Commonwealth Edison
One First National Plaza, Chicago, Illinois
Address Reply to: Post Office Box 767
Chicago, Illinois 60690

April 21, 1983

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Subject: Braidwood Station Units 1 and 2
Additional FSAR Information
NRC Docket Nos. 50-456/457

References (a): B. J. Youngblood letter to L. O. DelGeorge dated January 14, 1983

(b): B. J. Youngblood letter to L. O. DelGeorge dated February 1, 1983

Dear Mr. Denton:

The above References requested that the Commonwealth Edison Company provide certain additional information concerning our FSAR for Braidwood Station Units 1 and 2.

The Attachment to this letter provides our response to Questions 241.6, 241.8, 362.4 and 362.5. Our FSAR will be amended to include the information contained in the Attachment to this letter as appropriate.

Please address any questions that you or your staff may have concerning this matter to this office.

One (1) signed original and fifteen (15) copies of this letter with Attachment are provided for your use.

Very truly yours,

E. Douglas Swartz

E. Douglas Swartz
Nuclear Licensing Administrator

Attachment

cc: J. G. Keppler - RIII
RIII Inspector - Braidwood

B001

6150N

QUESTION 241.6

"Provide the following information for the seismic Category I Essential Service Water Supply and discharge pipe lines:

"(1) Provide a longitudinal subsoil profile along the ESW pipelines from the Lake Screen House to the plant and from the plant to the Discharge Outlet structure. Show the zones of soft material and/or loose material, if any, which were replaced by competent material during construction.

"(2) Provide transverse cross-sections showing excavation limits and complete details of placement of backfill materials such as concrete, bash*and other backfill materials.

"(3) Show details of placement of backfill near the connection between pipes and structures. What are the estimates total and differential settlements of these points?

"(4) Discuss the potential for liquefaction of the in situ material beneath and surrounding the seismic Category I buried pipes (Essential Services Water Supply and Discharge pipes).

"(5) Seismic Category I Essential Service Water Supply pipe (ESWS) and non-safety related Circulating Water Supply pipe are buried in a common trench. If the circulating water supply size breaks as a result of an SSE event, evaluate its effect on the potential for liquefaction of the material surrounding the ESWS pipe.

"(6) Provide quantitative and procedural details of the dynamic analysis of the seismic Category I buried piping. How are the static and dynamic properties of the in situ soils, bash*and structural fill considered in the analyses? How is the site amplification effect considered in your analysis?"

"'*Lean Concrete'"

RESPONSE

(1) A discussion of the excavation and backfilling of the essential service cooling water pipelines is included

in Subsection 2.5.4.5.4. Details of the pipeline subgrade and type of backfill are provided. A soil profile along the pipelines between the plant and lake screen house is given in Figure 2.5-25.

Table Q241.6-1 presents a complete summary, by pipeline location, of the pipeline subgrade and backfill conditions. As stated in the table, all pipelines are founded on either compacted granular fill in the main plant excavation or on Wedron silty clay till from the main plant to the screen house and discharge structure. The pipelines were either encased in lean concrete or bash and/or backfilled with compacted granular fill. The granular fill was compacted to 85% minimum relative density to top of pipes, concrete, or bash and minimum 80% above to grade.

The only zones of soft or loose subgrade material that were found, occurred because some excavations were left open during the fall and winter of 1978 exposing the till to weathering. Since the pipeline had already been placed prior to exposure of the subgrade to winter conditions, a revised method of pipeline support not requiring pipeline removal was employed. Subsection 2.5.4.5.4.1 discusses this area in detail.

(2) Table Q241.6-1 summarizes details of pipeline subgrade and backfill materials. Exact excavation limits and cross-sections are not provided.

(3) The ESW pipelines connect with the main building, lake screen house, and the ESW discharge structure. At the main building interface, the ESW pipelines are encased in reinforced concrete and travel beneath the heater bay foundation surrounded by compacted granular fill and enter the turbine room base mat. The point of maximum differential settlement occurs as the encased pipeline enters the turbine room mat. The pipeline has been designed to take with adequate margin the 1/2-inch estimated differential settlement. Total and differential settlement of the main building has been discussed in detail in the response to Question 362.1.

At the lake screen house interface, the ESW pipes are founded on till and encased in bash. The total and differential settlements expected are that for the lake screen house (1/4 and 1/8 inch, respectively), and are discussed in Subsection 2.5.4.10.2.1. Design of the ESW pipelines is discussed in more detail in response to part 6 of this question.

At the ESW discharge structure interface, the discharge pipes are encased in lean concrete and backfilled with granular fill to minimum 85% relative density. Cross-sections are given in Figure Q362.8-1. Backfill has been discussed in response to Question 241.4. Settlement is expected to be negligible since the structure and pipeline are supported on Wedron silty clay till. See the response to Question 241.4 for further discussion of the ESW discharge structure.

(4) The ESW pipelines are either founded on Wedron glacial till or compacted granular fill within the main plant excavation. The pipelines are backfilled with bash, concrete, or compacted fill. The compacted fill was placed to a minimum 85% relative density. The glacial till and compacted fill are not susceptible to liquefaction. For further discussion, see Subsection 2.5.6.5.2 on liquefaction potential and the response to Question 241.7.

(5) The ESWS pipelines are founded on Wedron silty clay till and are backfilled with bash to the top of the pipes. Figure 2.5-25 shows a profile along the pipeline alignment. The top of the till is above the top of the pipes in most areas and in all cases is above the pipe centerline. The till and bash will nto erode if the circulating water supply pipes should break.

(6) Quantitiative and Procedural Details of the Dynamic Analysis of the Seismic Category I Buried Piping

The methodology used to perform the dynamic analysis of the seismic Category I buried piping is described in the response to Question 130.33.

The variability of the supporting soil strata has been accounted for in the dynamic analysis by conservatively choosing the design particle velocity and the apparent shear wave velocity. The static properties of the in situ soil and compacted fill have been accounted for by conservatively choosing the modulus of subgrade reaction.

