G-000-105 .55

5548

GEOTECHNICAL EXPLORATION OF THE COAL STORAGE FACILITY

11/02/88

DOE-60-89
DOE-FN OEPA
21
LETTER

Department of Energy
Oak Ridge Operations
P.O. Box 2001
Oak Ridge, Tennessee 37831—

5548

November 2, 1988
DOE-60-89

Mr. Tom Winston, Chief
Ohio Environmental Protection Agency
Southwest District Office
40 South Main Street
Dayton, OH 45402

Dear Mr. Winston:

GEOTECHNICAL EXPLORATION OF THE COAL STORAGE FACILITY

Enclosed please find a copy of the report for characterization of the soils underlying the Coal Storage Facility. This exploration was conducted in response to the Proposed Consent Decree requirements set forth in Section IV, Control of Wastewater and Runoff, Paragraph C. The decree requires that this report be submitted to the Ohio EPA by November 4, 1988, which is within one hundred-fifty (150) days after the approval of the Boring Location Plan.

The results included in this report indicate that the existing soil conditions provide groundwater protection that meets or exceeds those specified in the decree. The primary criteria used to determine the need for placing a liner beneath the existing coal storage area is equivalent to three (3) feet of clay with a permeability coefficient no greater than $1x10^{-7}$ cm/sec. The characterization of the soils underlying this area classified the major soil type as an overconsolidated glacial till which is medium stiff to hard in consistency and has an average soil permeability of $5.2x10^{-8}$ cm/sec. Therefore, no liner should be required to be placed beneath the existing Coal Storage Facility.

If you have any questions or require additional information, please contact Mary Stone of my staff at (513) 738-6656.

Sincerely,

James A. Reafsnyder
Site Manager

DP-84:Stone

5548

Enclosure:
Geotechnical Exploration of the Coal Storage Facility

cc w/enclosure:
G. Mitchell, OEPA-Dayton
R. Bendula, OEPA-Dayton
C. McCord, USEPA-V
M. Wilson, ORO, SE-31

cc w/o enclosure:
D. J. Brettschneider, WMCO
R. C. Kispert, WMCO
C. R. Conner, WMCO
L. C. Bogar, WMCO

Original Library Copy

5548

THE WESTINGHOUSE MATERIALS COMPANY OF OHIO GEOTECHNICAL EXPLORATION COAL STORAGE FACILITY

WESTINGHOUSE ENVIRONMENTAL ENGINEERING
PROJECT NO. 4144-88-309
SEPTEMBER 20, 1988

000003

Attachment to:

5548

Westinghouse
Environmental Services

Environmental Engineering

225 Corporate Court
Suite K
Fairfield, Ohio 45014
(513) 874-4111
FAX (513) 874-6017

September 20, 1988

The Westinghouse Materials Company of Ohio
P.O. Box 398704
Cincinnati, Ohio 45239-8704

Attention: Elizabeth A. Jursek

Regarding: Geotechnical Exploration
Coal Storage Facility
Feed Materials Processing Center
Fernald, Ohio
WMCO Purchase Order No. 401563-00
Project No. 4144-88-309

Dear Miss Jursek:

Submitted herewith are the results of the geotechnical exploration performed for the above-referenced project. The tasks were performed in general accordance with our Proposal Number CP-1347 dated June 7, 1988. The work was authorized through WMCO Purchase Order 401563-00 dated June 20, 1988.

The report presents a description of the project, scope of work provided, subsurface conditions encountered and all laboratory and field test results. Should you have any questions or if we can be of further assistance, please contact us.

Respectfully submitted,

Westinghouse Environmental Engineering

Ronald F. Roelker

Ronald F. Roelker, E.I.T.
Geotechnical Engineer

Reviewed by:

Ronald J. Ebelhar

Ronald J. Ebelhar, P.E.
Engineering Department Manager

RFR/kd

Attachment

000004

TABLE OF CONTENTS

	PAGE
INTRODUCTION	1
FIELD EXPLORATION	1
LABORATORY TESTING	2
SURFACE CONDITIONS	2
SUBSURFACE CONDITIONS	3
GROUNDWATER	3
CLOSING	4
APPENDIX	

APPENDIX

SOIL BORING PLAN

SOIL BORING PROFILES

BORING LOGS

LABORATORY TEST RESULTS

INTRODUCTION

This report presents the results of the subsurface exploration performed for the existing coal storage facility located in the north-central vicinity of the FMPC production area. The main purpose of the exploration was to define the subsurface conditions, develop pH profiles and determine permeability of the in-situ soil strata. The following sections present the field and laboratory procedures used and results of the tests performed.

FIELD EXPLORATION

The field exploration program consisted of six soil test borings advanced from 10 to 12 ft. below existing grades. The borings were located in the area of the existing coal stockpile which is in the north-central vicinity of the processing area. The boring locations are shown on the Soil Boring Plan (Figure 1).

The boring locations and elevations were established in the field by referencing from existing topographic features. All borings were advanced by continuous sampling in accordance with the Standard Method for Penetration Test and Split-Barrel Sampling of Soils (ASTM D1586). In addition to the standard split-spoon sampling procedures, undisturbed 3-inch-diameter thin-walled Shelby tube samples (ASTM D1587) were also obtained at the locations and approximate depths noted on the boring logs. Upon completion of the test borings and final water level measurements, the holes were backfilled with Volclay cement grout mix.

