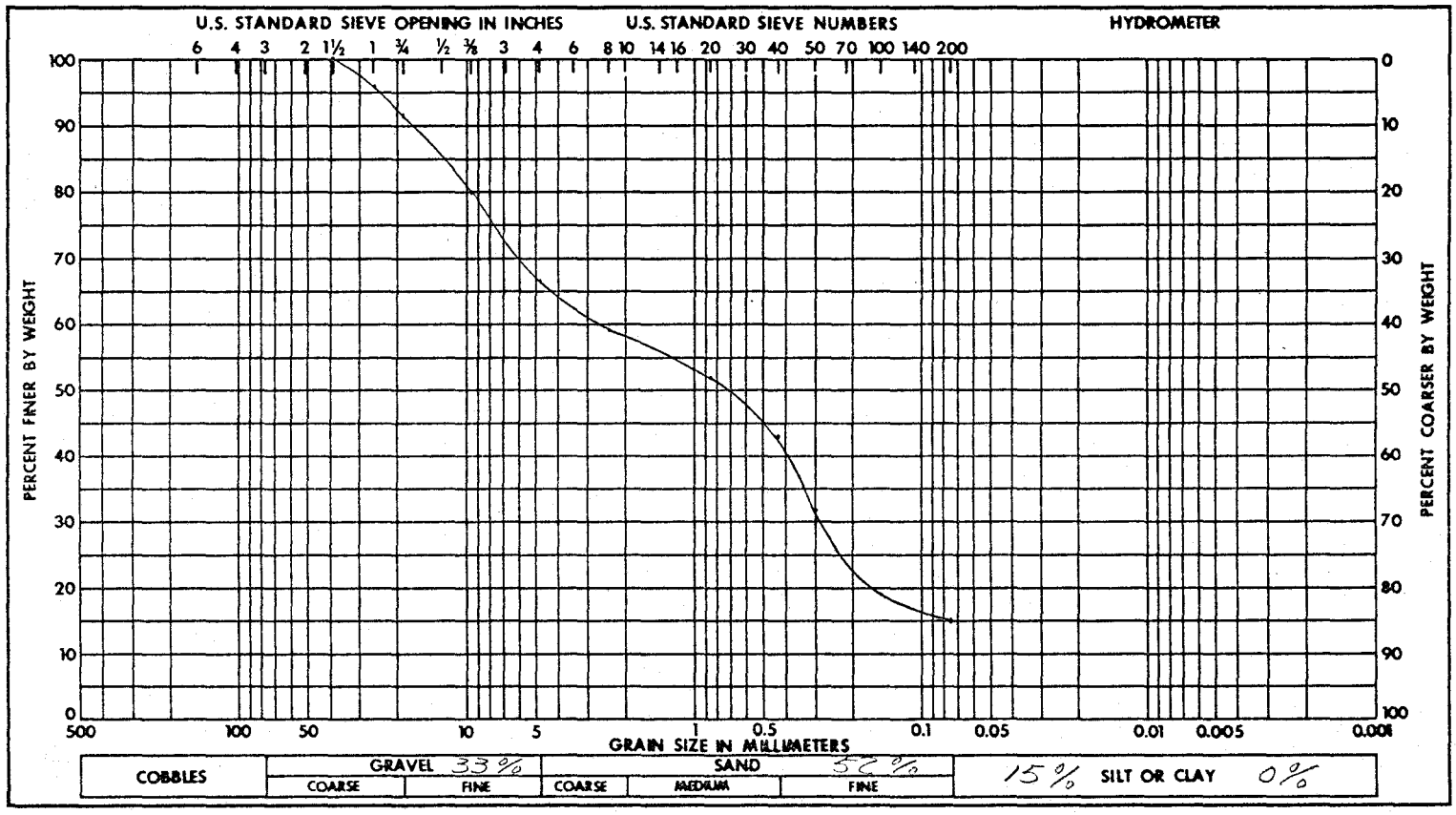
Soil Symbol	G-SM	Liquid Limit, %	NP
Moisture Content, %	11.9	Plastic Limit, %	NP
Specific Gravity		Plasticity Index, %	NP
		Shrinkage Limit, %	

Remarks:

Project Johnsonville S. P.	
Feature	
Boring No. SS-6A	Sample No. 2A
Station	Range
Date 11-2-77	Elevation 365.9-364.9

GRAIN SIZE ANALYSIS

Tested by: _____ Reviewed by: _____



Soil Symbol	G-SM	Liquid Limit, %	NP
Moisture Content, %	20.0	Plastic Limit, %	NP
Specific Gravity		Plasticity Index, %	NP
		Shrinkage Limit, %	

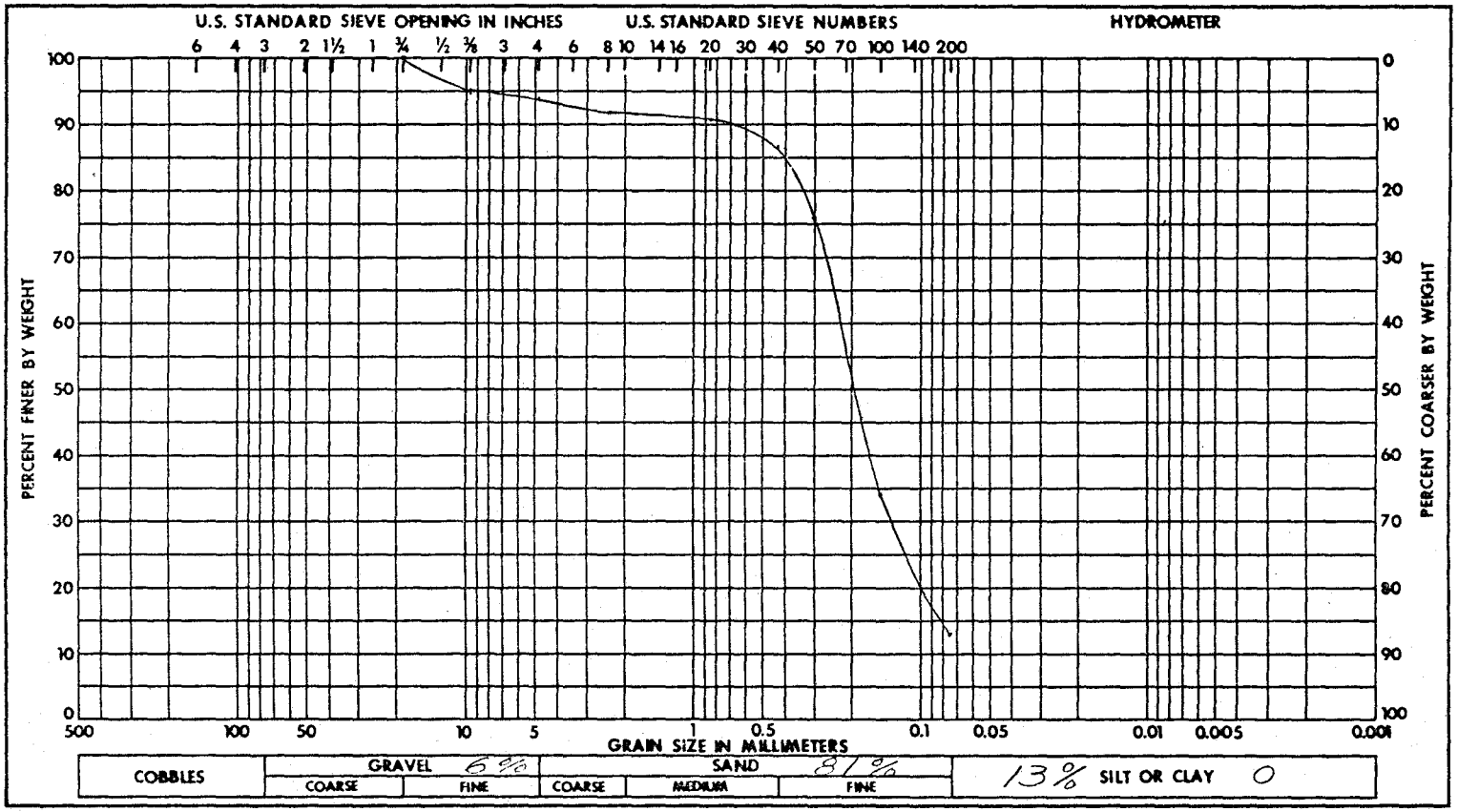
Remarks:

Project Johnsonville S. P.	
Feature	
Boring No. SS-6A	Sample No. 3A
Station	Range
Date 11-2-77	Elevation 363.9-362.9

GRAIN SIZE ANALYSIS

Tested by: _____ Reviewed by: _____

ATTACHMENT 6
CONST-QCP 5.3



Soil Symbol	SM	Liquid Limit, %	NP
Moisture Content, %	31.4	Plastic Limit, %	NP
Specific Gravity		Plasticity Index, %	NP
		Shrinkage Limit, %	

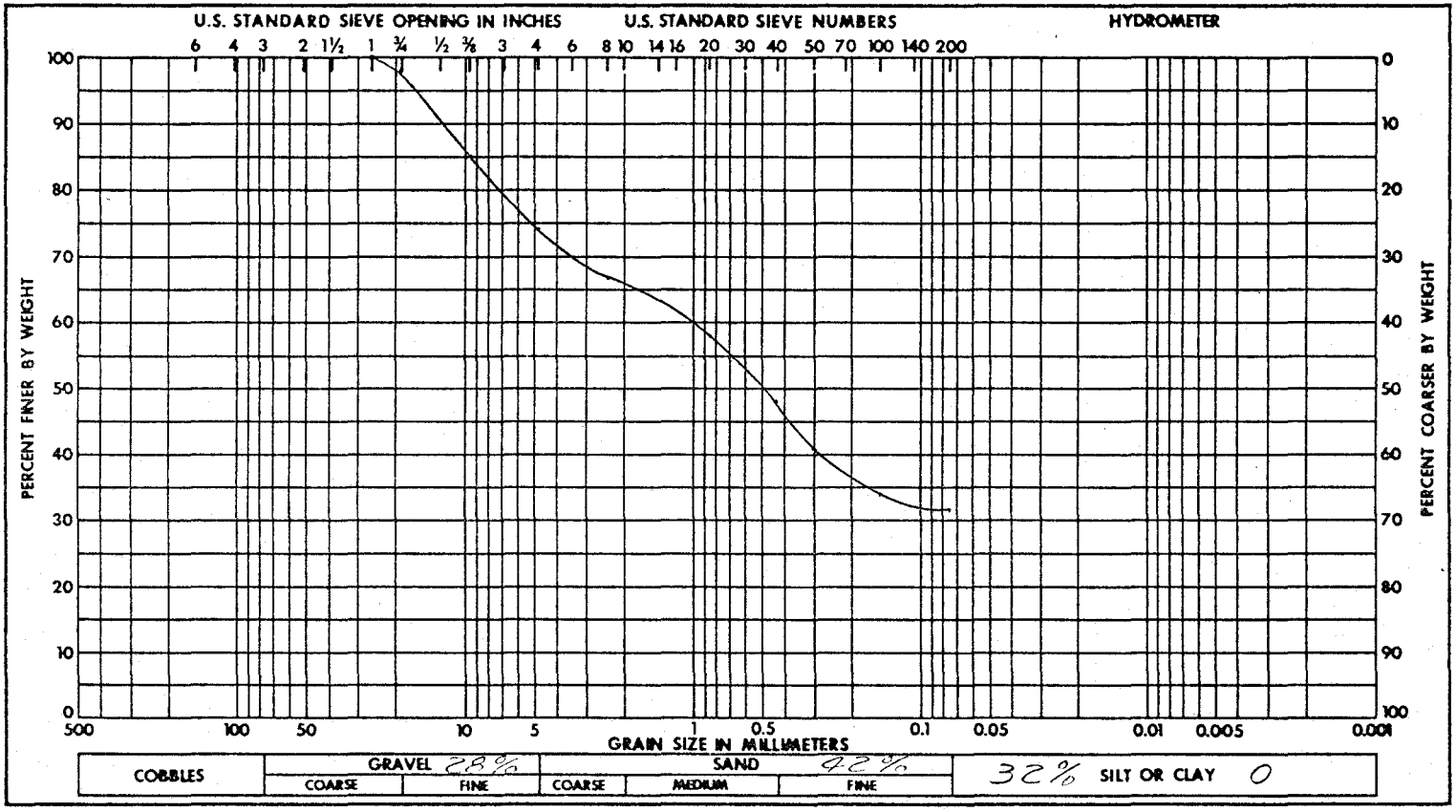
Remarks:

Project Johnsonville S. P.	
Feature	
Boring No. SS-6A	Sample No. 4A
Station	Range
Date 11-2-77	Elevation 361.9-360.9

GRAIN SIZE ANALYSIS

TVA 10199 (CONST-6-77)

Tested by: _____ Reviewed by: _____



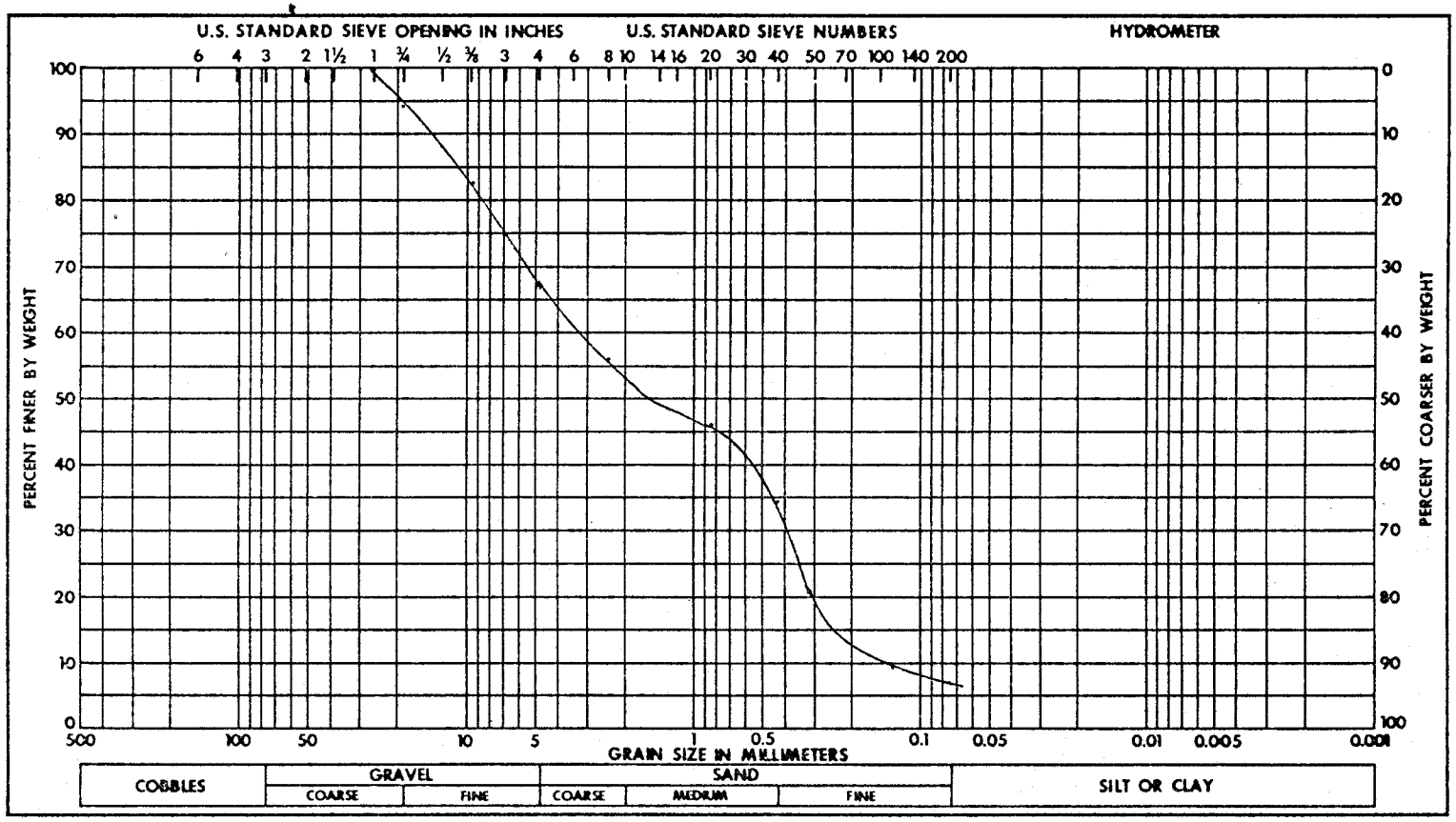
Soil Symbol	GSM	Liquid Limit, %	NP
Moisture Content, %	14.9	Plastic Limit, %	NP
Specific Gravity		Plasticity Index, %	NP
		Shrinkage Limit, %	

Remarks:

Project Johnsonville S. P.	
Feature	
Boring No. SS-6B	Sample No. 1A
Station	Range
Date 11-2-77	Elevation 367.9-366.9

GRAIN SIZE ANALYSIS

Tested by: _____ Reviewed by: _____



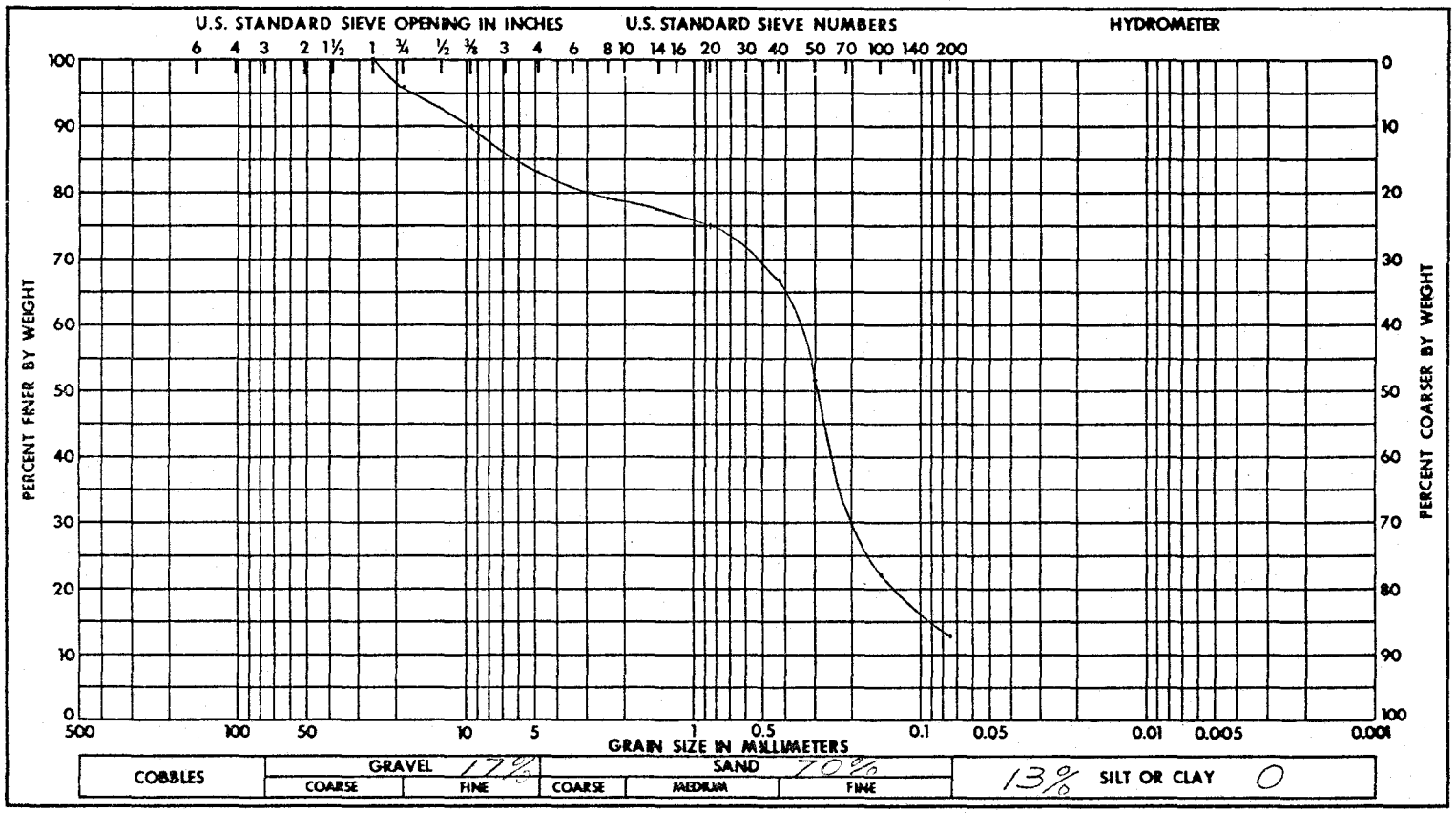
Soil Symbol	G-SP-SM	Liquid Limit, %	NP
Moisture Content, %		Plastic Limit, %	NP
Specific Gravity		Plasticity Index, %	NP
		Shrinkage Limit, %	