TABLE Q241.6-1

ESSENTIAL SERVICE WATER PIPES - SUBGRADE AND BACKFILL CONDITIONS

PIPELINE LOCATION	SUBGRADE	BACKFILL
C line turbine wall at 31+35 S, 43+90 E to 33+06.5 S (4 pipes)	Pipeline subgrade consisted of medium-fine sand backfill compacted to 85% RD within main plant excavation.	Medium-fine sand to top of piping compacted to 85% RD (min). Above pipe backfill compacted to 80% RD (min) also sand.
33+06.5 S to 33+92.5 S (4 pipes)	Pipeline subgrade consisted of medium-fine sand backfill compacted to 85% RD within main plant excavation.	Encased in concrete backfilled with medium-fine sand and compacted to 85% RD min. to top of concrete and 80% RD min. above concrete.
33+92.5 S to 37+50 S (4 pipes)	Pipeline subgrade consisted of medium-fine sand backfill compacted to 85% RD within main plant excavation.	Medium-fine sand to grade. Compacted to 85% RD min. to top of pipes & 80% RD min. above pipes.
37+50 S to 49+20 S (4 pipes)	Wedron Silty Clay Till FSAR 2.5.4.5.1 Figs. 2.5-16 & 2.5-25	Pipes encased in Bash. Bash encasement backfilled to grade to 80% RD min.
49+20 S to 50+90 S (Screenhouse) (2 pipes)	Wedron Silty Clay Till FSAR 2.5.4.5.1 Figs. 2.5-16 & 2.5-25	Pipes encased in Bash and backfilled to grade to 80% RD min.
49+20 S to 51.06 S (2 pipes)	Wedron Silty Clay Till FSAR 2.5.4.5.1 Figs. 2.5-16 & 2.5-25	Pipes encased in Bash and backfilled to grade to 80% RD min.
51.06 S to 51.14 S (2 pipes)	Wedron Silty Clay Till FSAR 2.5.4.5.4.1 & Fig. 2.5-16 & 2.5-25	Bash encasement and backfilled with sand compacted to 80% RD min.
51.14 S to 52+00 S (2 pipes)	Wedron Silty Clay Till FSAR 2.5.4.5.4.1 & Fig. 2.5-16 & 2.5-25	Bash encasement and backfilled with sand to 80% RD min.
52+00 S to 81+17.25 S (within ESCP to ESWDS)	Pipeline encasement supported on pads founded on Wedron Silty Clay Till - 2.5.4.5.4.1	Encased in lean concrete. Backfilled with sand to 85% min. RD.

QUESTION 241.8

"Provide cross section details of the interior dike located west of the ESCP. Present the results of the static and dynamic stability analyses performed. Investigate if a flow-type of failure of this dike would deposit material in the ESCP thereby effecting its capacity."

RESPONSE

Cross-section details of the interior dike located west of the ESCP are given as Section 18 in Figure 2.4-35. Plan view of the interior dike west of the ESCP is given in Figure 2.4-28. The toe of the interior dike at elevation 590 feet is located approximately 80 feet west of the top of the ESCP slope.

The static and dynamic stability analyses for the interior dike are summarized in Table Q241.8-1.

The interior dike is not a Category I structure and was not designed for SSE loading.

The effect of failure of the interior dike on the ESCP was investigated by conservatively assuming that the entire failure slip circle of soil is deposited downstream beginning at the interior dike toe. This surcharge of failed soil will remain 50 feet or more away from the top of the ESCP slope and thereby not act as a critical surcharge at the head of the ESCP slope.

In the unlikely event that material from a failed portion of the interior dike did enter the ESCP, the volume of soil is so small that it would have an insignificant effect on the operation of the ESCP.

TABLE Q241.8-1

SUMMARY OF STATIC AND DYNAMIC

STABILITY ANALYSES FOR INTERIOR DIKE

LOADING CONDITIONS	MINIMUM FACTOR OF SAFETY PROVIDED
a. Static Loading Conditions	
1. End of Construction - no water	2.0
2. Full Reservoir - Water Elevation 595 feet	1.9
3. Rapid Drawdown - Water Reduced from Elevation 595 feet to 592 feet	1.3
b. Pseudostatic Loading Conditions with 0.12 Seismic Coefficient	
1. End of Construction - no water	1.3
2. Full Reservoir - Water Elevation 595 feet	1.2
3. Rapid Drawdown Water Reduced from Elevation 595 feet to 592 feet	0.8

path of higher permeability than the remainder of the Equality Formation. Therefore, the methods of seepage analyses and analysis conditions discussed in Subsections 2.5.6.6.1 and 2.5.6.6.2 are valid as this seepage path does not exist.

As a result of NRC staff comments on the above response, (letter dated February 1, 1983, from B. J. Youngblood to L. O. DelGeorge), additional information is provided. Refer to the response to Question 362.5.

QUESTION 362.5

"In your analysis, the critical condition for maximum seepage from the ESCP assumes that the level of water in the pond is at elevation 590.0 feet and the level of water outside the pond is at elevation 580.0 feet. However, the lowest water level recorded in piezometer LW-2, close to ESCP, is at elevation 577.5 feet (Figure 2.4-45). Using this as the level of water outside ESCP, the differential head causing seepage is 12.5 feet rather than the 10.0 feet used in your analysis. What is the rationale for using ten feet differential head in your seepage analysis?"

RESPONSE

The median groundwater level for the period from July 1973 through May 1977 for LW-2 is 580.1 feet, MSL, which supports the head differential of 10 of 10 feet used in ESCP seepage analysis.

As a result of NRC staff comments on the above response and the response to Question 362.4, (letter dated February 1, 1983, from B. J. Youngblood to L. O. DelGeorge), additional information is provided below.

1. Aquifer Description

In our earlier response, it was stated that "the Equality Formation is composed primarily of fine to medium grained sands with some silt layers." This statement was made based on review of all the soil samples at the project site. Review of the essential service cooling pond borings, HS-1 through HS-18, and H-1 through H-4, and available grain size analyses indicates that the Equality Formation beneath the ESCP consists of dense to very dense, silty fine sands (SM) to fine sand (SP and/or SP-SM). Figures 2.5-84, 2.5-94, and 2.5-118 present grain size curves for these soils.