After the boreholes were drilled, the locations were surveyed by Westinghouse Environmental Engineering personnel. Coordinates were referenced from the northeast corner of Building 10 (Boiler Plant) and elevations were referenced from Catch Basin B-2 shown on the Boring Plan. The FMPC site coordinates and elevations of each boring are shown on the boring logs.

LABORATORY TESTING

Subsequent to the field exploration, all recovered soil samples and the driller's field logs were returned to our laboratory for classification and grouping by the Project Geotechnical Engineer. Index testing included gradation and plasticity testing of each major soil type encountered. The existing coal and surficial sand was not tested. One triaxial falling-head permeability test was then performed on each undisturbed Shelby tube sample. Permeability tests could not be performed on samples ST7 and ST8 due to extreme sample disturbance which sometimes results from extracting undisturbed samples in very stiff glacial till. All classification tests were performed according to the latest ASTM standards. Falling-head permeability tests were performed using procedures outlined in the U.S. Army Corps of Engineers Engineering Manual 1110-2-1906.

One pH test was performed on each recovered split-spoon sample. The pH test results for each respective sample are shown on the boring logs. This testing was performed by Howard Labs, Inc. in Dayton, Ohio.

SURFACE CONDITIONS

The coal storage area is located just east of Building No. 10 (Boiler Plant). Borings 1 to 4 are located within the coal stockpile limits and Borings 5 and 6 on either side of the existing settling basin located just south of the coal stockpile limits.

Grade at the stock piles is relatively flat except for the 3- to 4-ft.-high earth berm which surrounds the stockpile area on the north, east and south sides. At the time of exploration, the coal stockpile occupied the east half of the coal storage area and was about 10 to 12 ft. high. The coal had been removed at the boring

locations to an elevation near surrounding grades to permit drilling access.

SUBSURFACE CONDITIONS

The borings are shown graphically in profile on Figure 2. Strata changes, Penetration Resistance values and Shelby tube locations are also shown. Soil conditions under the coal pile are primarily glacial tills. Thin layers of sand or clay exist under the coal at three locations.

Borings 1 through 4 initially encountered coal. The coal varied in depth from 0.3 to 1.5 ft. About 0.5 ft. of brown fine sand was encountered beneath the coal at Boring 1 while 1.5 to 2.0 ft. of brown lean clay (CL) underlies the coal at Borings 2 and 4. Borings 5 and 6 initially encountered about 4 inches of gravel. The gravel is most likely fill material placed for erosion protection of the settling basin.

The main soil strata underlying the coal storage facility is a brown and gray lean clay with sand (glacial till). The till lies directly beneath the coal at Boring 3, the gravel at Borings 5 and 6 and beneath the fine sand and lean clay at the other borings. The till is a heterogeneous, unstratified, over-consolidated mixture of clay (20%), silt (50%), sand (20%), and gravel (10%) which is medium stiff to hard in consistency. Average natural moisture content is 15% and average wet density is 134 pcf. The fine-graded portion of the glacial till classify as CL in the Unified Soil Classification System.

Values of pH for soil solids averaged 7.0 and varied little with depth except at Borings 1 and 2. At Borings 1 and 2, the pH level decreased to near 2 between a depth of 2 and 3 ft. below grade, raising to near the average value below a depth of about 5 ft.