Remarks:
Cu = 22.0
Cc = .31

Project Johnsonville S.P.	
Feature	
Boring No. SS-6B	Sample No. 2A
Station	Range
Date 10-4-77	Elevation 365.9-369.9

GRAIN SIZE ANALYSIS

Tested by: _____ Reviewed by: _____



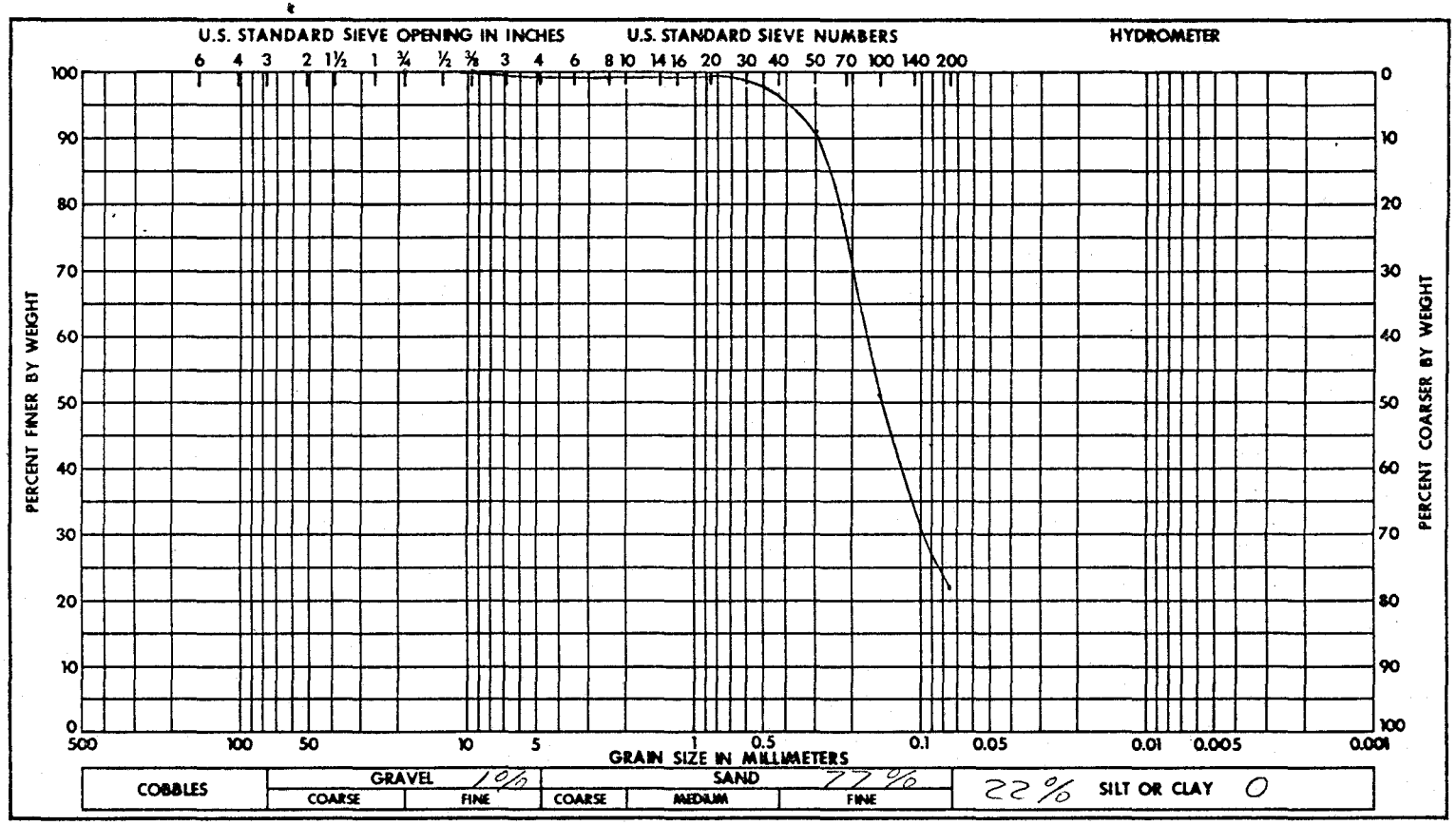
Soil Symbol	GSM	Liquid Limit, %	NP
Moisture Content, %	26.0	Plastic Limit, %	NP
Specific Gravity		Plasticity Index, %	NP
		Shrinkage Limit, %	

Remarks:

Project Johnsonville S. P.	
Feature	
Boring No. SS-6B	Sample No. 3A
Station	Range
Date 11-2-77	Elevation 363.9-362.9

GRAIN SIZE ANALYSIS

Tested by: _____ Reviewed by: _____



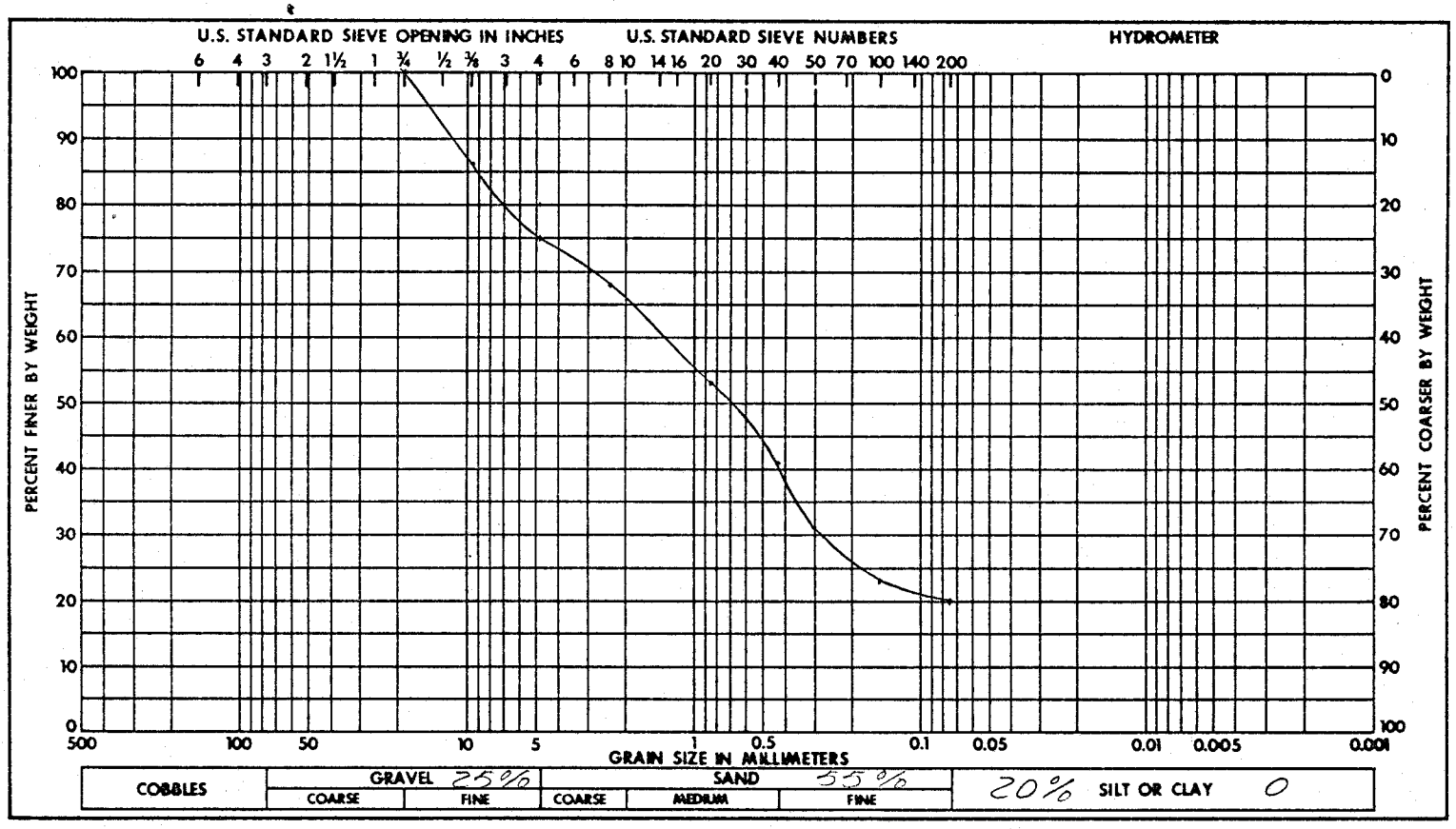
Soil Symbol	SM	Liquid Limit, %	NP
Moisture Content, %	32.6	Plastic Limit, %	NP
Specific Gravity		Plasticity Index, %	NP
		Shrinkage Limit, %	

Remarks:

Project Johnsonville S. P.	
Feature	
Boring No. SS-6B	Sample No. 4A
Station	Range
Date 11-2-77	Elevation 361.9-360.9

GRAIN SIZE ANALYSIS

Tested by: _____ Reviewed by: _____



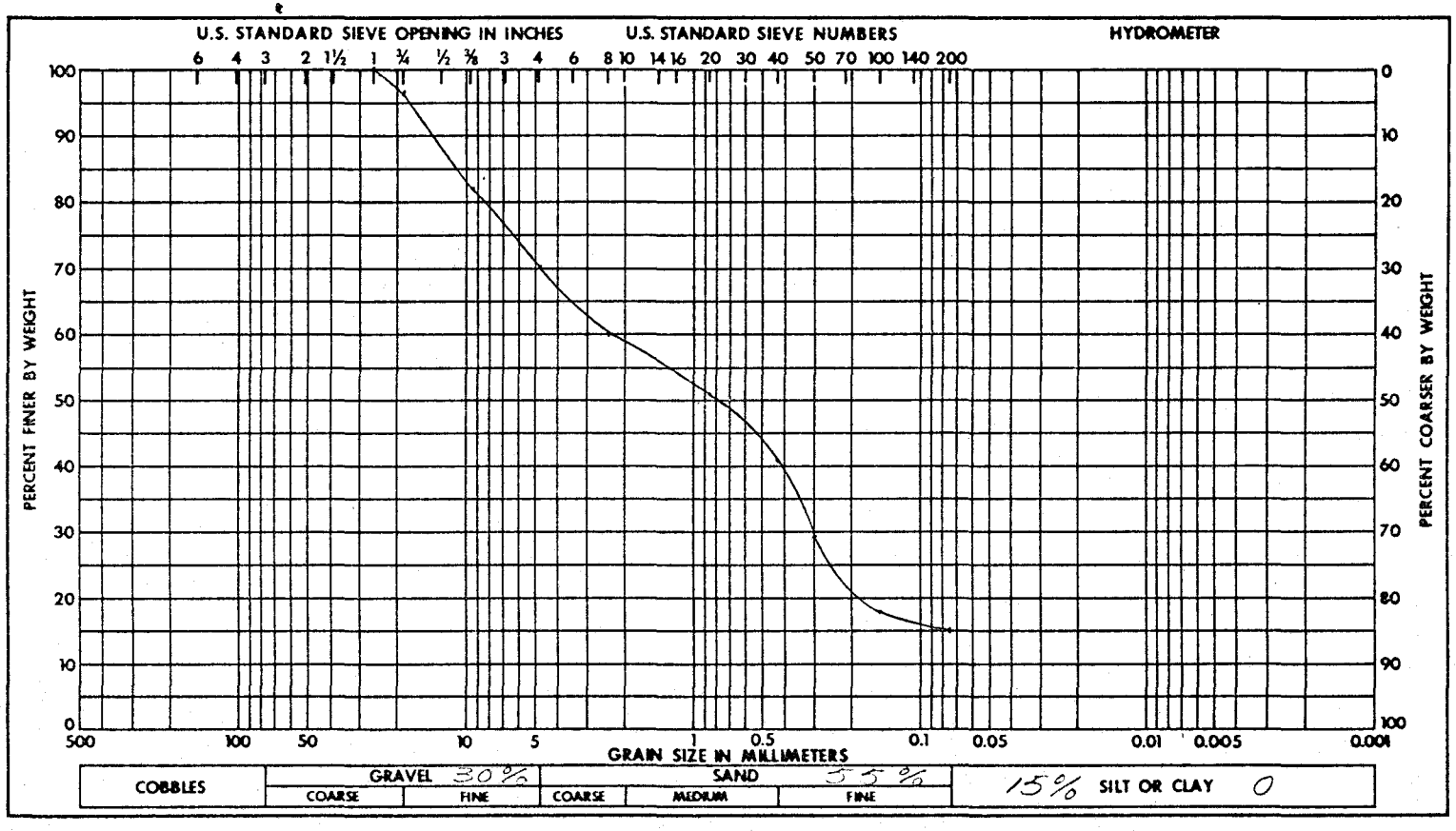
Soil Symbol	G-SM	Liquid Limit, %	NP
Moisture Content, %	10.8	Plastic Limit, %	NP
Specific Gravity		Plasticity Index, %	NP
		Shrinkage Limit, %	

Remarks:

Project Johnsonville S. P.	
Feature	
Boring No. SS-6C	Sample No. 1A
Station	Range
Date 11-2-77	Elevation 367.9-366.9

GRAIN SIZE ANALYSIS

Tested by: _____ Reviewed by: _____



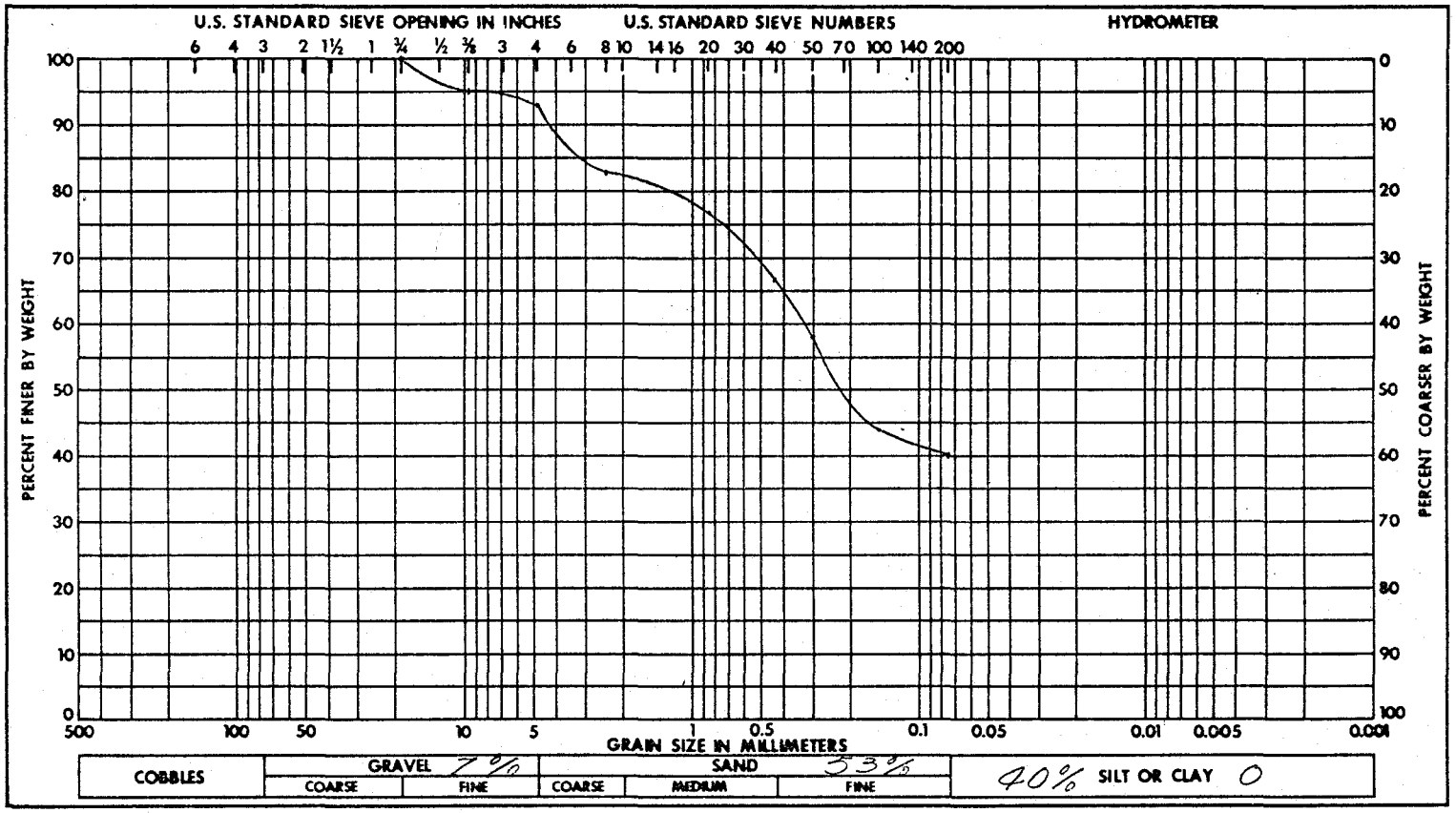
Soil Symbol	G-SM	Liquid Limit, %	NP
Moisture Content, %	15.7	Plastic Limit, %	NP
Specific Gravity		Plasticity Index, %	NP
		Shrinkage Limit, %	

Remarks:

Project Johnsonville S. P	
Feature	
Boring No. SS-6C	Sample No. 2A
Station	Range
Date 11-2-77	Elevation 365.9-364.9

GRAIN SIZE ANALYSIS

Tested by: _____ Reviewed by: _____



Soil Symbol	SM	Liquid Limit, %	NP
Moisture Content, %	23.0	Plastic Limit, %	NP
Specific Gravity		Plasticity Index, %	NP
		Shrinkage Limit, %	