It was stated in our earlier response that "in some borings and mapped sections, a 1 to 4 foot thick layer of coarse gravel, cobbles, and boulders in a fine to medium grained sand matrix occurs directly above the clay till of the Wedron Formation." For clarification, the thickness of the gravel and cobbles was not 1 to 4 feet, but were contained within a 1 to 4 foot thick layer of fine sand, silty sand, and/or clayey sand. For instance, the geologic Section 23 referred to in the question, contains reference to two 4 to 6 inch layers of

fine to coarse gravel near the bottom with 1 to 2 inch of lag gravel at the bottom.

Based on the review of logs of borings drilled in or near the ESCP, no borings reveal a 1 to 4 foot thick layer of coarse gravel, cobbles, or boulders within the Equality Formation. Only boring HS-14 indicated the presence of a thin gravel layer approximately 0.4 foot thick directly above the clay till layer. Boring H-1 located 800 feet east of the ESCP indicated a lag gravel layer within the Wedrom till formation beneath a 3.5 foot thick layer of silty clay till.

Six additional borings DSS-1 and DSS-66 through DSS-70 were drilled near the ESCP. There locations are shown in Figure 2.5-90. Logs of these borings are shown in Figures Q362.4-1 through Q362.4-6. All of these borings show the lag gravel within the Wedron Formation and in most cases within a silty clay matrix.

In summary, review of the ESCP borings, including the six additional borings, conclusively show that a layer of coarse gravels, cobbles, and/or boulders does not exist in the Equality Formation beneath the ESCP and in most cases, the gravel that is encountered is found within the Wedron Formation in a silty clay matrix or beneath a layer of silty clay till.

2. Aquifer Thickness

The seepage analyses for the ESCP are based on an aquifer thickness of 13 feet below elevation 584 feet. Based on the review of HS-series, DSS-1 and DSS-66 through DSS-70 borings, the thickness of the aquifer below elevation 584 feet in the ESCP area, in general, varies from 0.3 feet to 11.5 feet with few exceptions. Boring DSS-69 indicates a thickness of 13.1 feet and boring HS-5 indicates a thickness of 16.5 feet. The average thickness of the sand layer is approximately 9 feet. See Figure 2.5-93 for profiles within the ESCP.

Therefore, the seepage analysis based on a 13-foot thick layer of aquifer is very conservative with respect to the actual average of in situ conditions.

3. Coefficient of Permeability (k) Values

It was reported in an earlier response that "the k values of SP and SM material ranged from 7.37×10^{-2} cm/sec to 3.658×10^{-4} cm/sec with an average permeability of approximately 6.7×10^{-3} cm/sec." These values are based on all the available laboratory data on permeability. However, if the soil samples obtained from the borings drilled in the ESCP area only are

considered, which is more representative, the k values for SP and/or SM materials range from 10.0×10^{-3} cm/sec to 8.0×10^{-4} cm/sec and averages 4.3×10^{-3} cm/sec. These permeability values for the ESCP area are given in Table Q362.5-1.

The laboratory permeability values for the HS series borings are constant head permeability tests on relatively undisturbed samples. The samples were obtained using an Osterberg sampler and the tube was fitted to a permeameter.

The laboratory k values were compared with k values estimated from the grain size distribution of selected soil samples. Permeability values were estimated based on: (a) D_{10} size using the Allen Hazens formula; (b) D_{10} size and uniformity coefficient C_u; and, (c) D_{20} size using the United States Bureau of Soil Conservations (USBSC) formula. The first two emprical relations are based on the laboratory test results. The Braidwood laboratory test results are within the range of these estimated values. The third empirical relation, USBSC's formula, yields the best correlation with coefficients of permeability based on pumping tests. The estimated k values based on this empirical relationship are lower (i.e., empervious) than that of the Braidwood laboratory test results. Comparison k values discussed here are reported in Table Q362.5-1.

The seepage analysis reported in Subsection 2.5.6.6.2 used an average value of coefficient of permeability equal to 6×10^{-3} cm/sec which is conservative with respect to the average value obtained for the ESCP from laboratory samples.

4. Boundary Conditions

In our seepage analysis the downstream exit point is approximately 380 feet from the bottom edge of the ESCP, which approximately corresponds to the nearest mine spoil. The hydraulic head with respect to the water level at the exit point is 6 feet based on boring logs drilled before construction of the cooling lake. However, a 10-foot head was used in the analysis. This head and the shortest exit point have yielded a higher gradient than actually existed resulting in higher quantity of seepage.

The lowest water level recorded in piezometer LW-2, close to the ESCP, is at elevation 577.5 feet. The hydraulic head in the ESCP with respect to this lowest water level is 12.5 feet. However, the shortest distance between the bottom edge of the ESCP and the piezometer LW-2 is approximately 4,700 feet. This corresponds to a much lower hydraulic gradient than that of the one used in our analysis. Therefore, the

seepage analysis reported in the FSAR is on the conservative side.

The north and west sides of the ESCP are located close to the perimeter dike of the cooling lake. See Figures 2.4-26 through 2.4-29. The perimeter dike has a slurry trench installed from elevation 597 feet to the top of the Wedron till and in most cases keyed into till. The trench is a soil-bentonite backfilled trench and will significantly reduce the amount of seepage from the ESCP even if the cooling lake dike fails. The seepage analysis reported in the FSAR assumes this slurry trench does not exist and is therefore conservative. See the response to Question 241.4 for more details on the slurry wall.

5. Summary

The seepage analysis presented in the FSAR is conservative for the following reasons:

a. Aquifer thickness used in analysis is 4 feet greater than the average thickness determined from the ESCP borings.

b. The gradient used in the analysis is higher than the actual gradient than existed before lake filling. In the event of a cooling lake failure, the ground at elevation 590 will remain saturated for some time. Any hydraulic gradient which may be established away from the ESCP will develop very slowly due to gravity drainage of the fine sands. Since seepage through these sands has been cut off by a slurry trench installed around the entire perimeter of the cooling lake, there sould be no hdyraulic gradient established. Photographs of the ESCP have documented that after the slurry trench was installed the ESCP remained under groundwater before the cooling lake was filled. The seepage analysis performed asumed no presence of a slurry trench cutoff and instantaneous development of a hydraulic gradient greater than anticipated or measured at any location prior to construction of the cooling lake. These factors are extremely conservative.

c. The coefficient of permeability used in the analysis is representative of the sands of the Equality Formation. It has been shown that it compares well with correlations using grain size and correlations developed using pumping tests.