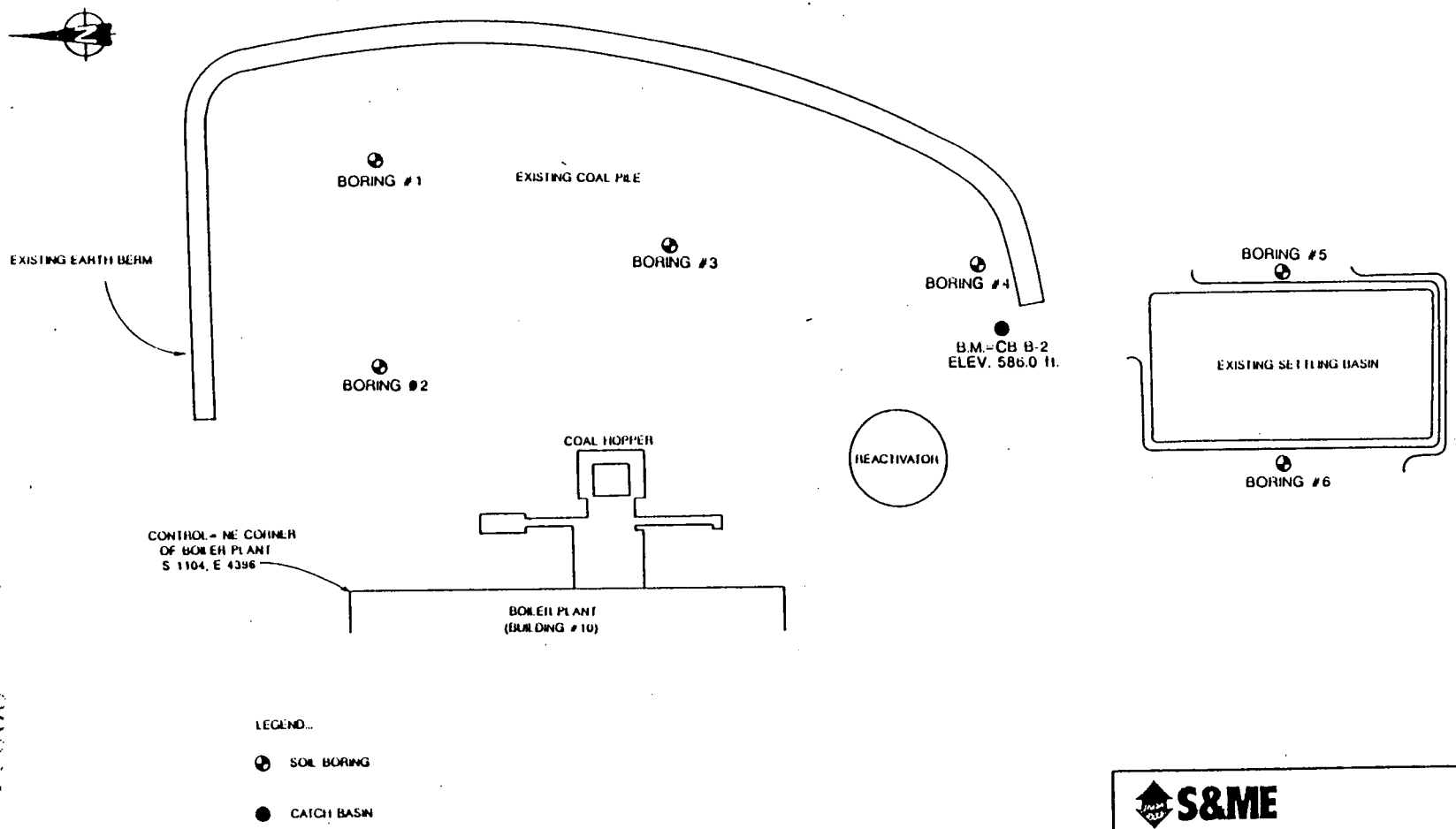
Based on the laboratory falling-head type permeability tests performed on undisturbed samples of the glacial till, the till ranges in permeability from 2.8×10^{-8} cm/sec to 8.0×10^{-8} cm/sec. The average permeability of the till is 5.2×10^{-8} cm/sec.

GROUNDWATER

Groundwater was not encountered in any of the borings at the time of drilling. We would anticipate groundwater to be present during the wetter seasons in the form of small, isolated pockets of perched groundwater.

CLOSING

We appreciate the opportunity of providing our professional and technical services to the Westinghouse Materials Company of Ohio. If you have any questions pertaining to the test methods and results or need further assistance, please contact us.



LEGEND...