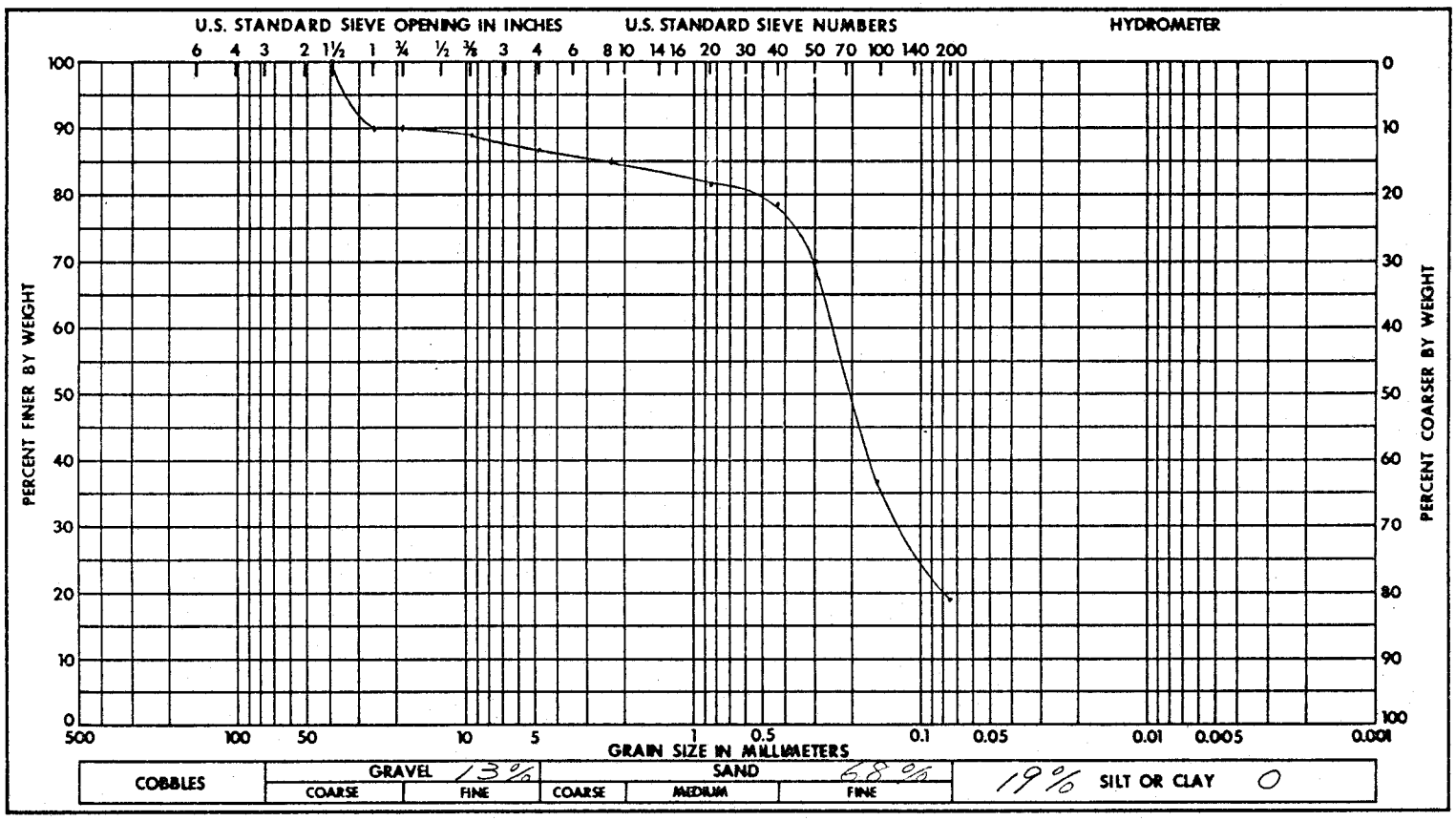
Remarks:

Project Johnsonville S. P.	
Feature	
Boring No. SS-6C	Sample No. 3A
Station	Range
Date 11-2-77	Elevation 363.9-362.9

GRAIN SIZE ANALYSIS

Tested by: _____ Reviewed by: _____

ATTACHMENT 6
CONST-QCP 5.3



Soil Symbol	G-SM	Liquid Limit, %	NP
Moisture Content, %	26.9	Plastic Limit, %	NP
Specific Gravity		Plasticity Index, %	NP
		Shrinkage Limit, %	

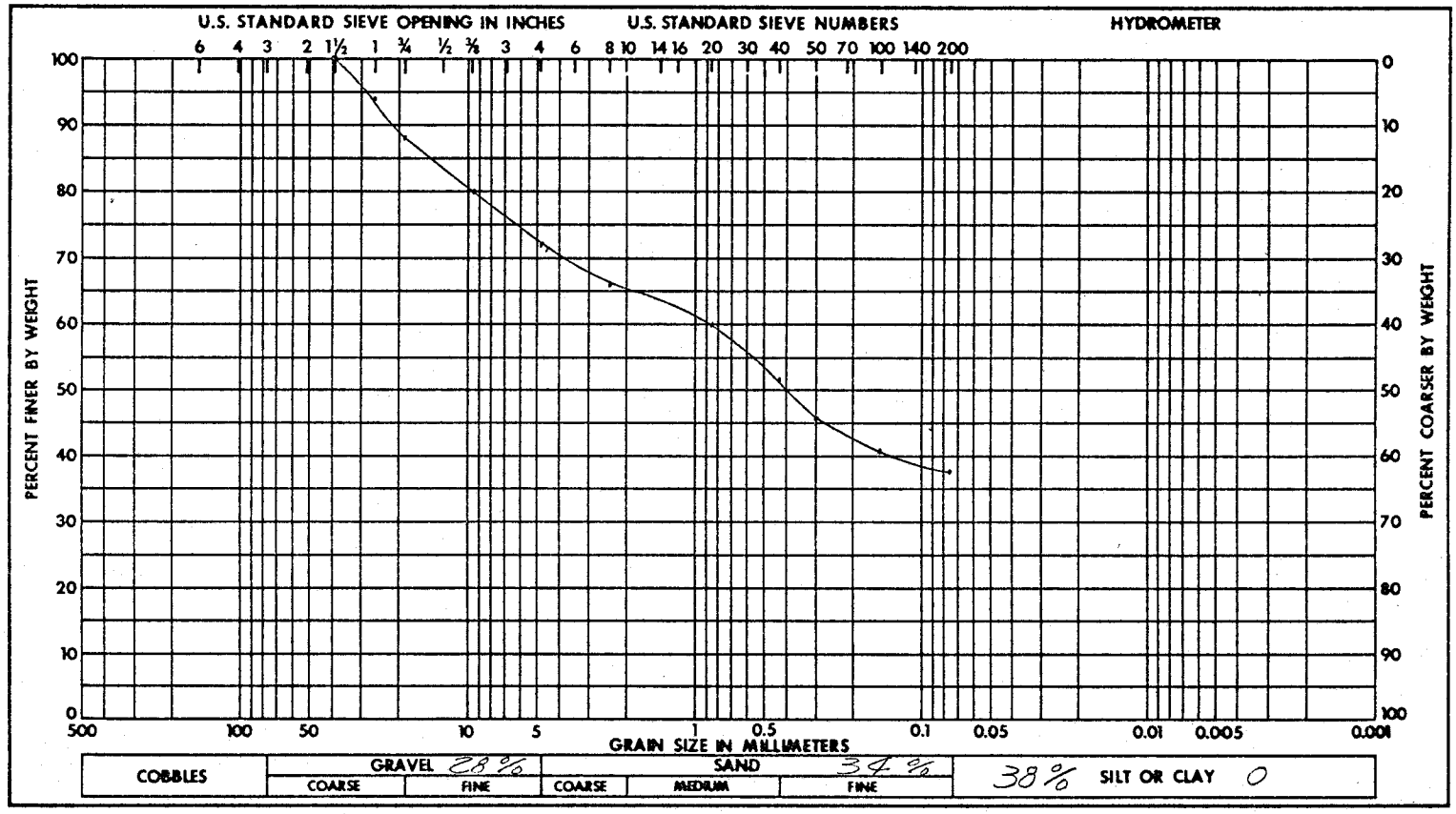
Remarks:

Project Johnsonville S. P.	
Feature	
Boring No. SS-6C	Sample No. 4A
Station	Range
Date 11-2-77	Elevation 361.9-360.9

GRAIN SIZE ANALYSIS

TVA 10199 (CONST-6-77)

Tested by: _____ Reviewed by: _____



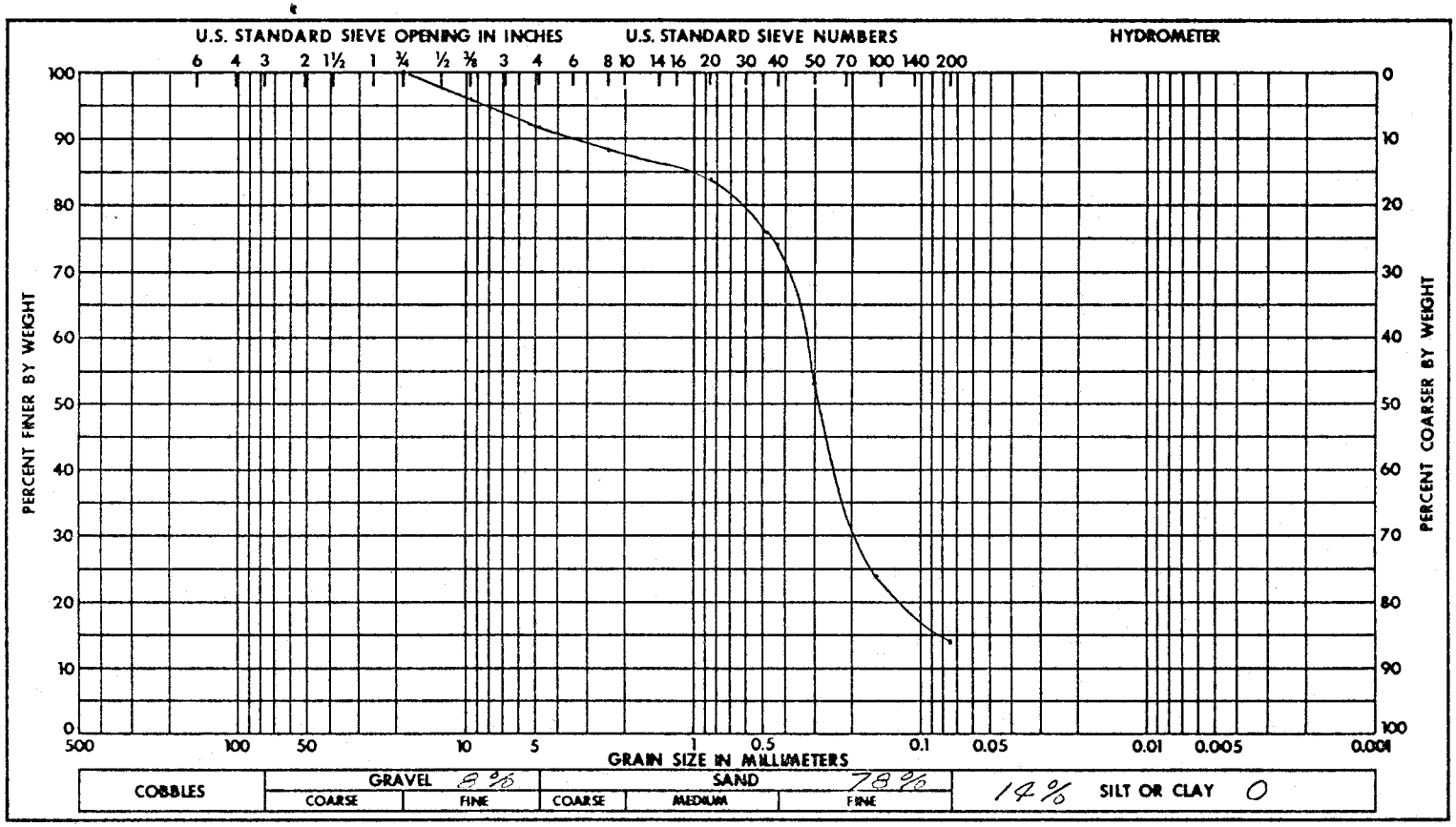
Soil Symbol	GSM	Liquid Limit, %	NP
Moisture Content, %	15.8	Plastic Limit, %	NP
Specific Gravity		Plasticity Index, %	NP
		Shrinkage Limit, %	

Remarks:

Project Johnsonville S. P.	
Feature	
Boring No. SS-6D	Sample No. 1A
Station	Range
Date 11-2-77	Elevation 367.9-366.9

GRAIN SIZE ANALYSIS

Tested by: _____ Reviewed by: _____



Soil Symbol	SM	Liquid Limit, %	NP
Moisture Content, %	27.0	Plastic Limit, %	NP
Specific Gravity		Plasticity Index, %	NP
		Shrinkage Limit, %	

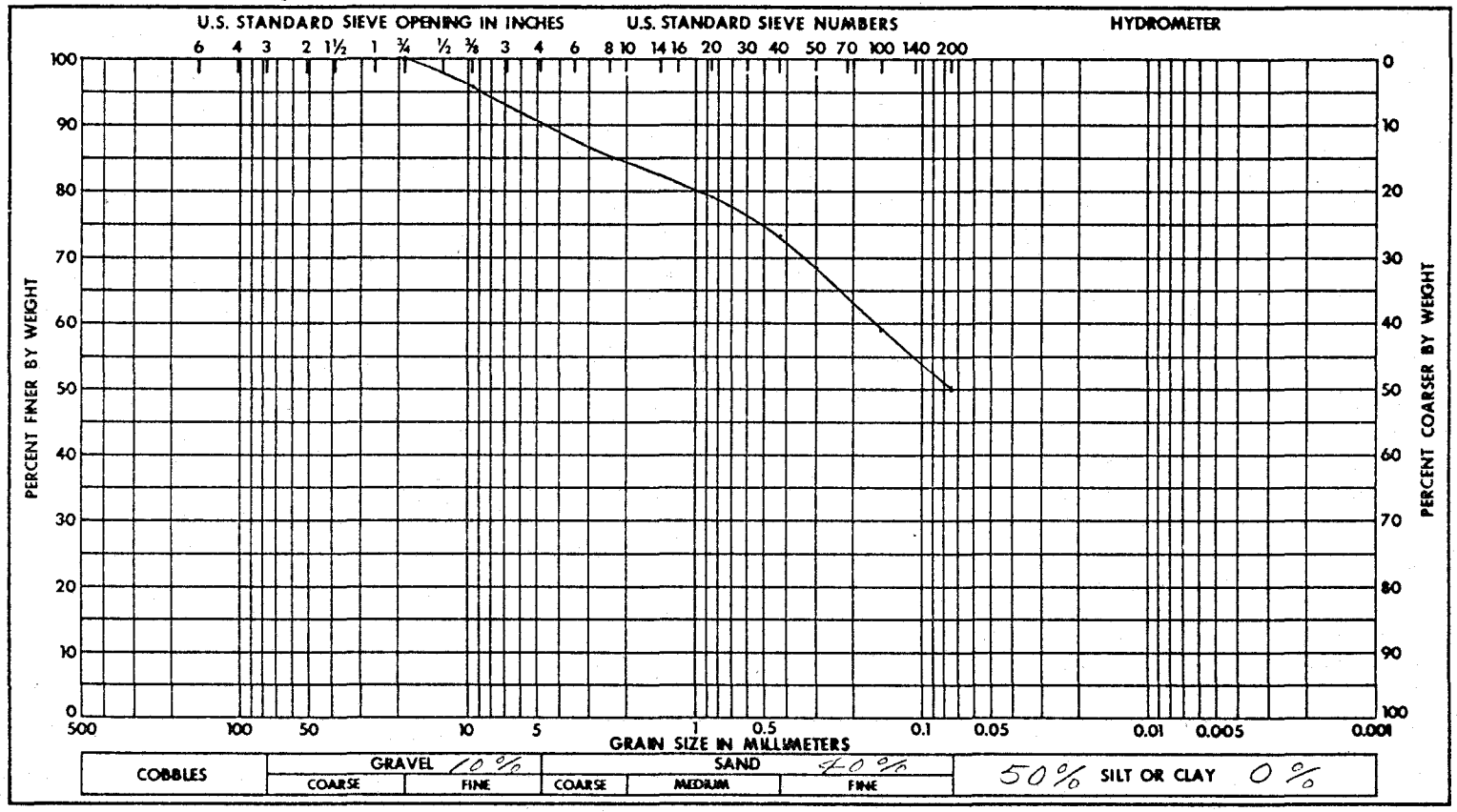
Remarks:

Project Johnsonville S. P.	
Feature	
Boring No. SS-6D	Sample No. 3A
Station	Range
Date 11-2-77	Elevation 363.9-362.9

GRAIN SIZE ANALYSIS

Tested by: _____ Reviewed by: _____

ATTACHMENT 6
CONST-QCP 5.3



Soil Symbol	ML	Liquid Limit, %	NP
Moisture Content, %	27.0	Plastic Limit, %	NP
Specific Gravity		Plasticity Index, %	NP
		Shrinkage Limit, %	

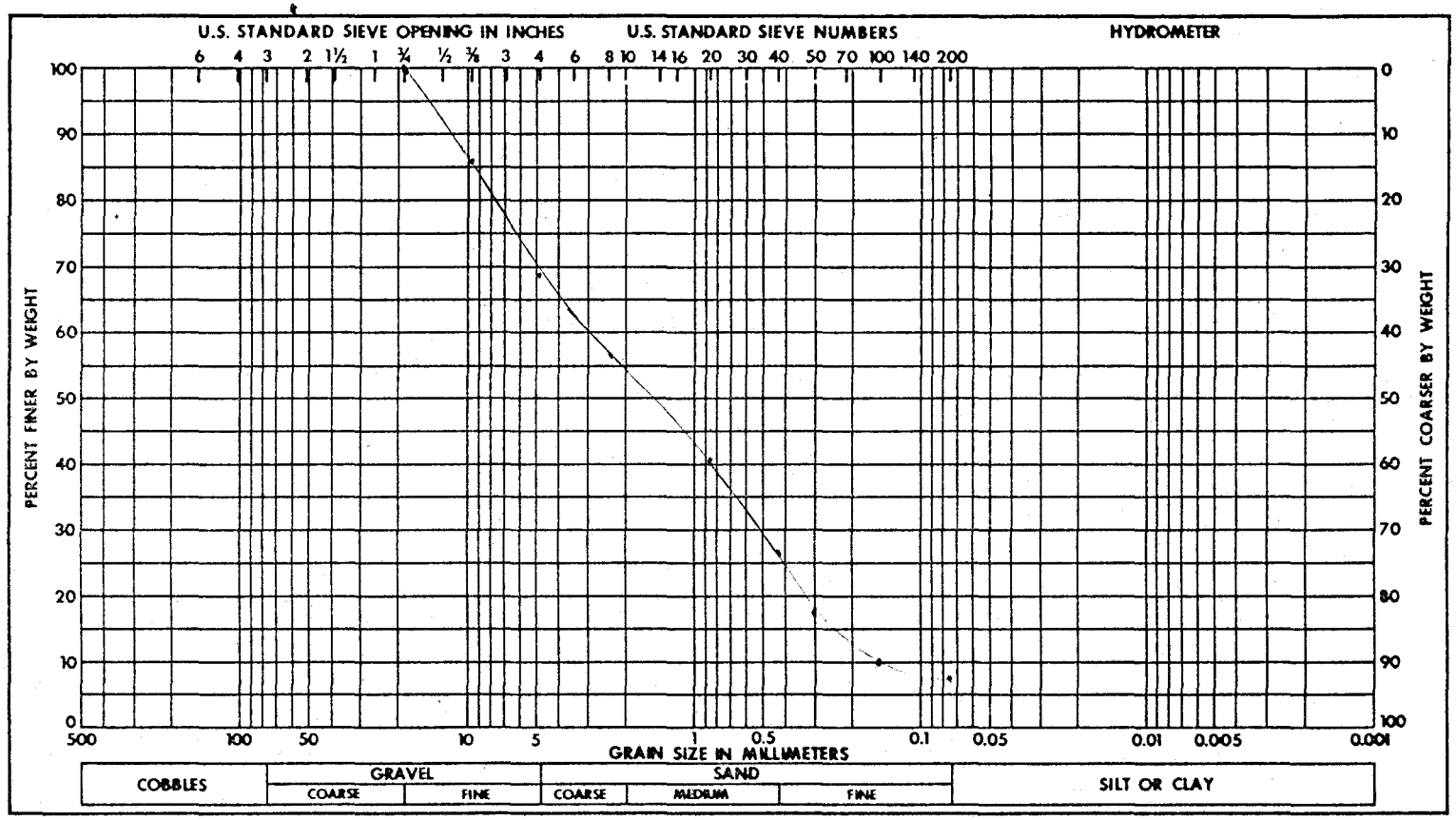
Remarks:

Project Johnsonville S. P.	
Feature	
Boring No. SS-6D	Sample No. 4A
Station	Range
Date 11-2-77	Elevation 361.9-360.9

GRAIN SIZE ANALYSIS

TVA 10199 (CONST-6-77)

Tested by: _____ Reviewed by: _____



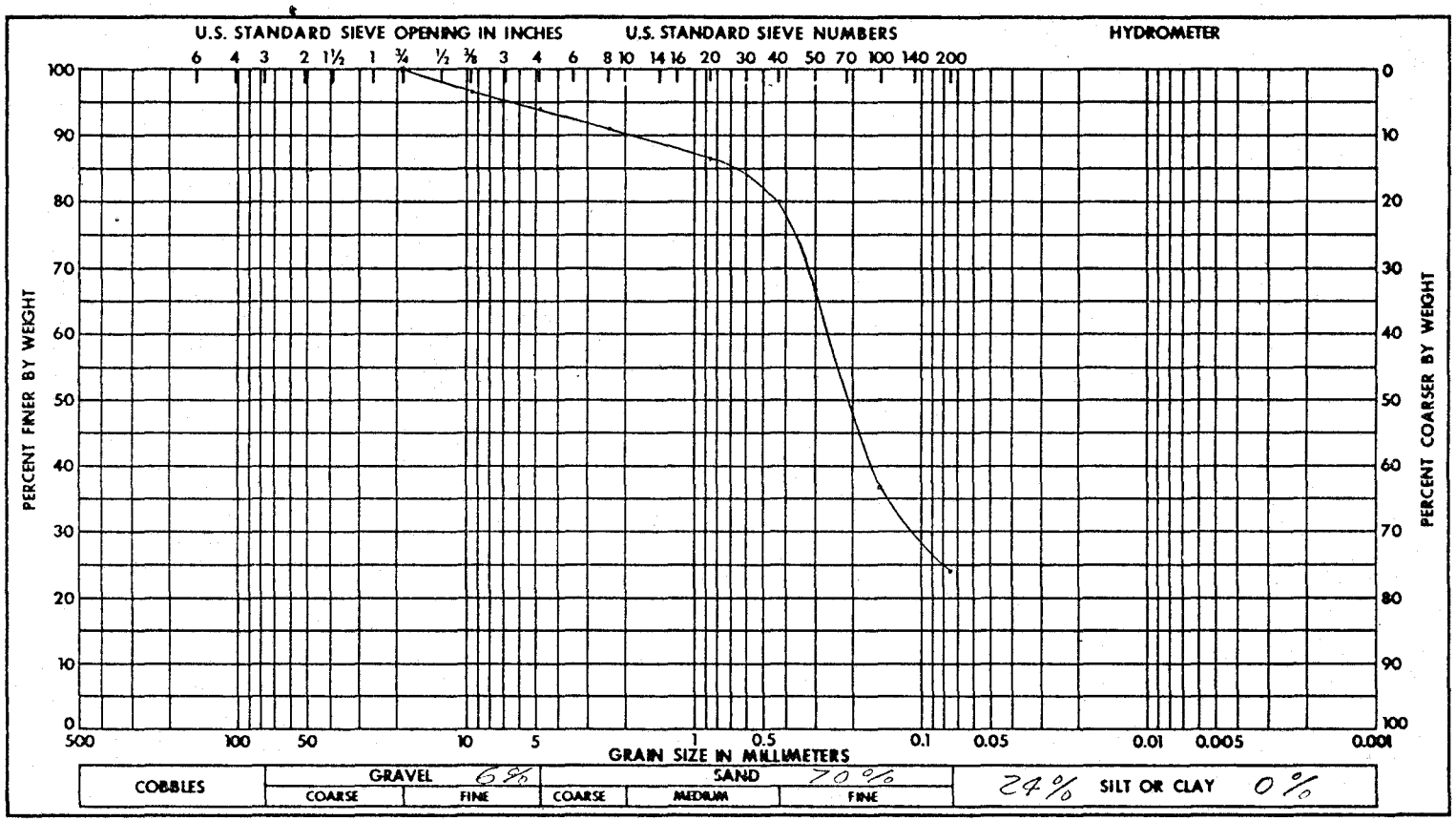
Soil Symbol	G-SP-SM	Liquid Limit, %	NP
Moisture Content, %		Plastic Limit, %	NP
Specific Gravity		Plasticity Index, %	NP
		Shrinkage Limit, %	

Remarks:
$C_u = 17.6$
$C_c = .51$

Project Johnsonville S. P.	
Feature	
Boring No. 556E	Sample No. 2A
Station	Range
Date 10-4-77	Elevation 365.4-364.4

GRAIN SIZE ANALYSIS

Tested by: _____ Reviewed by: _____



Soil Symbol	SM	Liquid Limit, %	NP
Moisture Content, %	24.7	Plastic Limit, %	NP
Specific Gravity		Plasticity Index, %	NP
		Shrinkage Limit, %	

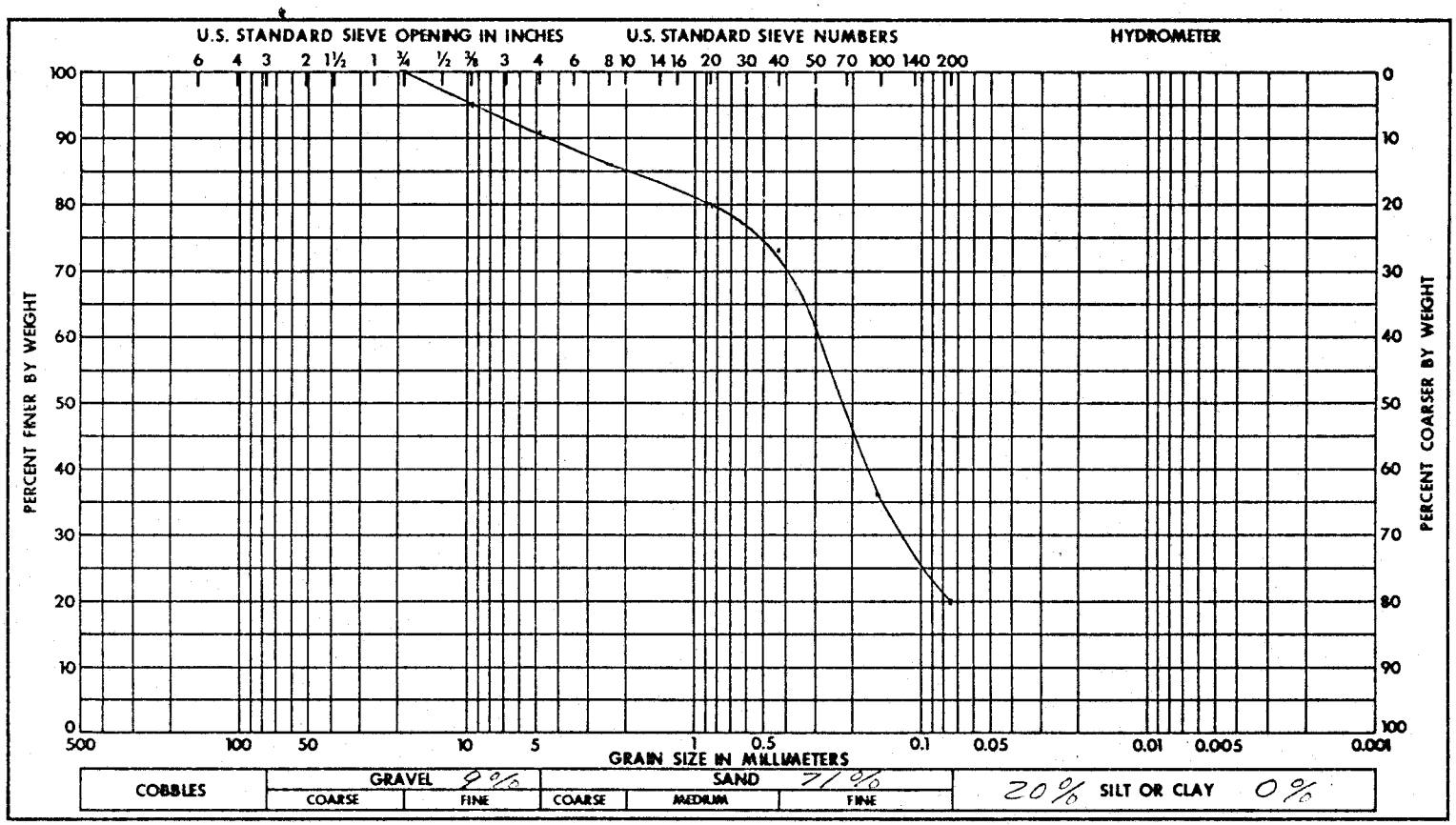
Remarks:

Project Johnsonville S. P.	
Feature	
Boring No. SS-6E	Sample No. 3A
Station	Range
Date 11-2-77	Elevation 363.4-362.4

GRAIN SIZE ANALYSIS

Tested by: _____ Reviewed by: _____

ATTACHMENT 6
CONST-QCP 5.3



Soil Symbol	SM	Liquid Limit, %	NP
Moisture Content, %	24.0	Plastic Limit, %	NP
Specific Gravity		Plasticity Index, %	NP
		Shrinkage Limit, %	

Remarks:

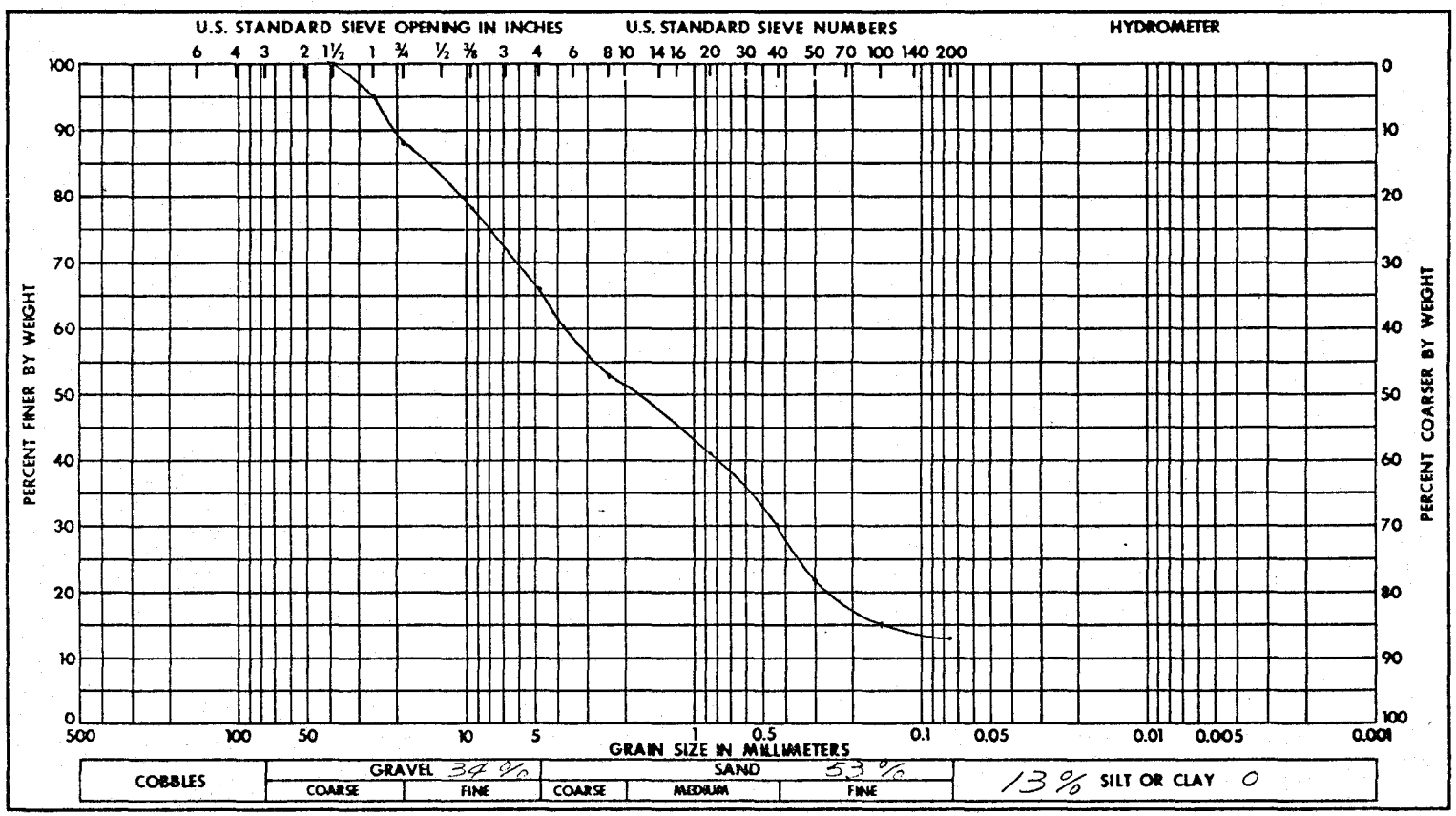
Project Johnsonville S. P.	
Feature	
Boring No. SS-6E	Sample No. 4A
Station	Range
Date 11-2-77	Elevation 361.4-360.8

GRAIN SIZE ANALYSIS

TVA 10199 (CONST-6-77)

Tested by: _____ Reviewed by: _____

ATTACHMENT 6
CONST-QCP 5.3



Soil Symbol	G-SM	Liquid Limit, %	NP
Moisture Content, %	8.95	Plastic Limit, %	NP
Specific Gravity		Plasticity Index, %	NP
		Shrinkage Limit, %	

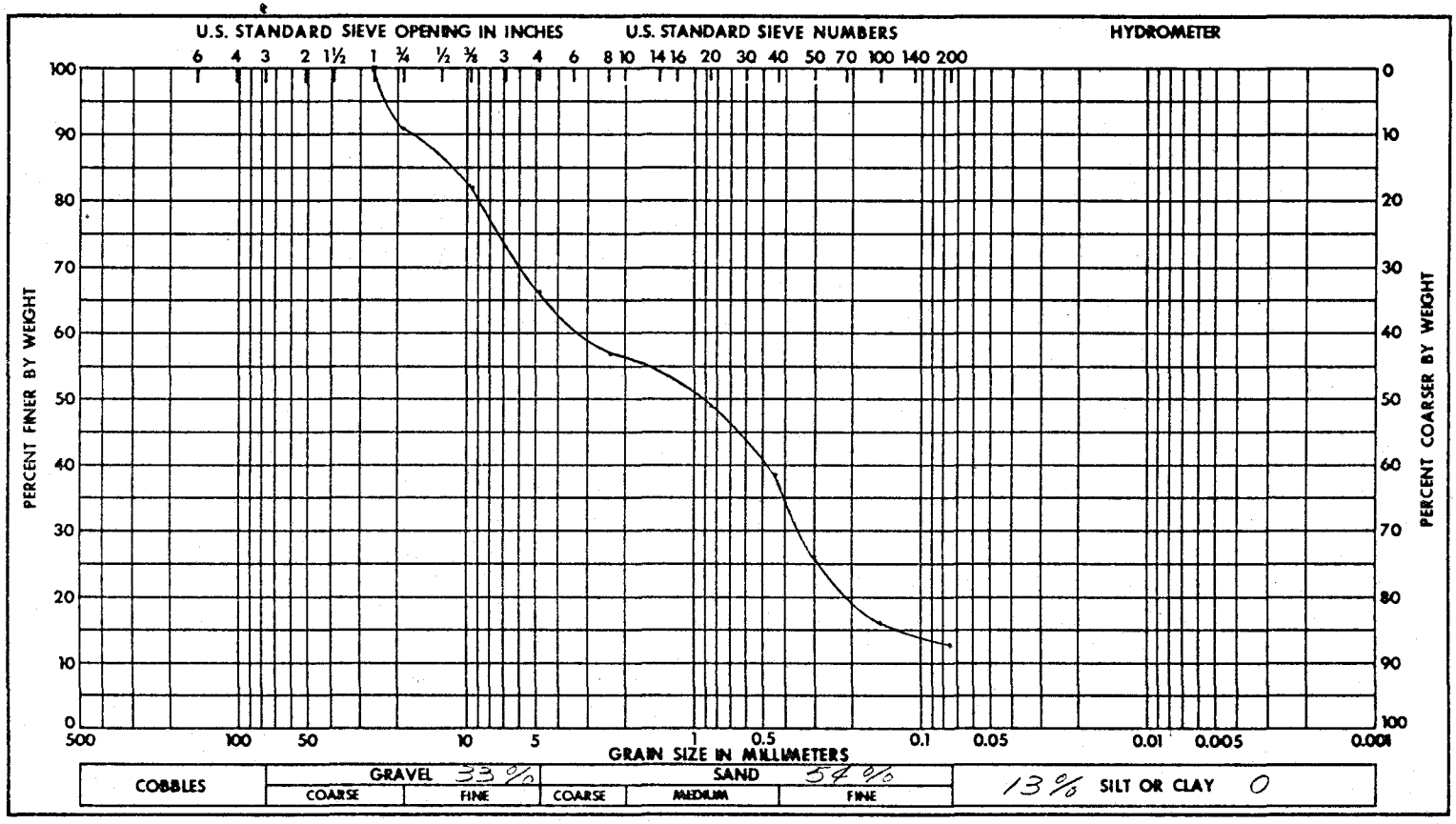
Remarks:

Project Johnsonville S. P.	
Feature	
Boring No. SS-6F	Sample No. 1A
Station	Range
Date 11-2-77	Elevation 368.3-367.3

GRAIN SIZE ANALYSIS

TVA 10199 (CONST-6-77)

Tested by: _____ Reviewed by: _____



Soil Symbol	G-SM	Liquid Limit, %	NP
Moisture Content, %	14.1	Plastic Limit, %	NP
Specific Gravity		Plasticity Index, %	NP
		Shrinkage Limit, %	