As requested, an additional seepage analysis has been performed using more conservative coefficients of

permeability. The coefficients of permeability in the vertical direction and horizontal direction are 6.7×10^{-3} cm/sec and 2.0×10^{-2} cm/sec, respectively. The differential head used is again 10 feet which has been shown to be very conservative. Again the seepage was determined assuming the slurry trench does not exist. Results indicate that the drop in elevation of the ESCP due to seepage over a 30-day period is approximately 1.5 feet. This seepage drop combined with loss due to evaporation of approximately 1 foot gives a total drop of 2.5 feet or to elevation 587.5 feet. The pond surface area at elevation 587.5 is 95.4 acres based on an October 1981 hydrographic survey of the ESCP. The 95.4 acres is equal to or greater than the design area at elevation 590 feet as shown in Figure 9.2-8. Additional discussion concerning the hydrographic survey is given in response to Question 371.19.

The analysis and discussions above clearly show that the seepage analysis is conservative and that the ESCP has ample supply of cooling water for the 30-day period.

TABLE Q362.5-1

SUMMARY OF PERMEABILITY VALUES

Boring Number	Sample Number	Sample Depth (ft)	USCS	γ_d (pcf)	D_{10} (mm)	D_{20} (mm)	-#200 (%)	C_u	k (cm/sec) See Note 1	See Note 2	See Note 3	See Note 4	Remarks
HS-2	1	4.1	ML	99.0	0.019	0.035	83	2.84	1.4×10^{-3}	-	-	-	
	2	8.0	SM	105.8	-	-	27	-	1.9×10^{-3}	-	-	-	
	3	14.0	SM	99.9	-	0.074	19	-	4.1×10^{-3}	-	-	0.9×10^{-3}	
	4	19.0	SP	101.6	0.092	0.120	3	1.74	10.0×10^{-3}	8.5×10^{-3}	9.1×10^{-3}	2.7×10^{-3}	
HS-3	1	4.0	SM	98.7	-	0.075	19	-	2.6×10^{-3}	-	-	0.9×10^{-3}	
	2	9.0	SM	102.4	-	0.084	16	-	4.1×10^{-3}	-	-	1.2×10^{-3}	
	3	14.0	SP-SM	104.7	0.088	0.120	9	1.93	7.0×10^{-3}	7.7×10^{-3}	8.1×10^{-3}	2.7×10^{-3}	
	4	19.0	SP	104.1	0.149	0.170	3	1.68	8.0×10^{-3}	2.2×10^{-2}	2.4×10^{-2}	6.1×10^{-3}	
	5	24.0	SP	105.8	0.140	0.170	3	1.71	7.0×10^{-3}	2.0×10^{-2}	2.1×10^{-2}	6.1×10^{-3}	
	6	27.8	ML	113.1	0.004	0.011	72	-	2.4×10^{-3}	-		-	
HS-6	2	10.0	SM	106.5	-	≈0.070	22	-	2.0×10^{-3}			$\approx 0.8 \times 10^{-3}$	
H-1	8	20.5	SP					-	8.3×10^{-3}				
	12	35.5	GM						0.9×10^{-3}				See N:5
	13	38.0	GM						0.8×10^{-3}				See N:5
	14	40.5	GM						0.8×10^{-3}				See N:5
H-2	6	13.0	SP						5.6×10^{-3}				
	8	20.5	SP						4.7×10^{-3}				
H-3	14	37.0	GM						0.8×10^{-3}				See N:6
H-4	13	25.5	ML						2.6×10^{-6}				

NOTES (N:):

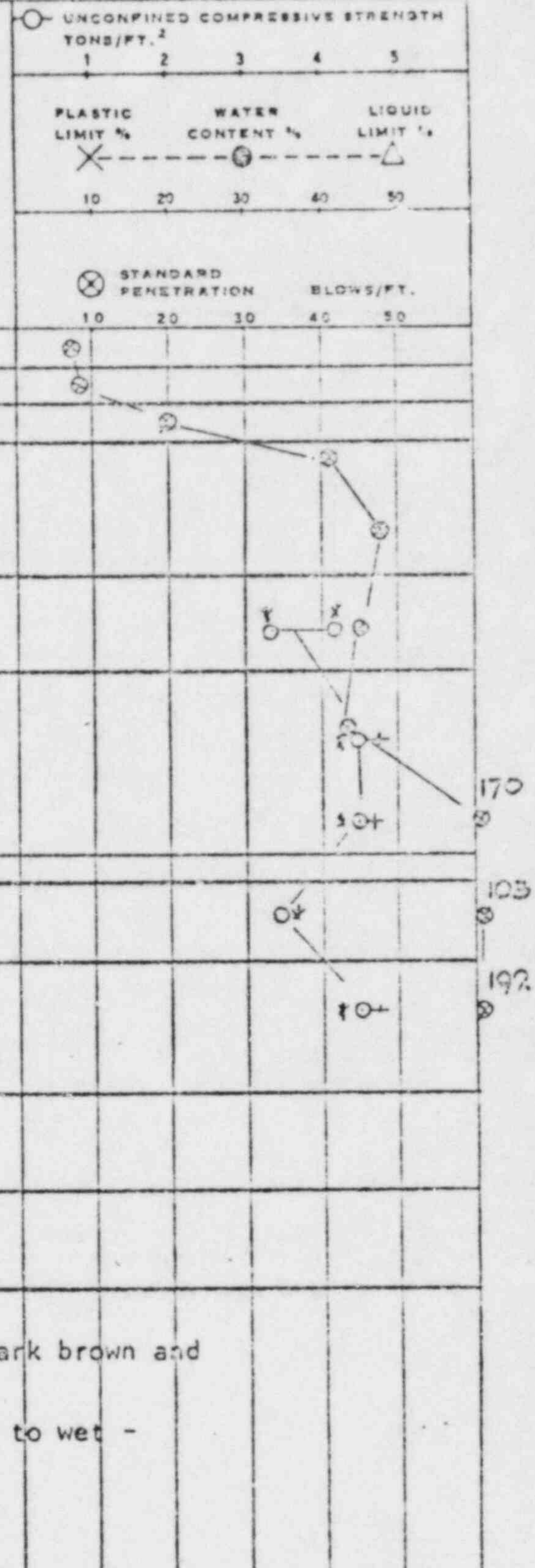
1. Laboratory k values are from the tests performed or relatively undisturbed samples.
2. k values based on Hazen's Formula, $k=100\ D_{10}^2$, cm/sec, where D_{10} in cm.
3. k values based on D_{10} (meters) and $C_u = D_{60}/D_{10}$. Reference: Beyer, W./Schweiger, "For the Determination of the Effective Porosity of Aquifers", Wasser Wirtsch, Wasser techn.19, No2., 1969, pp. 57-60.
4. k values based on D_{20} (mm), $k=0.36\ D_{20}^{2.3}$, cm/sec. Reference: Bialas, Z./Kleczkowski, A.S., "Practical Use of Certain Empirical Formulae to Determine Coefficient of Permeability k," Arch. Hydrotechn, vol.17, No.3, 1970, pp. 405-417.
5. The sample was obtained from the Wedron Formation till. The GM layer is overlain by 5 ft. of sand and 3.5 ft. of silty clay layer.
6. The sample was obtained from the Wedron Formation till. The GM layer is overlain by 11 feet of silt layer.