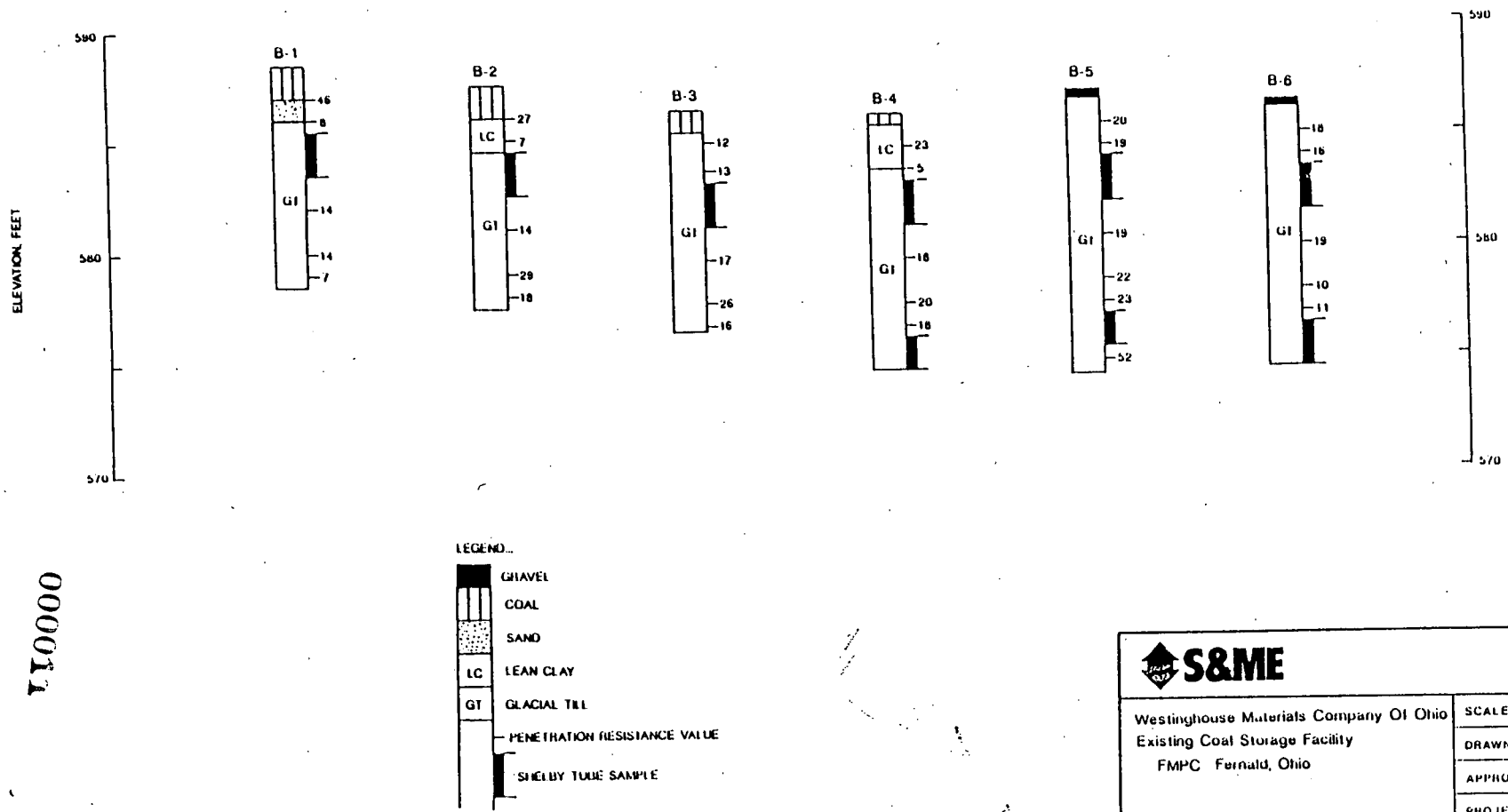
- SOIL BORING
- CATCH BASIN

S&ME — CINCINNATI, OHIO

Westinghouse Materials Company Of Ohio Existing Coal Storage Facility FMPC Fernald, Ohio	SCALE: Not To Scale
	DRAWN BY: MAR
	APPROVED BY: RFR
	PROJECT NO: 4144-88-309
SOIL BORING PLAN	DATE: July 1988 — FIGURE: 1

000010

5548



S&ME CINCINNATI, OHIO

Westinghouse Materials Company Of Ohio
Existing Coal Storage Facility
FMPC Fernald, Ohio

SOIL BORING PROFILES

SCALE: As Shown
DRAWN BY: MAR
APPROVED BY: RFR
PROJECT NO: 4144-88-309
DATE: August 1988
FIGURE: 2

554 8

000011

CORRELATION OF PENETRATION RESISTANCE WITH RELATIVE DENSITY AND CONSISTENCY

	Penetration Resistance (1) (blows/ft.)	Relative Density
Sand and/or Gravel	0 to 4	Very loose
	5 to 10	Loose
	11 to 30	Medium dense
	31 to 50	Dense
	Over 50	Very dense
		Consistency
Silts and Clays	0 to 2	Very soft
	3 to 4	Soft
	5 to 8	Medium stiff
	9 to 15	Stiff
	16 to 30	Very stiff
	31 to 50	Hard
	Over 50	Very hard

(1) ASTM D 1586-74

A 2" outside diameter by 1-3/8" inside diameter split barrel sampler is driven 18" with a 140 pound hammer falling 30". The number of blows required for each 6" of penetration is recorded. The sum of the blows required for the final 12" of penetration is the Standard Penetration Resistance.

RECORD OF BORING NO. 2

Client: Westinghouse Materials Company of Ohio

Page: 1 of 1

Project: Existing Coal Storage Facility

Project No.: 4144-88-309

Boring Location: S1112 E4484

Elev. (ft.)	Depth (ft.)	Description	Sample No.	pH	Sample Depth (ft.)	Sample Type	Blows per 6"	Recovery (in.)
587.5	0.0							
		Coal	1	5.9	0.0-1.0	SS	19-19-8	12
586.0	1.5							
		Brown and gray lean clay with coal, moist - medium stiff	2	2.3	2.0-3.0	SS	3-4	12
584.5	3.0							
		Brown sandy lean clay, moist - very stiff to hard (glacial till)	3ST		3.0-5.0	ST	-----	18
			4	5.6	5.0-6.5	SS	4-6-8	18
			5	8.3	7.0-8.5	SS	11-12-17	18
			6	6.2	9.0-10.0	SS	8-10	2
577.5	10.0							
		Boring terminated at 10.0 ft.						

Dates Drilled: 7-26-88

Driller: J. Jones

Water Depth: Initial: None

Days after Completion:

Days after Completion:

Drilling Method: 4-1/4" I.D. Hollow-Stem Augers

Westinghouse Environmental Engineering
Cincinnati, Ohio

Environmental Engineering is a division of S&ME, Inc., a Westinghouse Electric Corporation subsidiary

5548

RECORD OF BORING NO. 3

Client: Westinghouse Materials Company of Ohio

Project: Existing Coal Storage Facility

Project No.: 4144-88-309

Boring Location: S1212 E4522

Elev. (ft.)	Depth (ft.)	Description	Sample No.	pH	Sample Depth (ft.)	Sample Type	Blows per 6"	Recovery (in.)
586.3	0.0							
		Coal	1	6.6	0.0-1.5	SS	4-4-8	18
585.3	1.0							
		Brown sandy lean clay,	2	6.8	2.0-3.0	SS	6-7	12
		moist - very stiff to	3ST		3.0-5.0	ST	-----	18
		hard (glacial till)	4	8.9	5.0-6.5	SS	7-8-9	18
			5	6.8	7.0-8.5	SS	6-11-15	18
577.3	9.0							
		Gray lean clay with sand,	6	7.0	9.0-10.0	SS	6-10	12
		moist - very stiff						
		(glacial till)						
576.3	10.0							
		Boring terminated at 10.0 ft.						