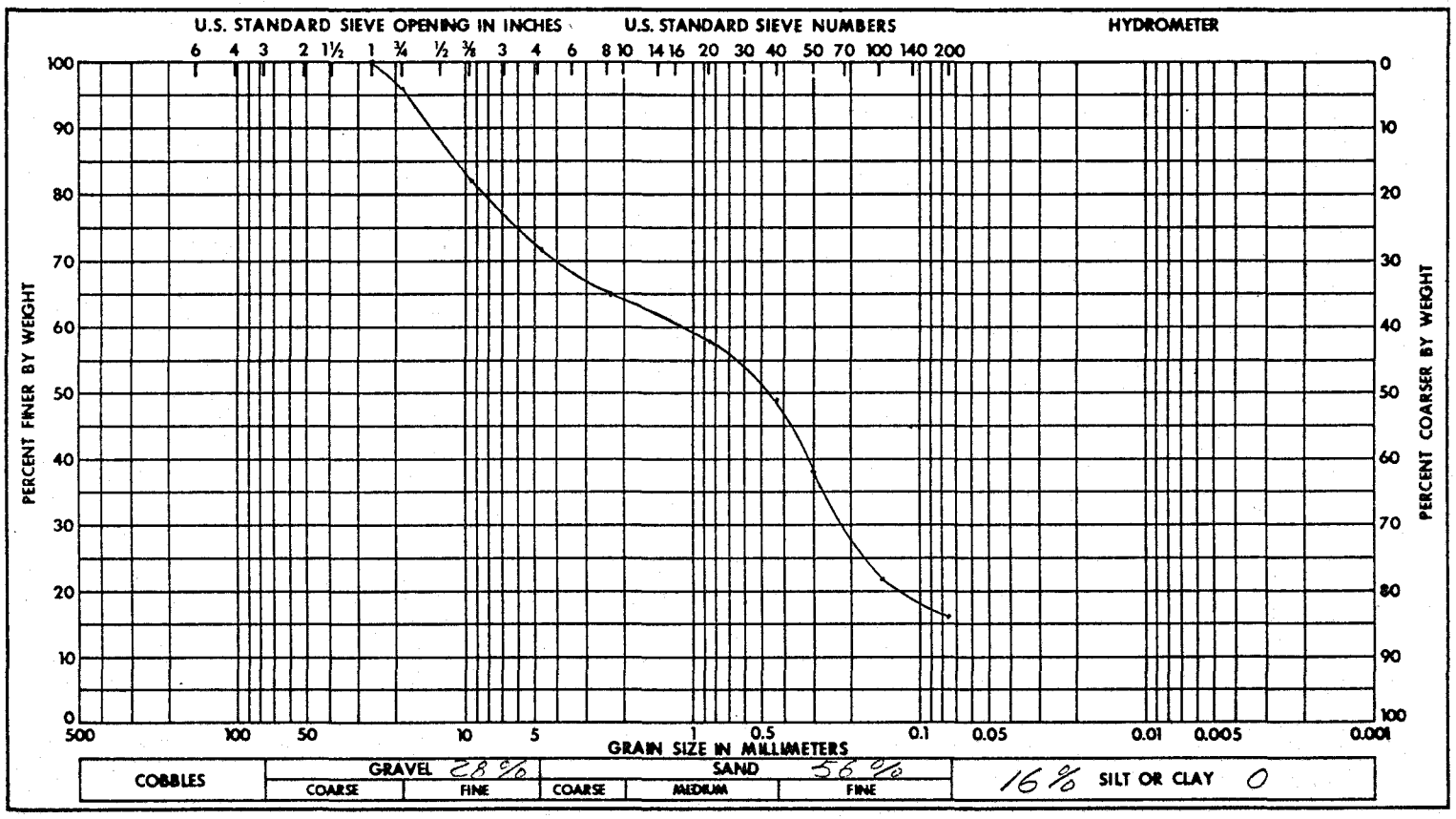
Remarks:

Project Johnsonville S. P.	
Feature	
Boring No. SS-6F	Sample No. 2A
Station	Range
Date 11-2-77	Elevation 3663-3653

GRAIN SIZE ANALYSIS

Tested by: _____ Reviewed by: _____

ATTACHMENT 6
CONST-QCP 5.3



Soil Symbol	G-SM	Liquid Limit, %	NP
Moisture Content, %	21.9	Plastic Limit, %	NP
Specific Gravity		Plasticity Index, %	NP
		Shrinkage Limit, %	

Remarks:

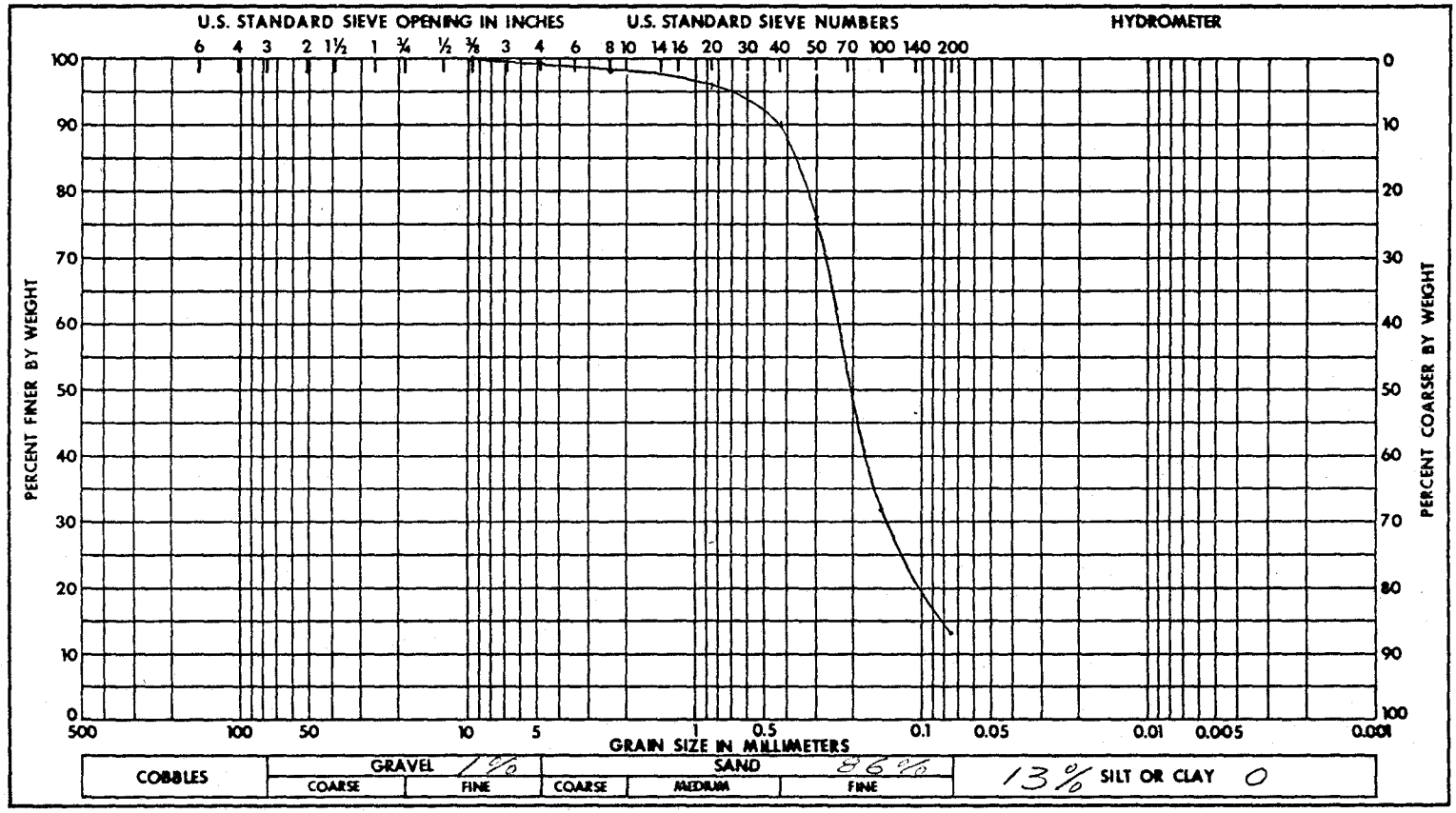
Project Johnsonville S. P.	
Feature	
Boring No. SS-6F	Sample No. 3A
Station	Range
Date 11-2-77	Elevation 3643-363.5

GRAIN SIZE ANALYSIS

TVA 10199 (CONST-6-77)

Tested by: _____ Reviewed by: _____

ATTACHMENT 6
CONST-QCP 5.3



Soil Symbol	SM	Liquid Limit, %	NP
Moisture Content, %	37.3	Plastic Limit, %	NP
Specific Gravity		Plasticity Index, %	NP
		Shrinkage Limit, %	

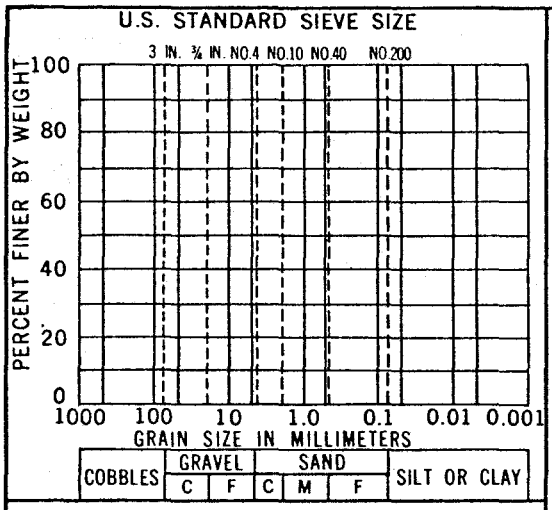
Remarks:

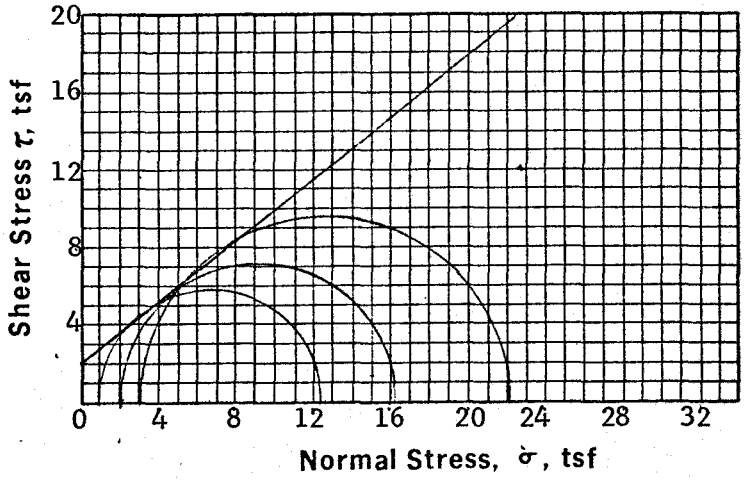
Project Johnsonville S. P.	
Feature	
Boring No. SS-6F	Sample No. 4A
Station	Range
Date 11-2-77	Elevation 362.3-361.5

GRAIN SIZE ANALYSIS

TVA 10199 (CONST-6-77)

Tested by: _____ Reviewed by: _____

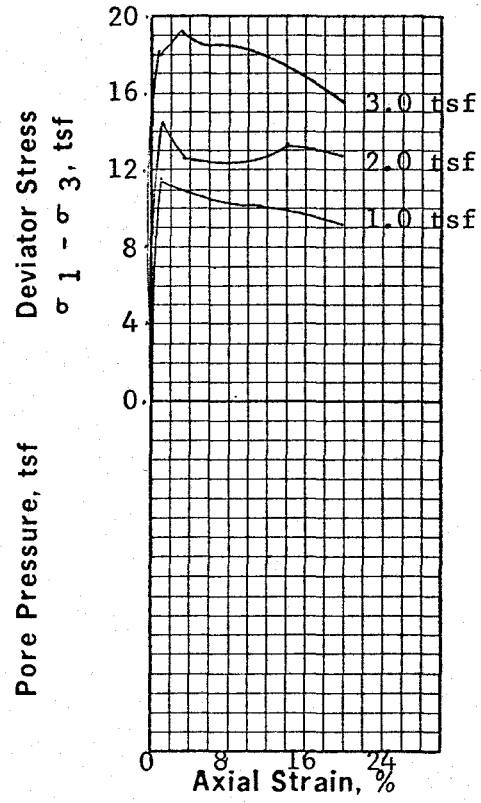




Type of Specimen	Remolded
Classification	
LL.	**G**
PI.	**D_{10}**

Shear Strength	ø Deg.	Tan ø	C, tsf
Apparent	39.0	.81	2.00
Effective	--	--	--

	Specimen Number	1	2	3	4
Initial	Moisture Content, %	9.8	10.1	8.8	
	Dry Density, pcf	123.1	122.2	123.9	
	Void Ratio	.390	.399	.380	
	Saturation, %	68.5	69.0	63.0	
Before Shearing	Moisture Content after Saturation, %	12.3	13.9	12.5	
	Saturation, %	100	100	100	
	Moisture Content after Consolidation, %	--	--	--	
	Void Ratio after Consolidation	--	--	--	
Final Moisture Content ,%		12.3	13.9	12.5	
Minor Principal Stress, σ_3, tsf		1.00	2.00	3.00	
Major Principal Stress, σ_1, tsf		12.40	16.18	22.05	
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		--	--	--	
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		--	--	--	
Time to Failure, min.		2	2	3	
Rate of strain, %/min.		1.00	1.00	1.00	
Specimen Height, in.		8.00	8.00	8.00	
Specimen Diameter, in.		4.00	4.00	4.00	



Remarks: Bottom Ash

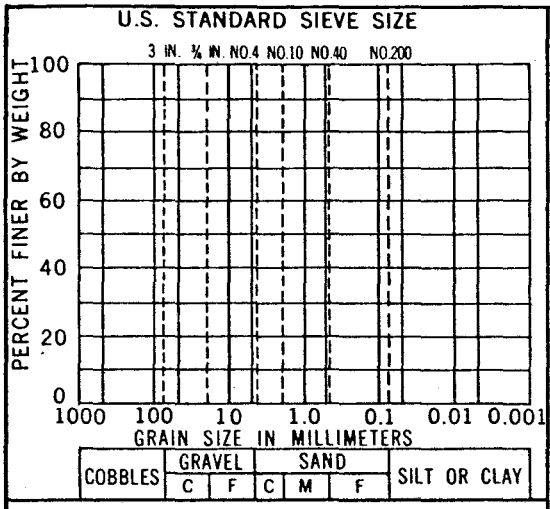
Project: Johnsonville Steam Plant

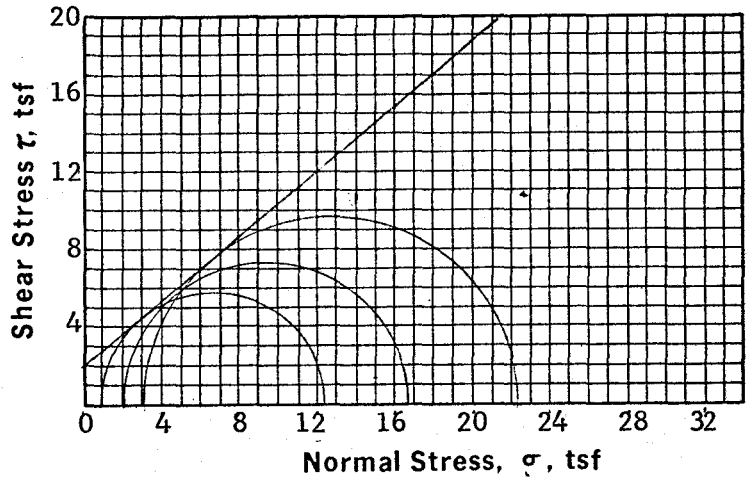
Feature

Boring No.	**Sample No.**
Station	Range
Date 10-7-77	**Elev.**

TRIAXIAL COMPRESSION TEST (Q)

Tested by: CEC Reviewed by: gcs

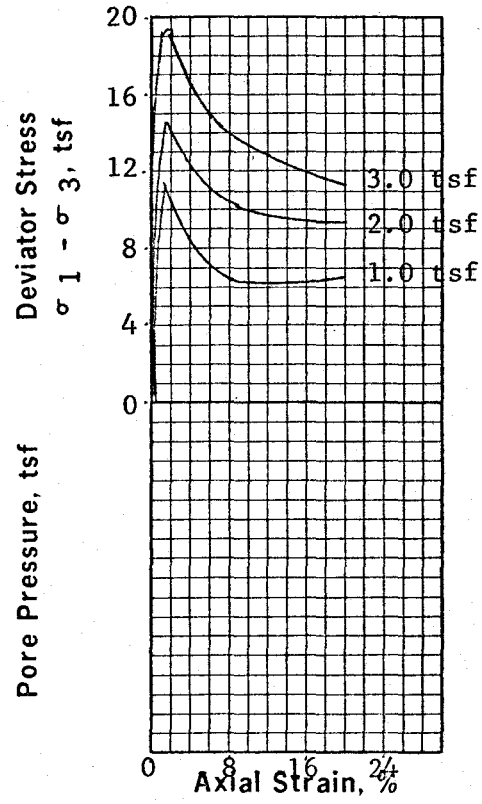




Type of Specimen	Remolded
Classification	
LL.	G
PI.	D_{10}

Shear Strength	ø Deg.	Tan ø	C, tsf
Apparent	40.0	.84	2.00
Effective	--	--	--

	Specimen Number	1	2	3	4
Initial	Moisture Content, %	9.2	9.0	9.8	
	Dry Density, pcf	124.5	125.5	122.9	
	Void Ratio	.374	.363	.391	
	Saturation, %	67.1	67.7	68.6	
Before Shearing	Moisture Content after Saturation, %	--	--	--	
	Saturation, %	--	--	--	
	Moisture Content after Consolidation, %	--	--	--	
	Void Ratio after Consolidation	--	--	--	
Final Moisture Content ,%		9.0	8.9	9.6	
Minor Principal Stress, σ_3, tsf		1.00	2.00	3.00	
Major Principal Stress, σ_1, tsf		12.54	16.71	22.53	
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		--	--	--	
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		--	--	--	
Time to Failure, min.		2	2	2.5	
Rate of strain, %/min.		1.00	1.00	1.00	
Specimen Height, in.		8.00	8.00	8.00	
Specimen Diameter, in.		4.00	4.00	4.00	

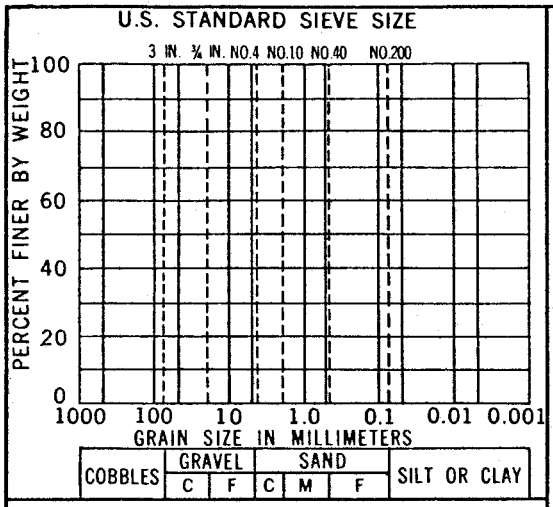


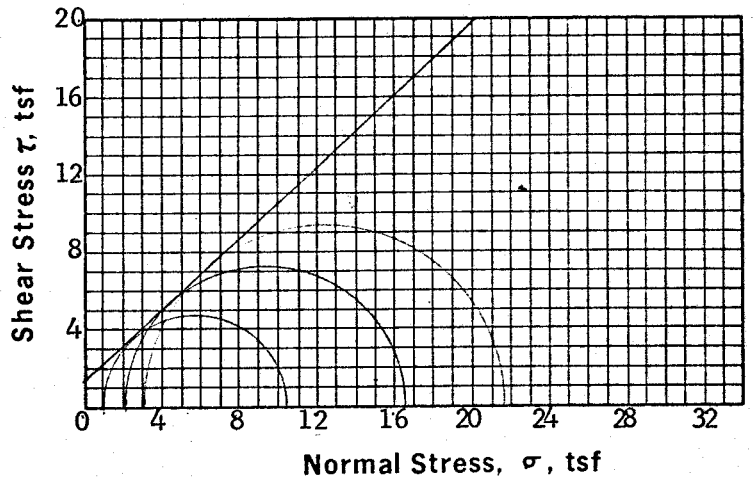
Remarks: Bottom Ash

Project: Johnsonville Steam Plant	
Feature	
Boring No.	Sample No.
Station	Range
Date 10-6-77	Elev.