File 5.8.4.6

OWNER	LOG OF BORING NUMBER
Commonwealth Edison Co.	DSS-1
PROJECT NAME	**ARCHITECT-ENGINEER**
Braidwood Power Station	Sargent & Lundy, Engineers

SITE LOCATION: Braidwood, Illinois

ELEVATION / DEPTH	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL	UNIT DRY WT. LBS./FT.³
					SURFACE ELEVATION	
	1	SS			"A"	
	2	SS			"B"	
	3	SS			Silty sand, trace clay & roots - light gray & brown - medium dense - moist to wet (SM)	
	4	SS				
10.0	5	SS			Fine sand, trace silt - gray and brown - dense - wet - saturated (SP)	
	6	SS			Silty clay, trace sand and gravel - gray - very tough (CL)	
20.0	7	SS			Silty clay, trace to some sand, trace gravel - gray to gray & brown - hard (CL-ML)	
	8	SS			Boulders & cobbles, trace silt and clay - very dense (GP)	
30.0	9	SS			Silty clay, trace sand and gravel - brown & gray - very tough (CL)	
	10	SS			Clayey silt (loose siltstone) - gray - very dense - moist (ML-CL)	
40.0	Run 1	DB			Dark gray micaceous shale - weathered Recovery = 100%	
50.0	Run 2	DB			Dark gray micaceous shale - weathered Recovery = 88%	
					End of Boring "A": Fine sand, trace clay and silt - dark brown and gray - loose - moist (SP) "B": Sand and silt - gray brown - moist to wet - medium dense (SP-SM) 40' of 4" casing used.	



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES

WL 5.9' WS or WD	BORING STARTED	2-27-73
WL 3.5' BCR 5' ACR	BORING COMPLETED	2-27073
WL Cave-in @ 6' W.D. Cave-in @ 36' A.B.	RIG 10-A	FOREMAN DVB

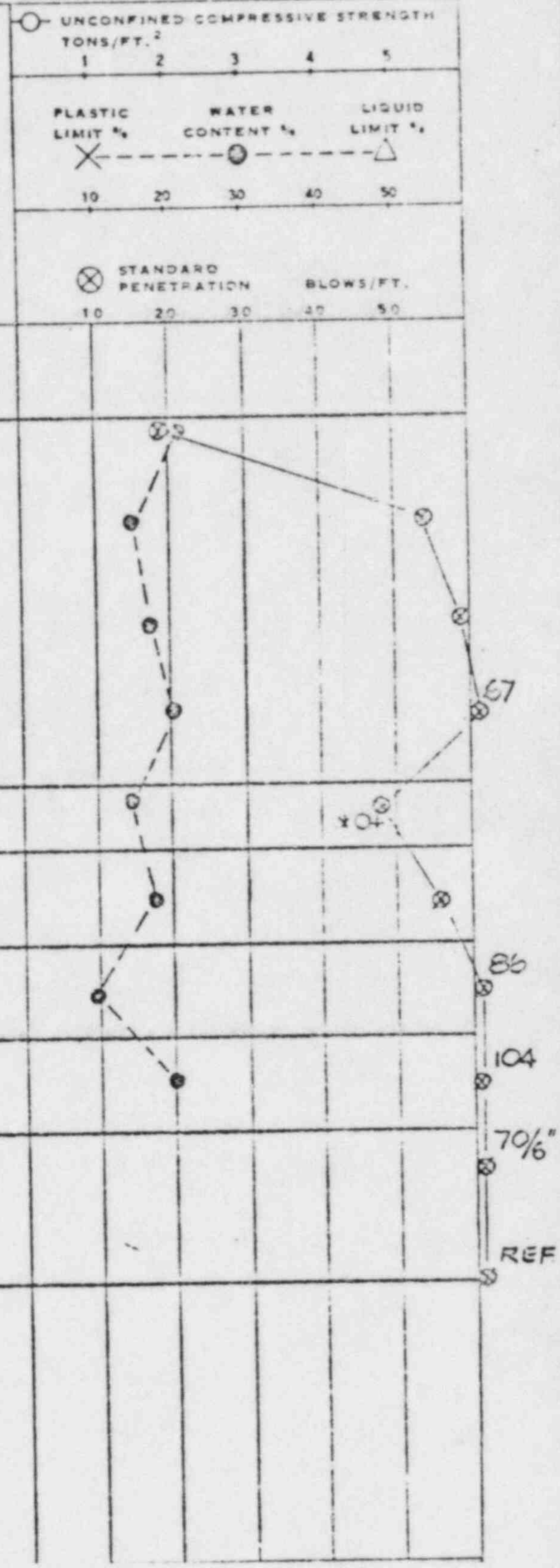
BRAIDWOOD - FSAR
FIGURE Q362.5-1
LOG OF BORING DSS-1