Dates Drilled: 7-26-88

Driller: J. Jones

Water Depth: Initial: None

Days after Completion:

Days after Completion:

Drilling Method: 4-1/4" I.D. Hollow-Stem Augers

Westinghouse Environmental Engineering
Cincinnati, Ohio

000014

RECORD OF BORING NO. 4

Client: Westinghouse Materials Company of Ohio

Page: 1 of 1

Project: Existing Coal Storage Facility

Project No.: 4144-88-309

Boring Location: S1356 E4522

Elev. (ft.)	Depth (ft.)	Description	Sample No.	pH	Sample Depth (ft.)	Sample Type	Blows per 6"	Recovery (in.)
586.2	0.0							
		Coal	1	6.4	0.0-1.0	SS	13-13-10	12
585.7	0.5							
		Dark gray sandy lean clay with coal chips, moist - medium stiff	2	6.4	2.0-3.0	SS	2-3	2
583.7	2.5							
		Brown lean clay with sand, moist - very stiff (glacial till)	3ST		3.0-5.0	ST	-----	24
			4	7.1	5.0-6.5	SS	5-8-10	18
			5	7.2	7.0-8.5	SS	5-8-12	24
			6	7.1	9.0-10.0	SS	6-12	12
			7ST		10.0-10.5	ST	-----	6
			8ST		11.0-11.5	ST	-----	0
574.7	11.5							
		Auger refusal at 11.5 ft.						
		Boring terminated at 11.5 ft.						

Dates Drilled: 7-27-88

Driller: J. Jones

Water Depth: Initial: None

Days after Completion:

Days after Completion:

Drilling Method: 4-1/4" I.D. Hollow-Stem Augers

Westinghouse Environmental Engineering
Cincinnati, Ohio

5548

RECORD OF BORING NO. 5

Client: Westinghouse Materials Company of Ohio

Project: Existing Coal Storage Facility

Project No.: 4144-88-309

Boring Location: S1481 E4518

Elev. (ft.)	Depth (ft.)	Description	Sample No.	pH	Sample Depth (ft.)	Sample Type	Blows per 6"	Recovery (in.)
586.8	0.0							
		Gravel	1	6.6	0.0-1.0	SS	8-8-12	12
586.5	0.3							
		Brown sandy lean clay, slightly moist - very stiff	2	6.6	2.0-3.0	SS	7-12	12
581.8	5.0							
		Brown sandy lean clay, moist - very stiff to very hard (glacial till)	3ST		3.0-5.0	ST	-----	12
			4	6.9	5.0-6.5	SS	5-8-11	18
			5	7.2	7.0-8.5	SS	10-9-13	18
			6	7.0	9.0-10.0	SS	11-12	12
			7ST		10.0-11.5	ST	-----	0
			8		11.5-12.5	SS	25-27	12
574.3	12.5							
		Boring terminated at 12.5 ft.						

Dates Drilled: 7-26-88

Driller: J. Jones

Water Depth: Initial: None

Days after Completion:

Days after Completion:

Drilling Method: 4-1/4" I.D. Hollow-Stem Augers

Westinghouse Environmental Engineering
Cincinnati, Ohio

Environmental Engineering is a division of S&ME, Inc., a Westinghouse Electric Corporation subsidiary

RECORD OF BORING NO. 6

Client: Westinghouse Materials Company of Ohio

Project: Existing Coal Storage Facility

Project No.: 4144-88-309

Boring Location: S1481 E4442

Elev. (ft.)	Depth (ft.)	Description	Sample No.	pH	Sample Depth (ft.)	Sample Type	Blows per 6"	Recovery (in.)
586.6	0.0							
		Gravel						
586.3	0.3							
		Brown lean clay with sand and coal, moist - very stiff	1	8.2	0.0-1.0	SS	6-6-12	12
584.6	2.0							
		Brown sandy lean clay, moist - very stiff (glacial till)	2	6.4	2.0-3.0	SS	5-11	12
			3ST		3.0-5.0	ST	-----	12
			4	7.0	5.0-6.5	SS	10-10-9	18
			5	7.1	7.0-8.5	SS	4-5-5	18
			6	7.0	9.0-10.0	SS	4-7	12
576.6	10.0							
		Gray sandy lean clay, moist - very stiff (glacial till)	7ST		10.0-12.0	ST	-----	24
574.6	12.0							
		Boring terminated at 12.0 ft.						