TRIAXIAL COMPRESSION TEST (Q)

Tested by: CEC Reviewed by: JCS

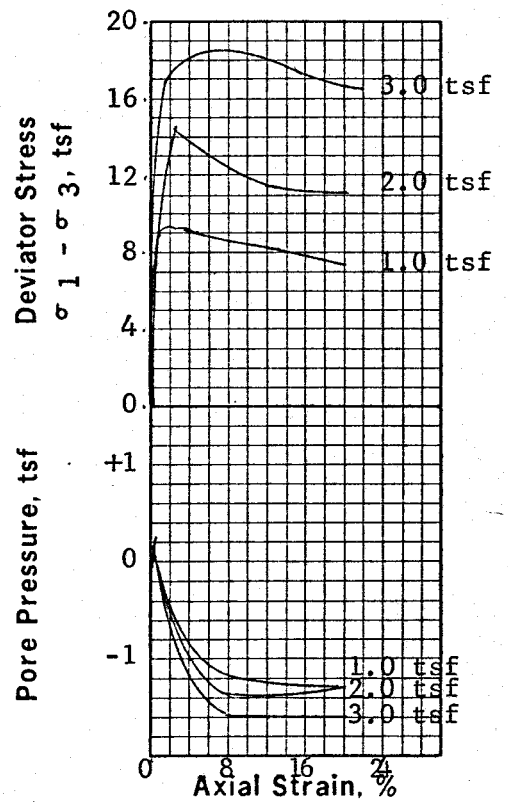




Type of Specimen	Remolded
Classification	
LL.	G
PI.	D_{10}

Shear Strength	ø Deg.	Tan ø	C, tsf
Apparent	42.0	.90	1.50
Effective	37.5	.77	1.20

	Specimen Number	1	2	3	4
Initial	Moisture Content, %	8.8	9.8	9.6	
	Dry Density, pcf	124.2	123.4	123.6	
	Void Ratio	.377	.386	.384	
	Saturation, %	64.2	69.7	68.6	
Before Shearing	Moisture Content after Saturation, %	13.7	14.1	14.0	
	Saturation, %	100	100	100	
	Moisture Content after Consolidation, %	13.1	14.0	14.0	
	Void Ratio after Consolidation	.375	.378	.363	
Final Moisture Content ,%		13.1	14.0	14.0	
Minor Principal Stress, σ_3, tsf		1.00	2.00	3.00	
Major Principal Stress, σ_1, tsf		10.48	16.60	21.71	
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		1.55	2.99	4.40	
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		11.03	17.59	23.11	
Time to Failure, min.		8	12	30	
Rate of strain, %/min.		0.20	0.20	0.20	
Specimen Height, in.		8.00	8.00	8.00	
Specimen Diameter, in.		4.00	4.00	4.00	



Remarks: Bottom Ash

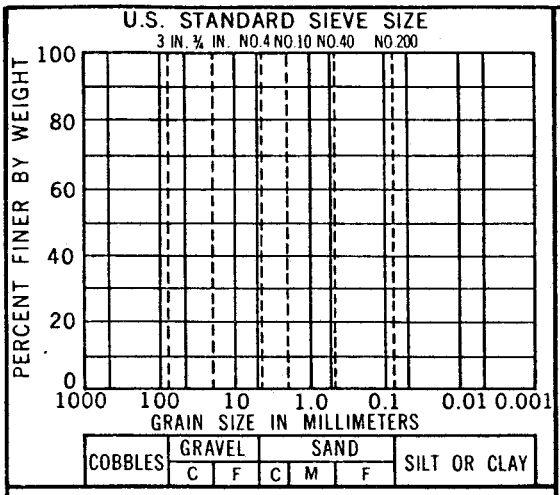
Project: Johnsonville Steam Plant

Feature

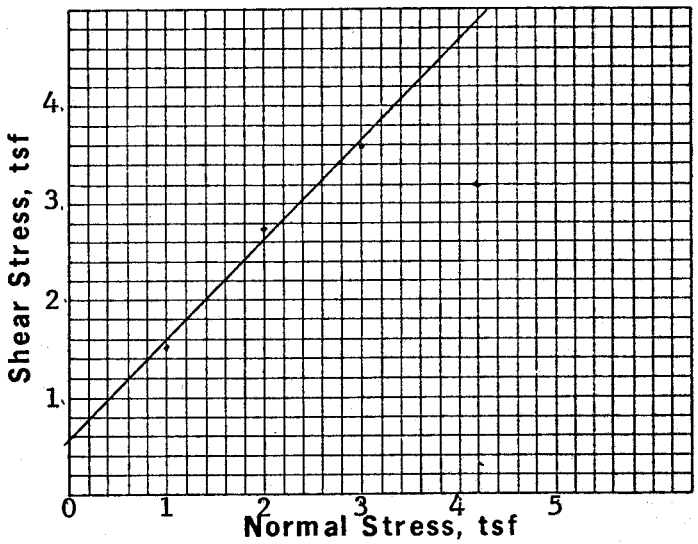
Boring No.	Sample No.
Station	Range
Date 10-7-77	Elev.

TRIAXIAL COMPRESSION TEST (R)

TVA 10195 (CONST-6-77) Tested by: CEC Reviewed by: ACS

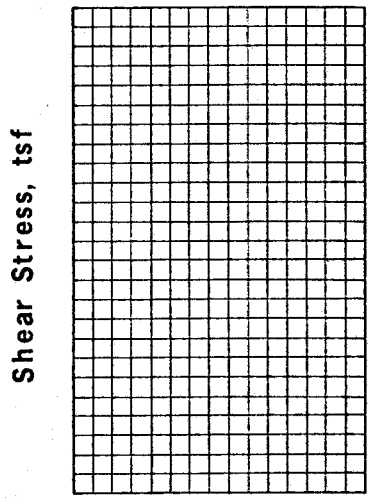


Type of Specimen	Remolded
Classification	
LL.	G
PI.	D_{10}



Test Number		1	2	3	4
Initial	Moisture Content, %				
	Dry Density, pcf	123.4	123.4	123.6	
	Void Ratio	.387	.387	.384	
	Saturation, %				
Final	Moisture Content, %	13.8	13.7	13.5	
	Saturation, %	100	100	100	
Normal Stress, tsf		1.00	2.00	3.00	
Max. Shear Stress, tsf		1.54	2.73	3.59	
Time to Failure, min.		55	100	80	
Deformation, in./min.		.004	.004	.004	
Specimen Height, in.		6.0	6.0	6.0	
Specimen Diameter, in.		12.0	12.0	12.0	

Shear Strength	ø Deg.	Tan.ø	C, tsf
	45.5	1.02	0.55



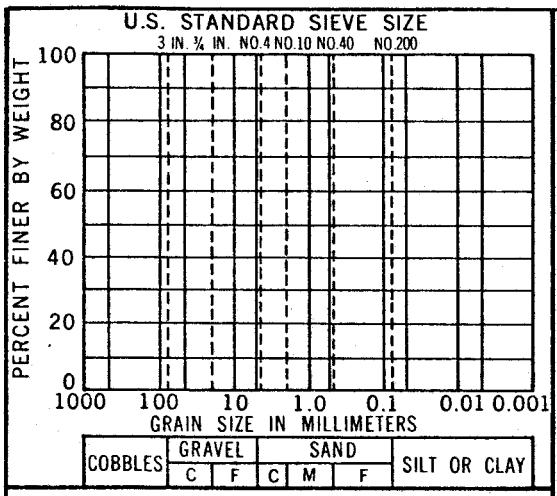
Horizontal Deformation, inches

Remarks: Bottom Ash

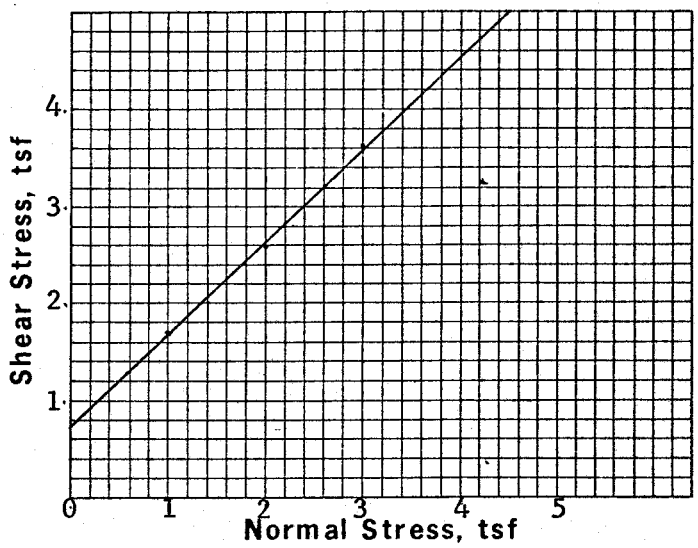
Project: Johnsonville Steam Plant	
Feature	
Boring No.	Sample No.
Station	Range
Date 10-5-77	Elev.

DIRECT SHEAR TEST (S)

Tested by: TAL Reviewed by: JCB

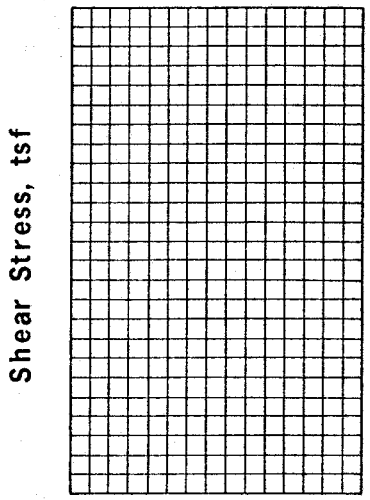


Type of Specimen	Remolded
Classification	
LL.	G
PI.	D_{10}



Test Number		1	2	3	4
Initial	Moisture Content, %				
	Dry Density, pcf	125.6	124.0	124.4	
	Void Ratio	.362	.380	.375	
	Saturation, %				
Final	Moisture Content, %	13.0	13.5	13.0	
	Saturation, %	100	100	100	
Normal Stress, tsf		1.00	2.00	3.00	
Max. Shear Stress, tsf		1.70	2.59	3.61	
Time to Failure, min.		40	53	75	
Deformation, in./min.		.004	.004	.004	
Specimen Height, in.		6.0	6.0	6.0	
Specimen Diameter, in.		12.0	12.0	12.0	

Shear Strength	ø Deg.	Tan.ø	C, tsf
	43.5	.95	0.72

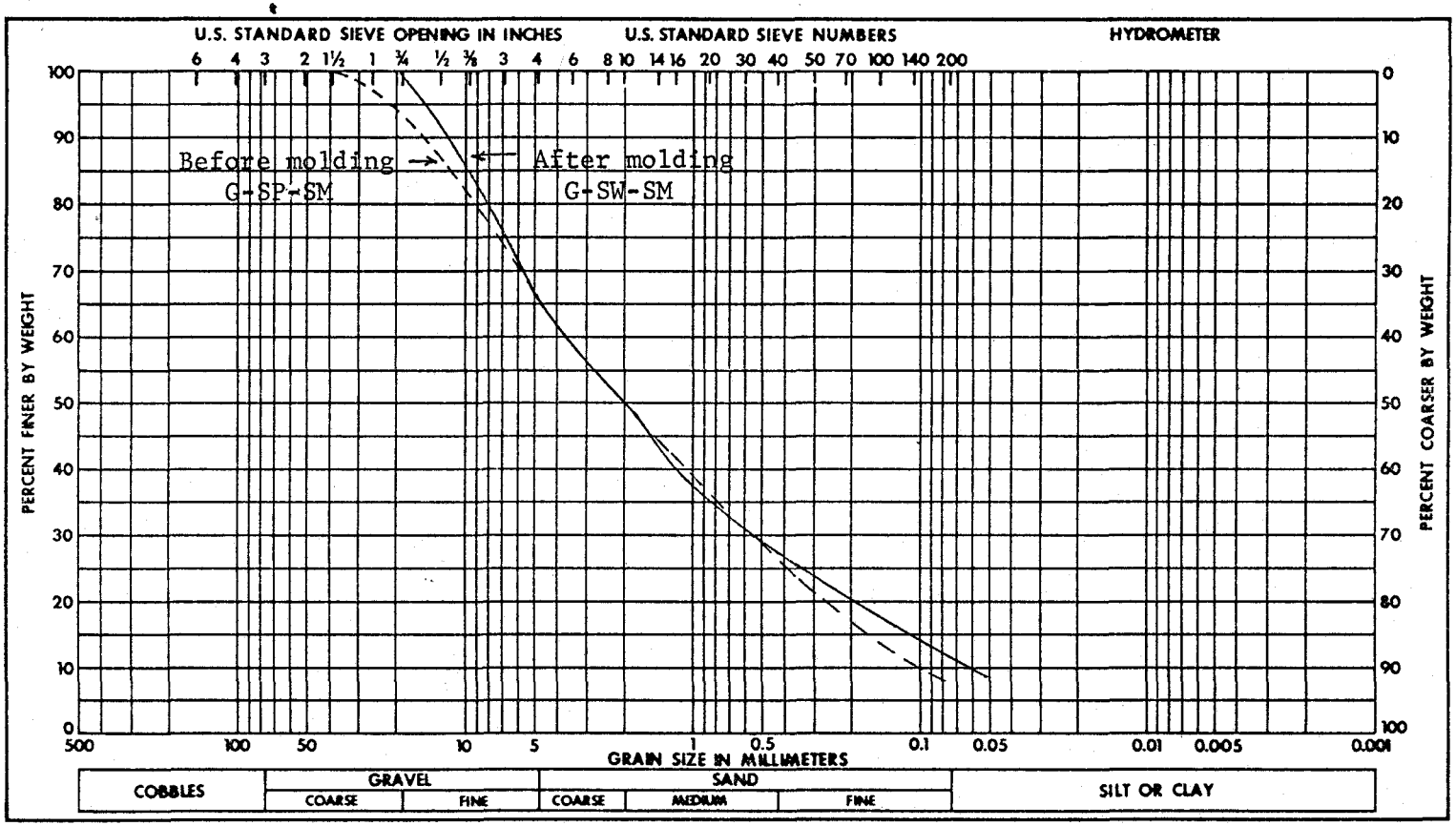


Remarks: Bottom Ash

Project: Johnsonville Steam Plant	
Feature	
Boring No.	Sample No.
Station	Range
Date 10-5-77	Elev.

DIRECT SHEAR TEST (S)

Tested by: TAL Reviewed by: _____



Soil Symbol		**Liquid Limit, %**	NP
Moisture Content, %		**Plastic Limit, %**	NP
Specific Gravity		**Plasticity Index, %**	NP
		Shrinkage Limit, %	

Remarks: Bottom Ash

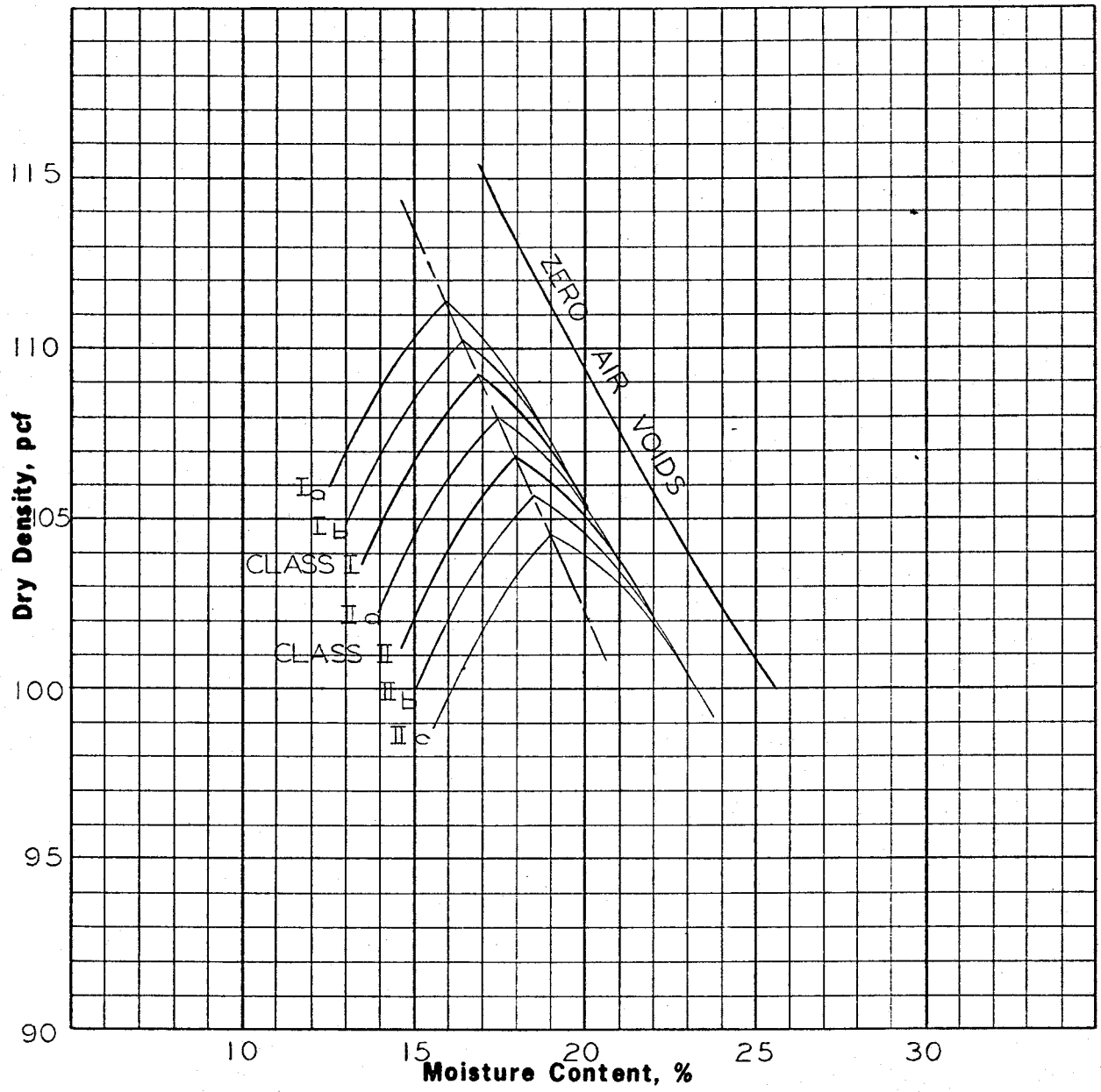
Project Johnsonville Steam Plant	
Feature	
Boring No.	**Sample No.**
Station	Range
Date 10-5-77	**Elevation**

GRAIN SIZE ANALYSIS

TVA 10199 (CONST-6-77)

Tested by: TAL

Reviewed by: JCS



Soil Class	Gravel %	Sand %	Silt %	Clay %	Specific Gravity	LL %	PI %	Optimum Moisture, %	Maximum Density, pcf
I-CL	0	21	42	37	2.69	42.1	23.6	16.9	109.2
II-CL	0	11	47	42	2.71	46.7	28.2	18.0	106.8

Plus No. 4 Specific Gravity, S S D	2.33
Plus No. 4 Absorption, %	6.9

Remarks:

Project JOHNSONVILLE S. P.