OWNER	LOG OF BORING NUMBER
Commonwealth Edison Co.	DSS-66 (Offset 10' S)

PROJECT NAME	ARCHITECT-ENGINEER
Braidwood Power Station	Sargent & Lundy, Engineers

SITE LOCATION
Braidwood, Illinois

ELEVATION / DEPTH	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL (SURFACE ELEVATION)	UNIT DRY WT. LBS./FT.³
		RB			Silty fine sand (No Sample)	
	1	SS			Fine sand, trace silt - light brown and gray - wet - dense to very dense (SP)	
10.0	2	SS				
	3	SS				
20.0	4	SS				
	5	SS			Silty clay, trace to some gravel, trace sand - gray - hard (CL)	
30.0	6	SS			Silty fine sand, trace clay - gray - wet - dense (SM)	
	7	SS			Silty, sandy & gravelly clay - gray - hard (SM-SC)	
40.0	8	SS			Fine sand, trace silt and clay - gray - wet - very dense (SP)	
	9	SS			Gray clayey shale No Sample	
50.0 / 51.0	10	SS			End of Boring 5' of 4" casing used. Bore hole grouted.	



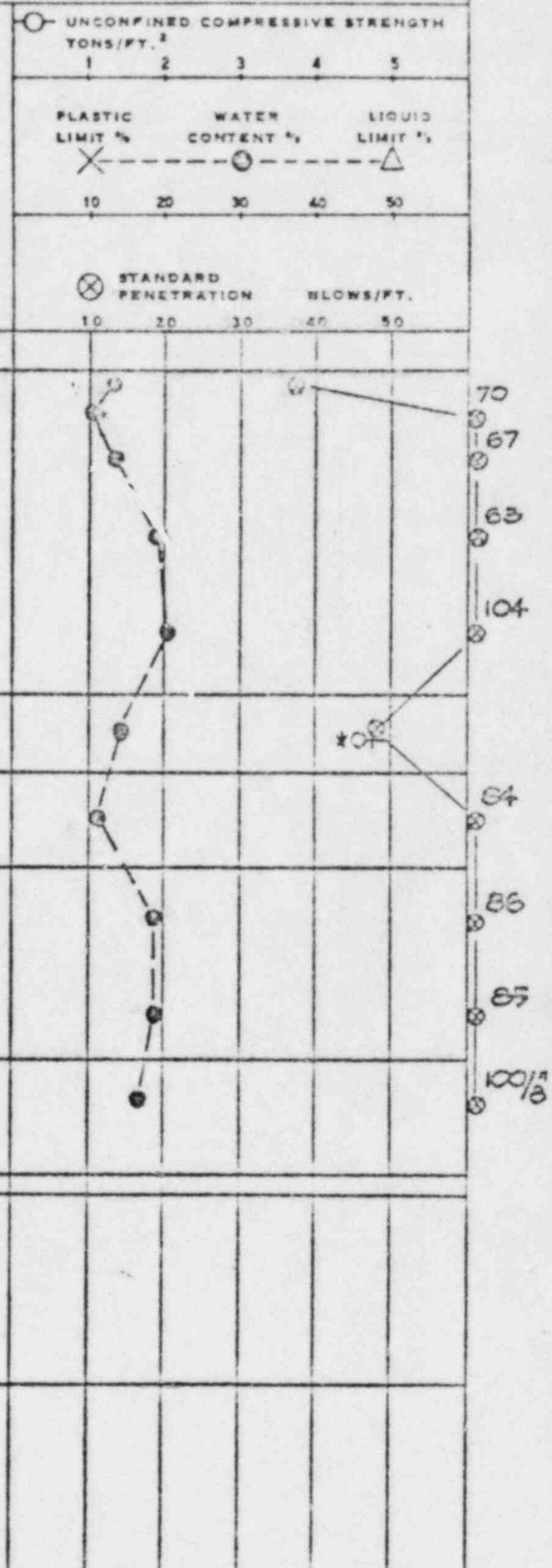
THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SO[IL TYPES]

WL	WS or WD	BORING STARTED	3-4-73
WL BCR	ACR	BORING COMPLETED	3-4-73
WL		RIG B-12 FOREMAN	JF

BRAIDWOOD - FSAR
FIGURE Q362.5-2
LOG OF BORING DSS-66

OWNER	LOG OF BORING NUMBER
Commonwealth Edison Co.	DSS-67
PROJECT NAME	**ARCHITECT-ENGINEER**
Braidwood Power Station	Sargent & Lundy
SITE LOCATION	
Braidwood, Illinois	

ELEVATION / DEPTH	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL / SURFACE ELEVATION	UNIT DRY WT. LBS./FT.³
		RB			No Sample	
	1	SS			Sand, trace silt - boulder at 18' - light brown and gray - dense to very dense - moist to wet (SP)	
	2	SS				
	3	SS				
10.0	4	SS				
	5	SS				
20.0	6	SS			Clayey silt, trace sand & gravel - gray - dense (ML-CL)	
	7	SS			Silty & sandy clay, trace gravel (CL-SC)	
30.0	8	SS			Fine to medium sand, trace gravel - gray - very dense - wet (SP)	
	9	SS				
40.0	10	SS			Silty sand, trace clay - gray - very dense - wet (SM)	
		RB				
					Dark gray shale	
50.0	Run 1	DB			Dark gray shale with thin lamination of light gray fine grained sandstone. Recovery = 95%, RQD = 45%	
60.0	Run 2	DB			Same as above Recovery = 88%, RQD = 57%	
65.0						
					(Contd. on Sheet 2)	



BRAIDWOOD - FSAR

FIGURE Q362.5-3

LOG OF BORING DSS-67

(SHEET 1 OF 2)

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES: IN SITU, THE TRANSITION MAY BE GRADUAL.