Dates Drilled: 7-26-88

Driller: J. Jones

Water Depth: Initial: None

Days after Completion:

Days after Completion:

Drilling Method: 4-1/4" I.D. Hollow-Stem Augers

Westinghouse Environmental Engineering
Cincinnati, Ohio

CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES
ASTM Designation: D 2487 – 85
(Based on Unified Soil Classification System)

5548

		Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A]		Soil Classification: Group Symbol	Soil Classification: Group Name[B]
Coarse-Grained Soils More than 50 % retained on No. 200 sieve	Gravels More than 50 % of coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5 % fines[C]	Cu ≥ 4 and 1 ≤ Cc ≤ 3[E]	GW	Well-graded gravel[F]
			Cu < 4 and/or 1 > Cc > 3[E]	GP	Poorly graded gravel[F]
		Gravels with Fines More than 12 % fines[C]	Fines classify as ML or MH	GM	Silty gravel[F,G,H]
			Fines classify as CL or CH	GC	Clayey gravel[F,G,H]
	Sands 50 % or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5 % fines[D]	Cu ≥ 6 and 1 ≤ Cc ≤ 3[E]	SW	Well-graded sand[I]
			Cu < 6 and/or 1 > Cc > 3[E]	SP	Poorly graded sand[I]
		Sands with Fines More than 12 % fines[D]	Fines classify as ML or MH	SM	Silty sand[G,H,I]
			Fines classify as CL or CH	SC	Clayey sand[G,H,I]
Fine-Grained Soils 50 % or more passes the No. 200 sieve	Silts and Clays Liquid limit less than 50	inorganic	PI > 7 and plots on or above "A" line[J]	CL	Lean clay[K,L,M]
			PI < 4 or plots below "A" line[J]	ML	Silt[K,L,M]
		organic	$\frac{\text{Liquid limit – oven dried}}{\text{Liquid limit – not dried}} < 0.75$	OL	Organic clay[K,L,M,N] Organic silt[K,L,M,O]
	Silts and Clays Liquid limit 50 or more	inorganic	PI plots on or above "A" line	CH	Fat clay[K,L,M]
			PI plots below "A" line	MH	Elastic silt[K,L,M]
		organic	$\frac{\text{Liquid limit – oven dried}}{\text{Liquid limit – not dried}} < 0.75$	OH	Organic clay[K,L,M,P] Organic silt[K,L,M,Q]
Highly organic soils		Primarily organic matter, dark in color, and organic odor		PT	Peat

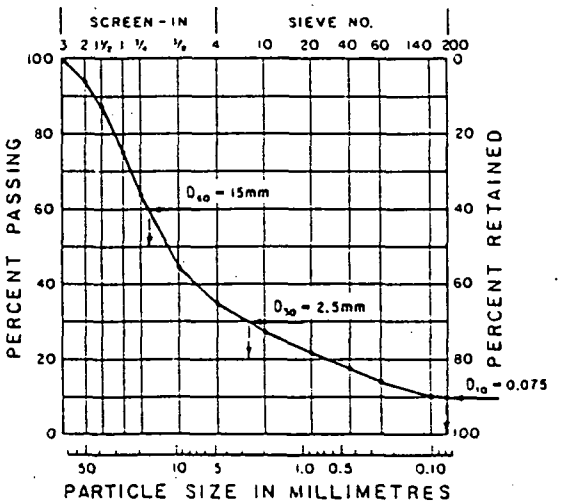
[A] Based on the material passing the 3-in. (75-mm) sieve.
[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
[C] Gravels with 5 to 12 % fines require dual symbols:
GW-GM well-graded gravel with silt
GW-GC well-graded gravel with clay
GP-GM poorly graded gravel with silt
GP-GC poorly graded gravel with clay
[D] Sands with 5 to 12 % fines require dual symbols:
SW-SM well-graded sand with silt
SW-SC well-graded sand with clay
SP-SM poorly graded sand with silt
SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

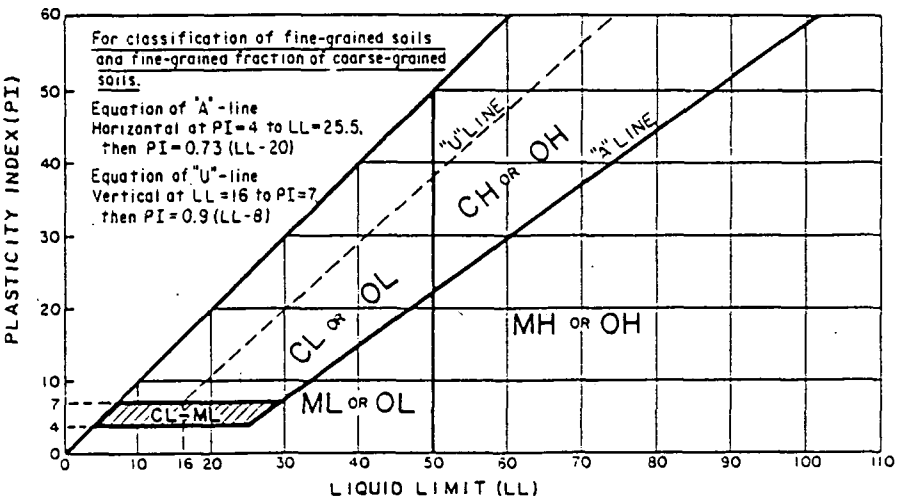
[F] If soil contains ≥ 15 % sand, add "with sand" to group name.
[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.
[H] If fines are organic, add "with organic fines" to group name.
[I] If soil contains ≥ 15 % gravel, add "with gravel" to group name.
[J] If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29 % plus No. 200, add "with sand" or "with gravel," whichever is predominant.
[L] If soil contains ≥ 30 % plus No. 200, predominantly sand, add "sandy" to group name.
[M] If soil contains ≥ 30 % plus No. 200, predominantly gravel, add "gravelly" to group name.
[N] PI ≥ 4 and plots on or above "A" line.
[O] PI < 4 or plots below "A" line.
[P] PI plots on or above "A" line.
[Q] PI plots below "A" line.