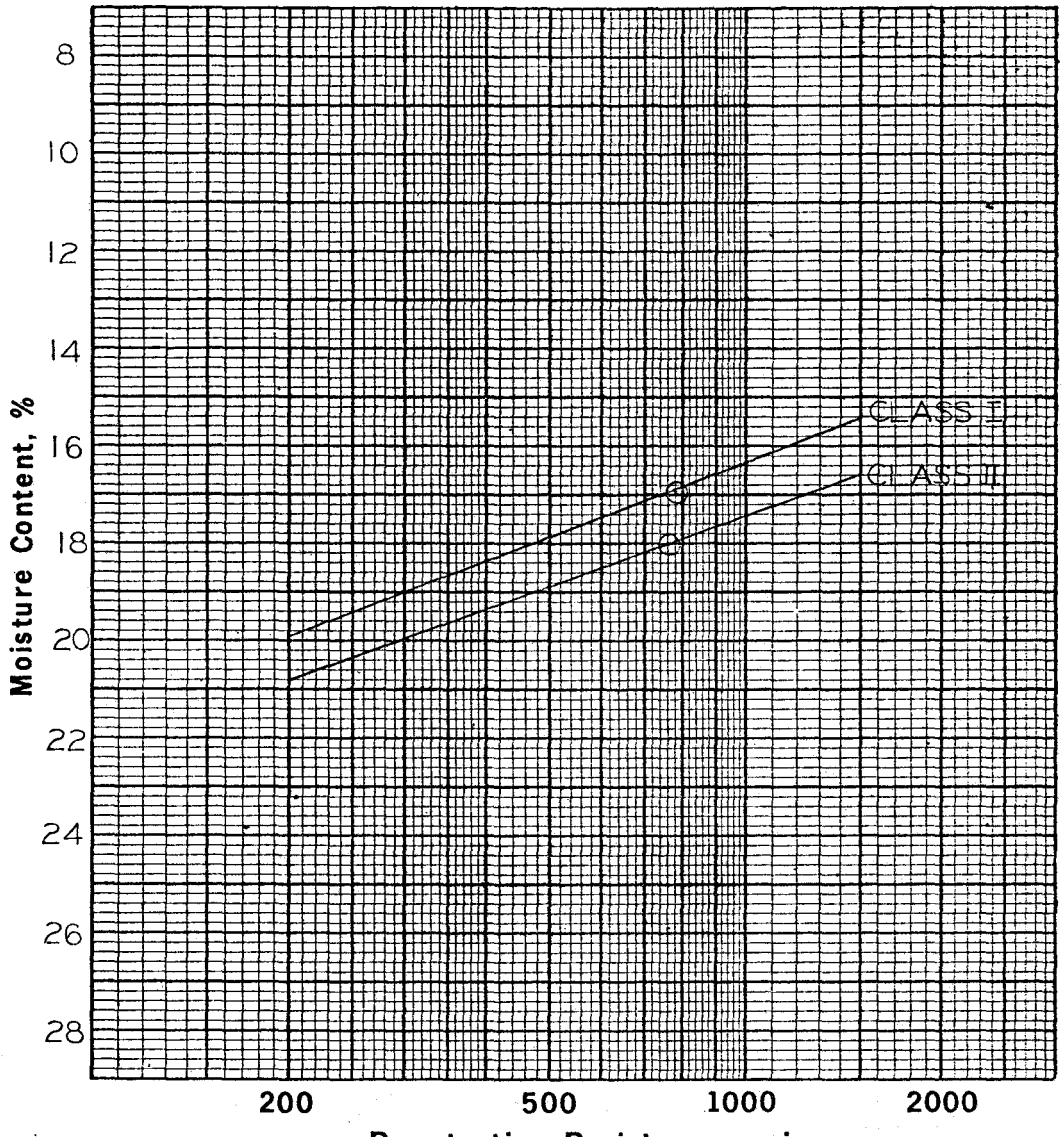
Feature BORROW AREA A AND B

Date Tested

COMPACTION TEST (FAMILY OF CURVES)

TVA 10201 (CONST-6-77)

Tested by: RW Reviewed by:



Soil Class	Optimum Moisture, %	Maximum Density, pcf	Penetration Resistance, psi
I-CL	16.9	109.2	790
II-CL	18.0	106.8	765

Remarks:

⊙ **Denotes Optimum Moisture**

Project JOHNSONVILLE S. P.

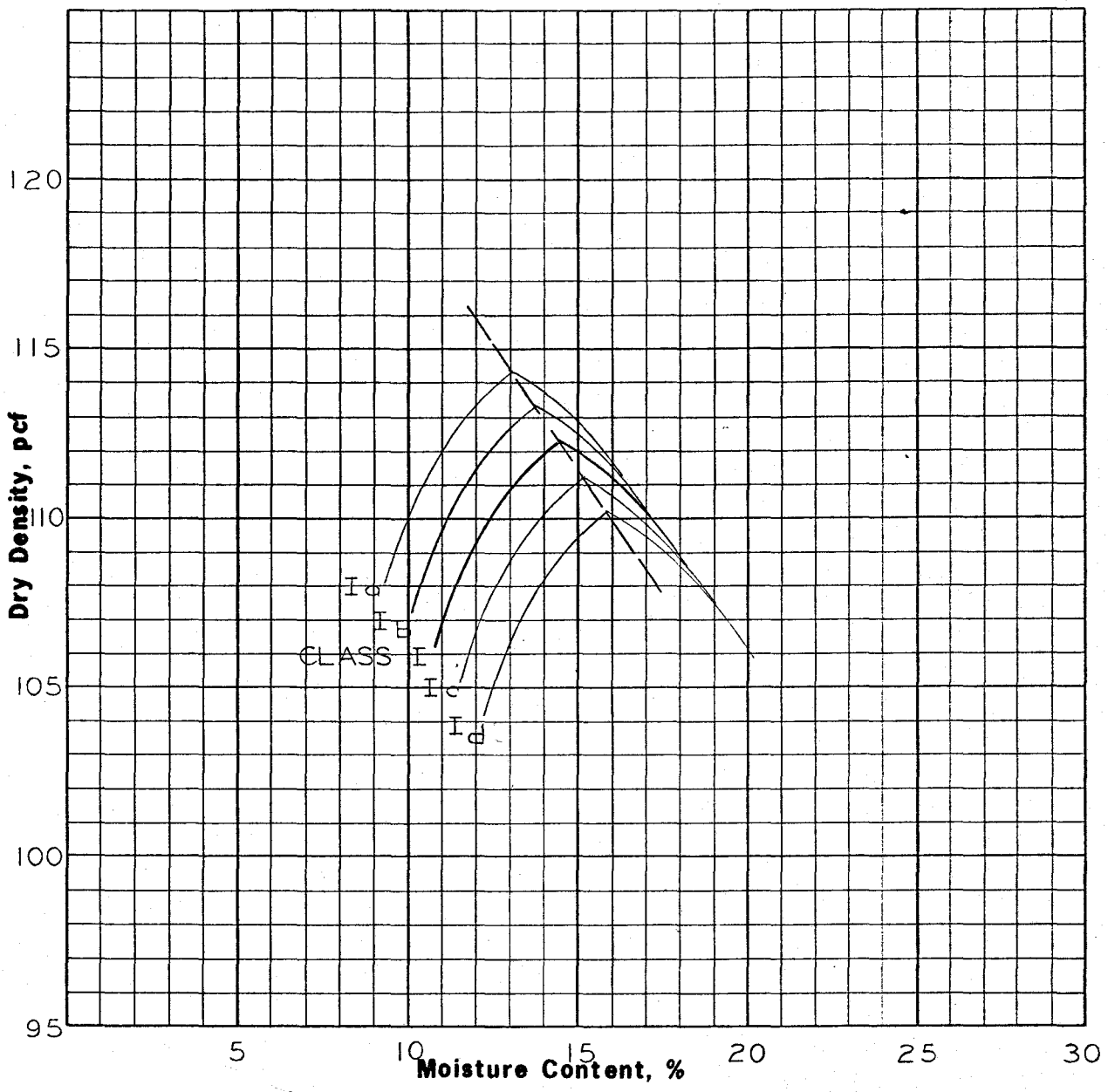
Feature BORROW AREA A AND B

Date Tested

MOISTURE - PENETRATION TEST

TVA 10200 (CONST-6-77)

Tested by: RLK Reviewed by:



Soil Class	Gravel %	Sand %	Silt %	Clay %	Specific Gravity	LL %	PI %	Optimum Moisture, %	Maximum Density, pcf
I-GC	40	28	14	18	2.69	45.1	25.7	14.5	112.3

Plus No. 4 Specific Gravity, S S D	2.33
Plus No. 4 Absorption, %	6.9

Remarks:

Project JOHNSONVILLE S. P.

GRAVELLY SOILS

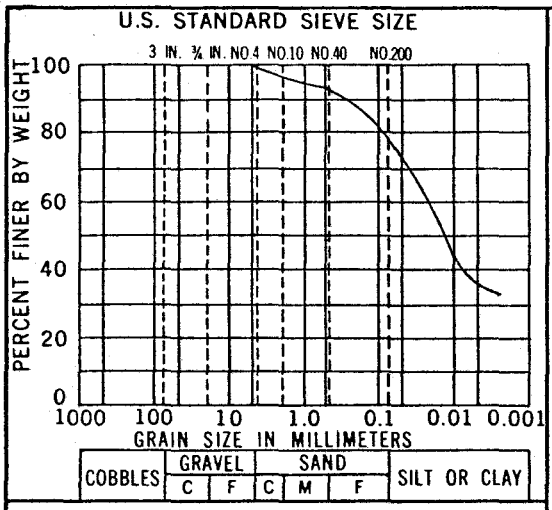
Feature BORROW AREA A

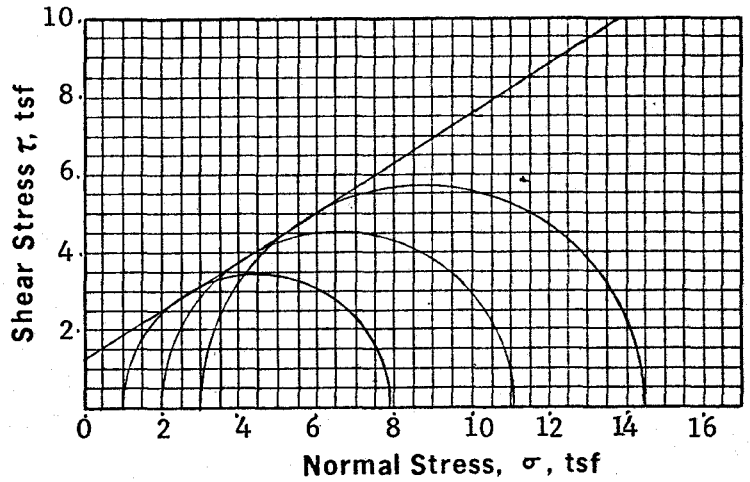
Date Tested 10-7-77

COMPACTION TEST (FAMILY OF CURVES)

TVA 10201 (CONST-6-77)

Tested by: RLV Reviewed by:

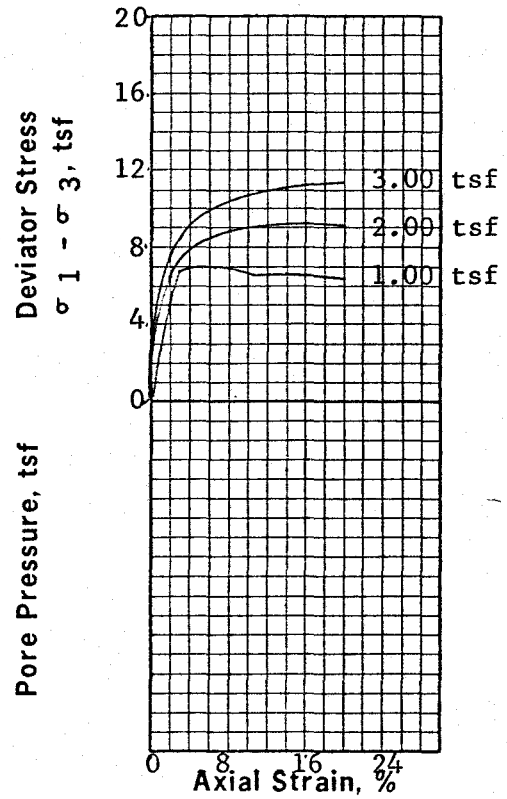




Type of Specimen	Remolded*		
Classification	CL		
LL.	42.1	**G**	2.69
PI.	23.6	**D_{10}**	--

Shear Strength	ø Deg.	Tan ø	C, tsf
Apparent	32.0	.62	1.30
Effective	--	--	--

	Specimen Number	1	2	3	4
Initial	Moisture Content, %	13.8	13.8	13.7	
	Dry Density, pcf	103.7	103.7	103.8	
	Void Ratio	.620	.620	.617	
	Saturation, %	60.1	60.1	59.9	
Before Shearing	Moisture Content after Saturation, %	--	--	--	
	Saturation, %	--	--	--	
	Moisture Content after Consolidation, %	--	--	--	
	Void Ratio after Consolidation	--	--	--	
Final Moisture Content ,%		13.8	13.8	13.7	
Minor Principal Stress, σ_3, tsf		1.00	2.00	3.00	
Major Principal Stress, σ_1, tsf		7.93	11.06	14.45	
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		--	--	--	
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		--	--	--	
Time to Failure, min.		5	15	19	
Rate of strain, %/min.		1.00	1.00	1.00	
Specimen Height, in.		3.17	3.17	3.17	
Specimen Diameter, in.		1.40	1.40	1.40	



Remarks: *Remolded at 3 percent dry of optimum moisture and at 95 percent of standard maximum dry density.

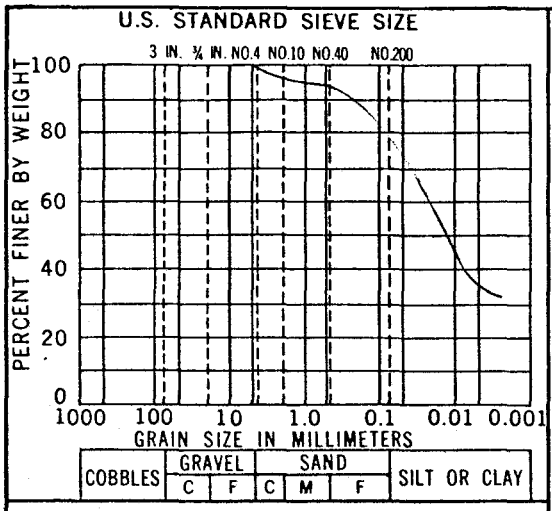
Project: Johnsonville Steam Plant

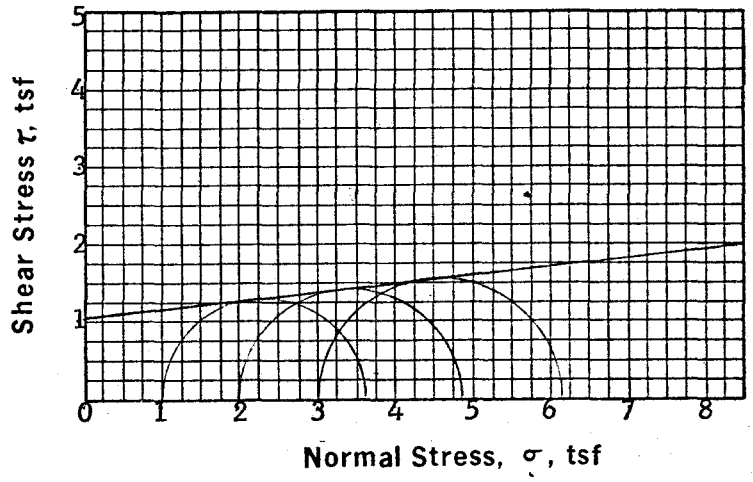
Feature Borrow Area A & B

Boring No.	**Sample No.** Class I
Station	Range
Date 10-14-77	**Elev.**

TRIAXIAL COMPRESSION TEST (Q)

Tested by: GMD-TRC Reviewed by: JCS

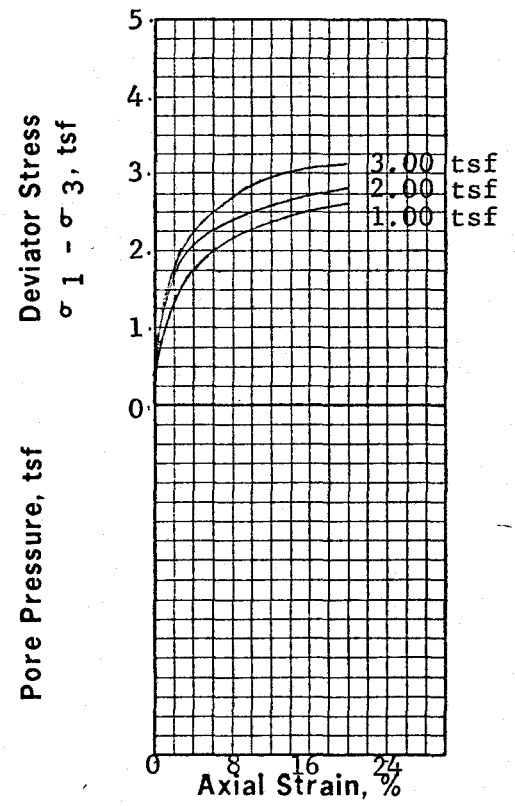




Type of Specimen	Remolded*		
Classification		CL	
LL.	42.1	**G**	2.69
PI.	23.6	**D_{10}**	--

Shear Strength	ø Deg.	Tan ø	C, tsf
Apparent	6.0	.11	1.05
Effective	--	--	--

	Specimen Number	1	2	3	4
Initial	Moisture Content, %	19.7	19.6	19.6	
	Dry Density, pcf	103.8	103.9	103.9	
	Void Ratio	.617	.616	.616	
	Saturation, %	85.8	85.5	85.3	
Before Shearing	Moisture Content after Saturation, %	--	--	--	
	Saturation, %	--	--	--	
	Moisture Content after Consolidation, %	--	--	--	
	Void Ratio after Consolidation	--	--	--	
Final Moisture Content ,%		19.6	19.5	19.5	
Minor Principal Stress, σ_3, tsf		1.00	2.00	3.00	
Major Principal Stress, σ_1, tsf		3.59	4.80	6.12	
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		--	--	--	
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		--	--	--	
Time to Failure, min.		20	20	20	
Rate of strain, %/min.		1.00	1.00	1.00	
Specimen Height, in.		3.17	3.17	3.17	
Specimen Diameter, in.		1.40	1.40	1.40	



Remarks: *Remolded at 3% wet of optimum moisture and at 95% of standard maximum dry density.