OWNER Commonwealth Edison Co.	LOG OF BORING NUMBER DSS-67 (Contd.)
PROJECT NAME Braidwood Power Station	ARCHITECT-ENGINEER Sargent & Lundy
SITE LOCATION Braidwood, Illinois	

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² 1 2 3 4 5

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % 10 20 30 40 50

STANDARD PENETRATION BLOWS/FT. 10 20 30 40 50

ELEVATION / DEPTH	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL / SURFACE ELEVATION	UNIT DRY WT. LBS./FT.³
					(Contd. from Sheet 1)	
65.0						
70.0	Run 3	DB			Dark gray shale with thin lamination of light gray fine grained sandstone. Recovery = 100%, RQD = 86%	
75.0						
					End of Boring	

*Calibrated Penetrometer

Casing used: 47' of NX
17' of 4"

Bore hole grouted.

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN S

WL	WS or WD	BORING STARTED	2-3-73
WL 18' BCR	ACR	BORING COMPLETED	2-3-73
WL		RIG 12A	FOREMAN CB

BRAIDWOOD - FSAR
FIGURE Q362.5-3
LOG OF BORING DSS-67
(SHEET 2 OF 2)

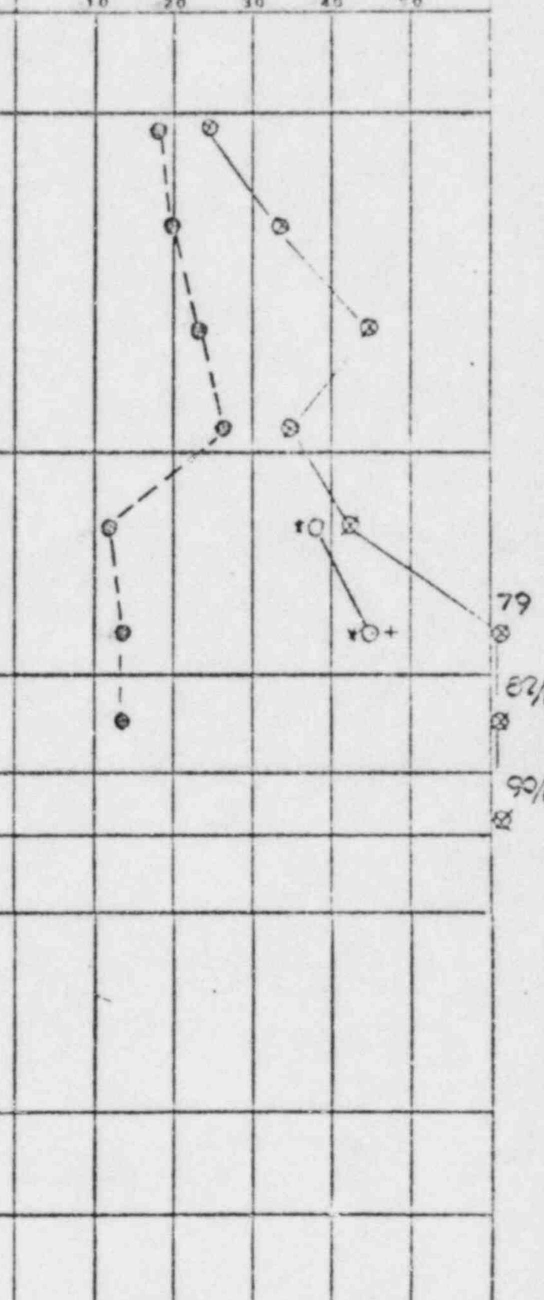
OWNER: Commonwealth Edison Co.	LOG OF BORING NUMBER: DSS-68
PROJECT NAME: Braidwood Power Station	ARCHITECT-ENGINEER: Sargent & Lundy, Engineers
SITE LOCATION: Braidwood, Illinois	

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² 1 2 3 4 5

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % 10 20 30 40 50

STANDARD PENETRATION BLOWS/FT. 10 20 30 40 50

ELEVATION / DEPTH	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL SURFACE ELEVATION	UNIT DRY WT. LBS./FT.³
		RB			No Sample	
10.0	1, 2, 3, 4	SS			Fine sand, trace silt - lt.brown to lt.gray - wet to saturated - dense (SP)	
20.0						
30.0	5, 6	SS			Silty, sandy, gravelly clay - gray - very tough to hard (CL)	
	7	SS			Silty fine sand, trace to some clay and gravel - gray - wet - very dense (SM-SC)	
40.0	8	SS			Fine sand, trace silt & gravel - gray - wet - very dense (SP)	
		RB			Gray clayey shale	
50.0	Run 1	DB			Light gray fine grained sandstone interbedded with thin lamination of dark gray clayey shale. Recovery = 100%, RQD = 10%	
60.0	Run 2	DB			Light gray fine grained sandstone interbedded with thin lamination of dark gray clayey shale. Recovery = 92%, RQD = 52%	
65.0	Run 3	DB			Lt.gray fine grained sandstone interbedded with thin lamination of dark gray clayey shale. Recovery = 100%, RQD = 90%	
					(Contd. on Sheet 2)	



BRAIDWOOD - FSAR
FIGURE Q362.5-4
LOG OF BORING DSS-68
(SHEET 1 OF 2)

OWNER	LOG OF BORING NUMBER
Commonwealth Edison Co.	DSS-68 (Contd.)
PROJECT NAME	ARCHITECT-ENGINEER
Braidwood Power Station	Sargent & Lundy, Engineers
SITE LOCATION	
Braidwood, Illinois	

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² — 1 2 3 4 5

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % — 10 20 30 40 50

STANDARD PENETRATION BLOWS/FT. — 10 20 30 40 50

ELEVATION / DEPTH	SAMPLE NO.	SAMPLE TYPE	SAMPLE DISTANCE	RECOVERY	DESCRIPTION OF MATERIAL / SURFACE ELEVATION	UNIT DRY WT. LBS./FT.³	
					(Contd. from Sheet 1)		
65.0	Run 4	DB			Dark gray shale interbedded with thin lamination of lt.gray fine grained sandstone. Recovery = 100%,		RQD = 90%
70.0	Run 5	DB			Light gray fine grained sandstone interbedded with thin lamination of dark gray shale. Recovery = 100%, RQD = 92%		
75.0					End of Boring		*Calibrated Penetrometer

Casing used: 5' of 4"
45' of NX

Bore hole grouted.