SIEVE ANALYSIS



$Cu = \frac{D_{60}}{D_{10}} = \frac{15}{0.075} = 200$ $\quad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}} = \frac{(2.5)^2}{0.075 \times 15} = 5.6$



S&ME

WESTINGHOUSE ENVIRONMENTAL ENGINEERING
LABORATORY TEST RESULTS

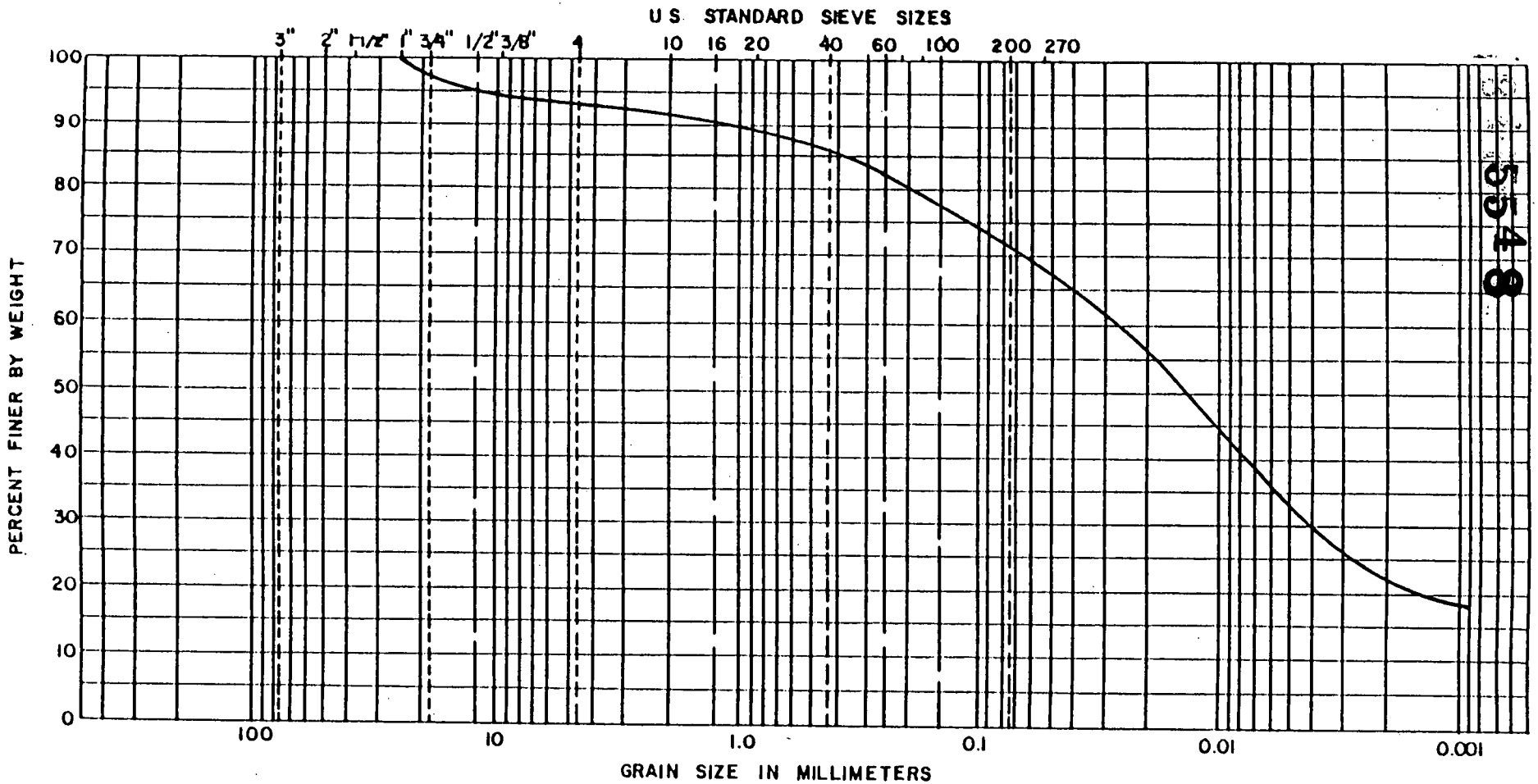
CLIENT: Westinghouse Materials Company of Ohio
PROJECT: Existing Coal Storage Facility
PROJECT NO: 4144-88-309

Boring No.	Sample No.	Depth (ft.)	Moisture Content %	Atterberg Limits LL %	PL %	PI %	Grain Size Analysis Gravel %	Sand %	Silt %	Clay %	Unit Weight Wet (pcf)	Dry (pcf)	Permeability (cm/sec)
B-1	ST1	3.0-5.0	15	27	17	10	7	21	51	21	135	118	8.0×10^{-8}
B-2	2	2.0-3.0		41	19	22	0	8	53	39			
	ST2	3.0-5.0	16								131	113	3.8×10^{-8}
B-3	ST3	3.0-5.0	18								132	112	6.2×10^{-8}
B-4	ST4	3.0-5.0	14								135	118	4.9×10^{-8}
	ST5	10.0-12.0	10								141	120	5.0×10^{-8}
B-5	ST6	3.0-5.0	N.A.										N.A.
	ST7	10.0-12.0	N.A.										N.A.
B-6	ST8	3.0-5.0	16								123	105	5.7×10^{-8}
	ST9	10.0-12.0	13								139	123	2.8×10^{-8}