Project: Johnsonville Steam Plant

Feature Borrow Area A & B

Boring No. | **Sample No.** Class I

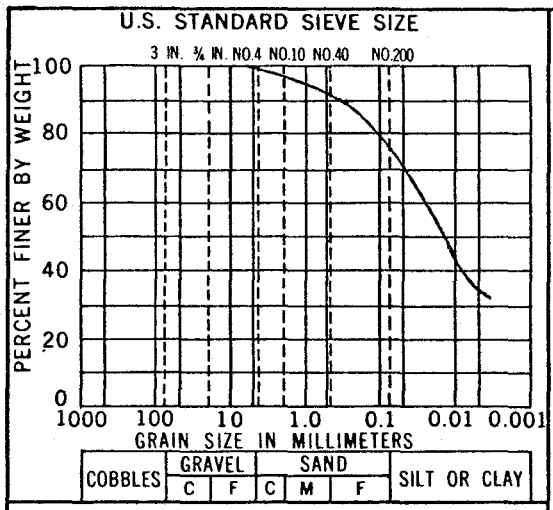
Station | Range

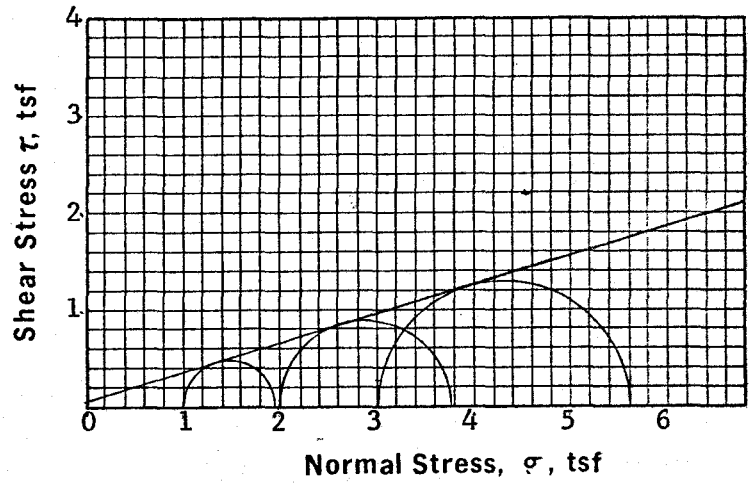
Date 10-14-77 | **Elev.**

TRIAXIAL COMPRESSION TEST (Q)

Tested by: GMD

Reviewed by: JCS

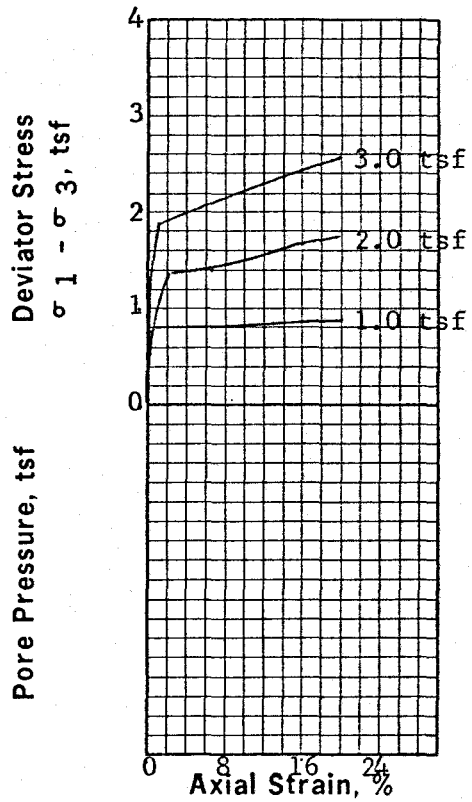




Type of Specimen	Remolded*		
Classification	CL		
LL.	42.1	G	2.69
PI.	23.6	D_{10}	--

Shear Strength	ø Deg.	Tan ø	C, tsf
Apparent	16.5	.30	0.06
Effective	--	--	--

	Specimen Number	1	2	3	4
Initial	Moisture Content, %	13.9	13.9	13.8	
	Dry Density, pcf	103.8	103.8	103.8	
	Void Ratio	.619	.619	.618	
	Saturation, %	60.5	60.5	60.2	
Before Shearing	Moisture Content after Saturation, %	23.0	23.0	23.0	
	Saturation, %	100	100	100	
	Moisture Content after Consolidation, %	22.7	21.7	20.8	
	Void Ratio after Consolidation	.573	.556	.528	
Final Moisture Content ,%		22.7	21.7	20.8	
Minor Principal Stress, σ_3, tsf		1.00	2.00	3.00	
Major Principal Stress, σ_1, tsf		1.92	3.78	5.59	
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		--	--	--	
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		--	--	--	
Time to Failure, min.		90	90	90	
Rate of strain, %/min.		0.20	0.20	0.20	
Specimen Height, in.		3.17	3.17	3.17	
Specimen Diameter, in.		1.40	1.40	1.40	

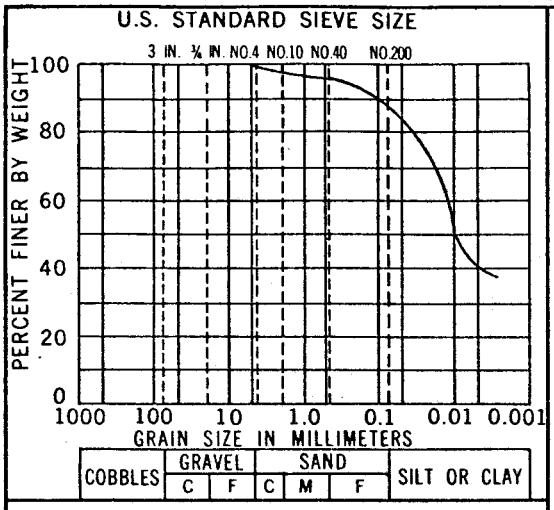


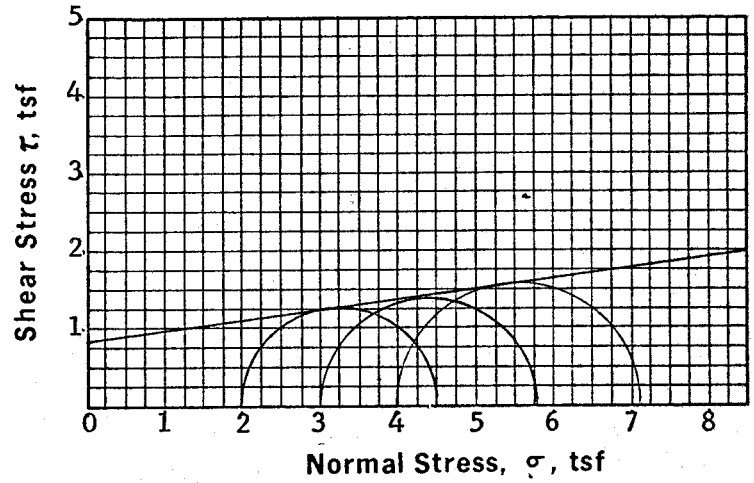
Remarks: Remolded at 3 percent dry of optimum moisture and at 95 percent of standard maximum dry density.

Project:	Johnsonville Steam Plant
Feature	Borrow Area A & B
Boring No.	Sample No. Class I
Station	Range
Date 10-13-77	Elev.

TRIAXIAL COMPRESSION TEST (R)

Tested by: CEC Reviewed by: JCS

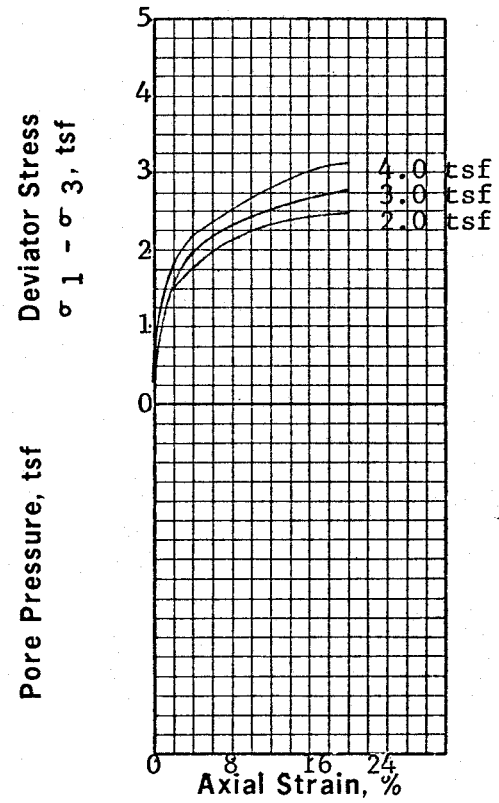




Type of Specimen	Remolded*		
Classification	CL		
LL.	46.7	**G**	2.71
PI.	28.2	**D_{10}**	--

Shear Strength	ø Deg.	Tan ø	C, tsf
Apparent	7.5	.13	0.82
Effective	--	--	--

	Specimen Number	1	2	3	4
Initial	Moisture Content, %	20.9	20.9	20.8	
	Dry Density, pcf	101.7	101.7	101.8	
	Void Ratio	.663	.663	.662	
	Saturation, %	85.2	85.2	85.0	
Before Shearing	Moisture Content after Saturation, %	--	--	--	
	Saturation, %	--	--	--	
	Moisture Content after Consolidation, %	--	--	--	
	Void Ratio after Consolidation	--	--	--	
Final Moisture Content ,%		20.8	20.8	20.7	
Minor Principal Stress, σ_3, tsf		2.00	3.00	4.00	
Major Principal Stress, σ_1, tsf		4.49	5.77	7.12	
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		--	--	--	
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		--	--	--	
Time to Failure, min.		20	20	20	
Rate of strain, %/min.		1.00	1.00	1.00	
Specimen Height, in.		3.17	3.17	3.17	
Specimen Diameter, in.		1.40	1.40	1.40	



Remarks: *Remolded at 3 percent wet of optimum moisture and at 95 percent of standard maximum dry density.

Project: Johnsonville Steam Plant

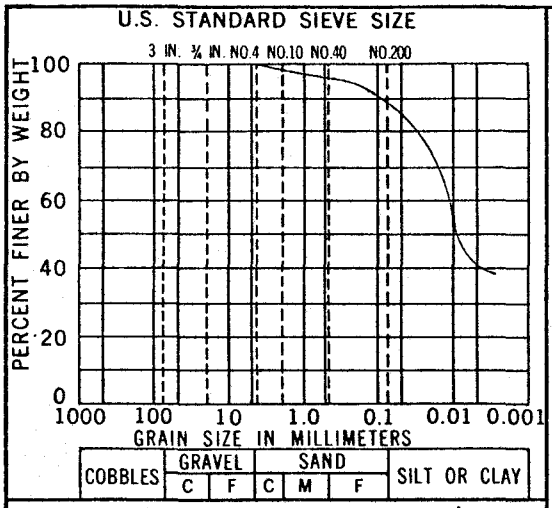
Feature Borrow Area A & B

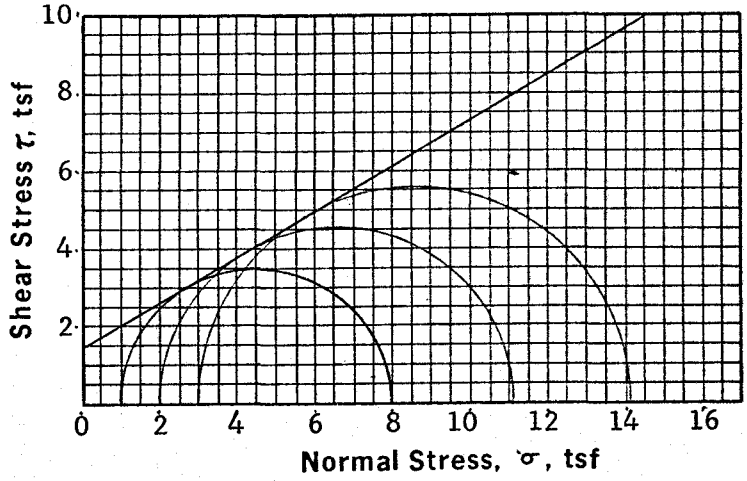
Boring No.	**Sample No.** Class II
Station	Range
Date 10-14-77	**Elev.**

TRIAXIAL COMPRESSION TEST (Q)

Tested by: GMD

Reviewed by: gcs

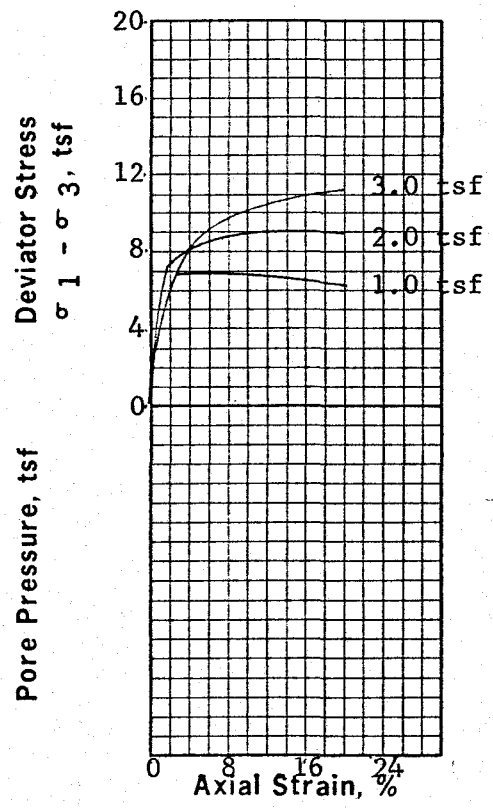




Type of Specimen	Remolded*		
Classification	CL		
LL.	46.7	G	2.71
PI.	28.2	D_{10}	--

Shear Strength	ø Deg.	Tan ø	C, tsf
Apparent	30.0	.58	0.75
Effective	--	--	--

	Specimen Number	1	2	3	4
Initial	Moisture Content, %	14.7	14.9	14.6	
	Dry Density, pcf	101.7	101.6	101.8	
	Void Ratio	.663	.666	.662	
	Saturation, %	60.2	60.7	59.9	
Before Shearing	Moisture Content after Saturation, %	--	--	--	
	Saturation, %	--	--	--	
	Moisture Content after Consolidation, %	--	--	--	
	Void Ratio after Consolidation	--	--	--	
Final Moisture Content ,%		14.6	14.7	14.6	
Minor Principal Stress, σ_3, tsf		1.00	2.00	3.00	
Major Principal Stress, σ_1, tsf		7.99	11.15	14.14	
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		--	--	--	
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		--	--	--	
Time to Failure, min.		3	13	20	
Rate of strain, %/min.		1.00	1.00	1.00	
Specimen Height, in.		3.17	3.17	3.17	
Specimen Diameter, in.		1.40	1.40	1.40	

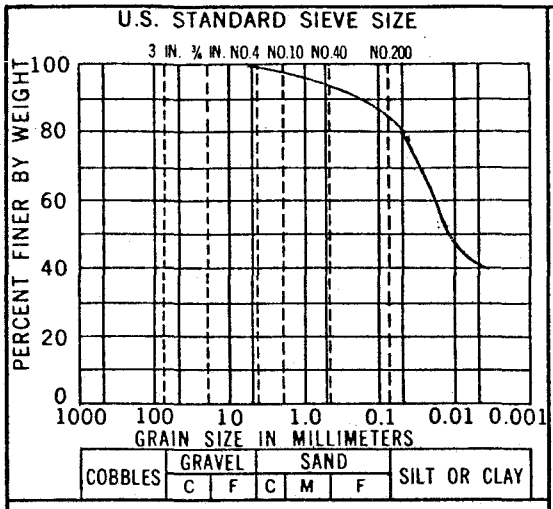


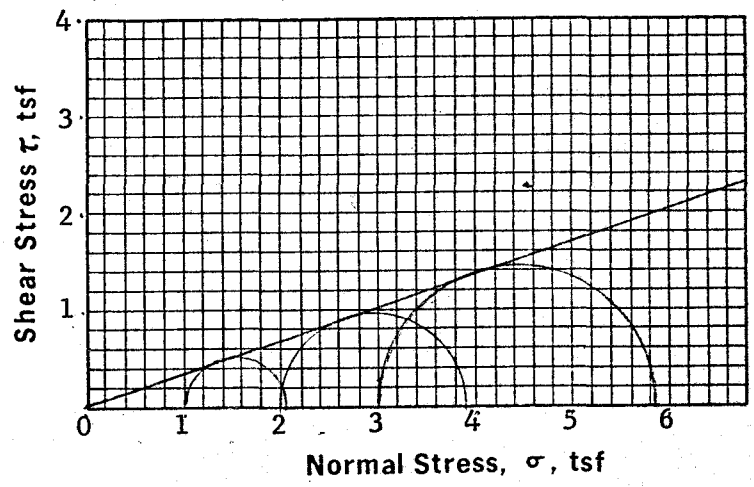
Remarks: *Remolded at 3 percent dry of optimum moisture and at 95 percent of standard maximum dry density.

Project:	Johnsonville Steam Plant
Feature	Borrow Area A & B
Boring No.	Sample No. Class II
Station	Range
Date 10-14-77	Elev.

TRIAXIAL COMPRESSION TEST (Q)

Tested by: GMD - TAC Reviewed by: JCS

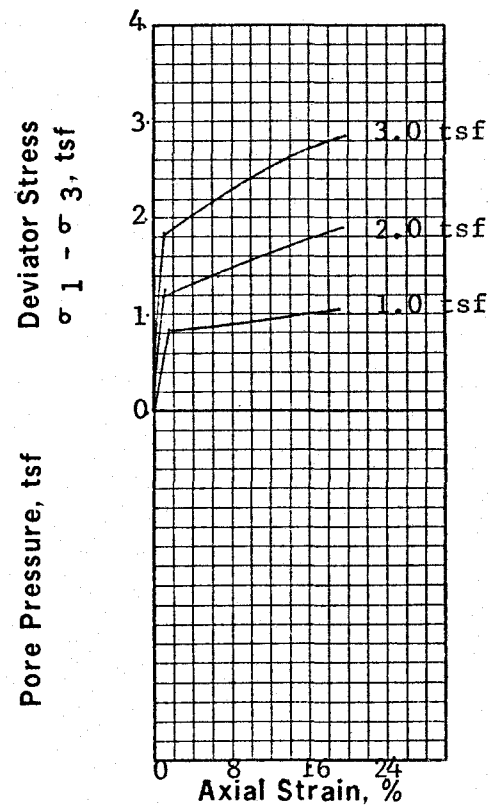




Type of Specimen	Remolded*		
Classification	CL		
LL.	46.7	G	2.71
PI.	28.2	D_{10}	--

Shear Strength	ø Deg.	Tan ø	C, tsf
Apparent	18.0	.33	0.05
Effective	--	--	--

	Specimen Number	1	2	3	4
Initial	Moisture Content, %	14.7	14.7	14.7	
	Dry Density, pcf	101.8	101.8	101.8	
	Void Ratio	.662	.662	.662	
	Saturation, %	60.2	60.2	60.1	
Before Shearing	Moisture Content after Saturation, %	24.4	24.4	24.4	
	Saturation, %	100	100	100	
	Moisture Content after Consolidation, %	23.4	22.5	21.8	
	Void Ratio after Consolidation	.631	.600	.551	
Final Moisture Content ,%		23.4	22.5	21.8	
Minor Principal Stress, σ_3, tsf		1.00	2.00	3.00	
Major Principal Stress, σ_1, tsf		2.07	3.93	5.86	
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		--	--	--	
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		--	--	--	
Time to Failure, min.		90	90	90	
Rate of strain, %/min.		0.20	0.20	0.20	
Specimen Height, in.		3.17	3.17	3.17	
Specimen Diameter, in.		1.40	1.40	1.40	



Remarks: *Remolded at 3 percent dry of optimum moisture and at 95 percent of standard maximum dry density.

Project: Johnsonville Steam Plant

Feature Borrow Area A & B

Boring No.	Sample No. Class II
Station	Range
Date 10-14-77	Elev.

TRIAXIAL COMPRESSION TEST (R)

TVA 10195 (CONST-6-77) Tested by: CEC Reviewed by: JCS