N.A. - Permeability test not run due to excessive sample disturbance

554 8

DUNCAN-PARNELL, INC., RALEIGH 867 919-833-4977



BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO.	ELEV./DEPTH	NAT. WC	L.L.	PL	PI	DESCRIPTION OR CLASSIFICATION
B-1	3.0-5.0	15	27	17	10	Lean clay with sand (CL) (Glacial Till)

JOB NO. 4144-88-309

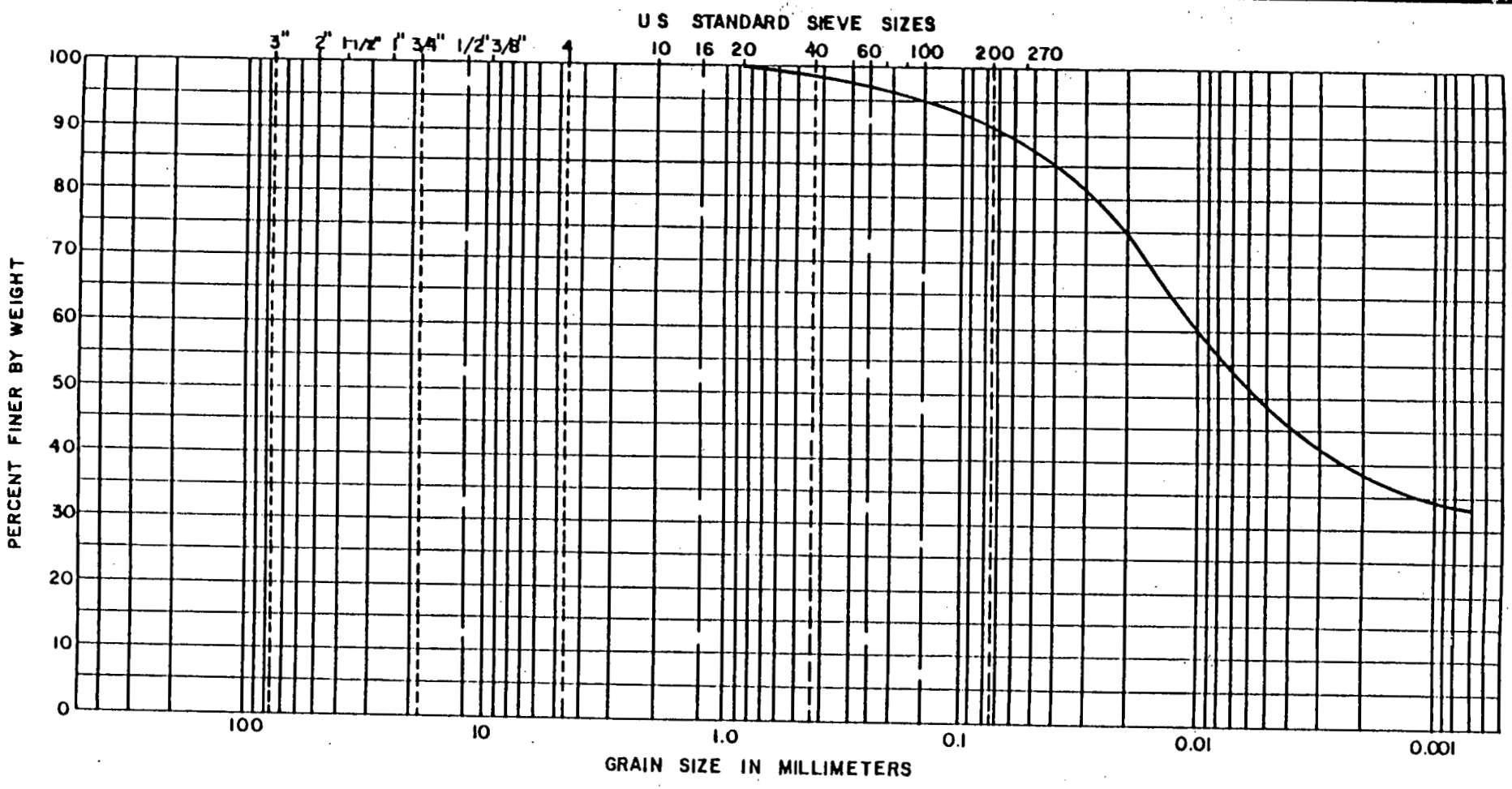
GRAIN SIZE DISTRIBUTION

S&ME

SM23-02

000020

DUNCAN-PARNELL, INC., RALEIGH 867 919-833-4077



BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO.	ELEV./ DEPTH	NAT. WC	L.L.	PL	PI	DESCRIPTION OR CLASSIFICATION
B-2	2.0-3.0'	NA	41	19	22	Lean clay (CL)

JOB NO. 4144-88-309

GRAIN SIZE DISTRIBUTION

S&ME

554

SM23-02