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SO

WL	WS or WD	BORING STARTED	3-3-73
WL BCR	ACR	BORING COMPLETED	3-3-73
WL		RIG B-12	FOREMAN JF

BRAIDWOOD - FSAR

FIGURE Q362.5-4

LOG OF BORING DSS-68

(SHEET 2 OF 2)

OWNER: Commonwealth Edison Co.

LOG OF BORING NUMBER: DSS-69 (Offset 20' South)

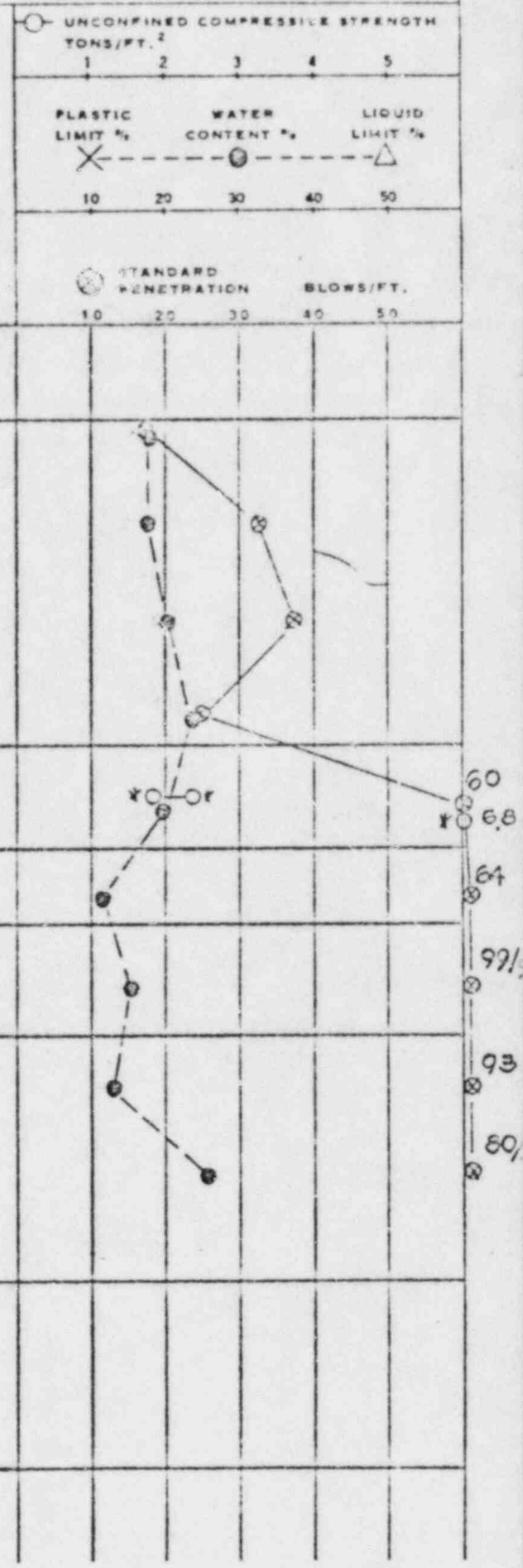
PROJECT NAME: Braidwood Power Station

ARCHITECT-ENGINEER: Sargent & Lundy, Engineers

SITE LOCATION: Braidwood, Illinois

ELEVATION / DEPTH	SAMPLE NO.	SAMPLE TYPE	DESCRIPTION OF MATERIAL (SURFACE ELEVATION)
		RB	Fine sand, trace silt - brown (No Sample)
	1	SS	Fine sand, trace silt - light brown and gray - wet - dense to medium dense (SP)
10.0	2	SS	
	3	SS	
20.0	4	SS	
	5	SS	Silty clay, trace sand & gravel - gray - tough to very tough (CL-CH)
30.0	6	SS	Silty and sandy clay, trace to some gravel, trace shale - gray - hard (CL)
	7	SS	Silty fine sand - brown and gray - moist - very dense (SM)
40.0	8	SS	Clayey shale - gray-brown
	9	SS	
50.0		RB	
60.0 / 61.0	Run 1	DB	Dark gray shale Recovery = 77%, RQD = 28%
			(Contd. on Sheet 2)

UNIT DRY WT. LBS./FT.³



BRAIDWOOD - FSAR
FIGURE Q362.5-5
LOG OF BORING DSS-69
(SHEET 1 OF 2)

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN SITU, THE TRANSITION MAY BE GRADUAL.

OWNER	LOG OF BORING NUMBER
Commonwealth Edison Co.	DSS-69 (Contd.)
PROJECT NAME: Braidwood Power Station	ARCHITECT-ENGINEER: Sargent & Lundy, Engineers
SITE LOCATION: Braidwood, Illinois	

Legend: UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² (1, 2, 3, 4, 5); PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % (10, 20, 30, 40, 50); STANDARD PENETRATION BLOWS/FT. (10, 20, 30, 40, 50)

ELEVATION / DEPTH	SAMPLE NO.	SAMPLE TYPE	DESCRIPTION OF MATERIAL (SURFACE ELEVATION)	UNIT DRY WT. LBS./FT.³
61.0			(Contd. from Sheet 1)	
70.0	Run 2	DB	Dark gray shale interbedded with thin lamination of lt.gray fine grained sandstone. Recovery = 97%, RQD = 76%	
80.0	Run 3	DB	Light gray, fine grained sandstone interbedded with thin lamination of dark gray shale. Recovery = 87%, RQD = 63%	
90.0	Run 4	DB	Light gray, fine grained sandstone interbedded with thin lamination of dark gray shale. Recovery = 94%, RQD = 84%	
100.0	Run 5	DB	Light gray fine grained sandstone interbedded with thin lamination of dark gray shale, with black coal from 92'10" to 93'8" Recovery = 37%, RQD = 14%	
			End of Boring	

Casing used: 10' of 4"
45' of NX

Bore hole grouted.

Pressure Tests taken: 51' to 61'
80' to 90'

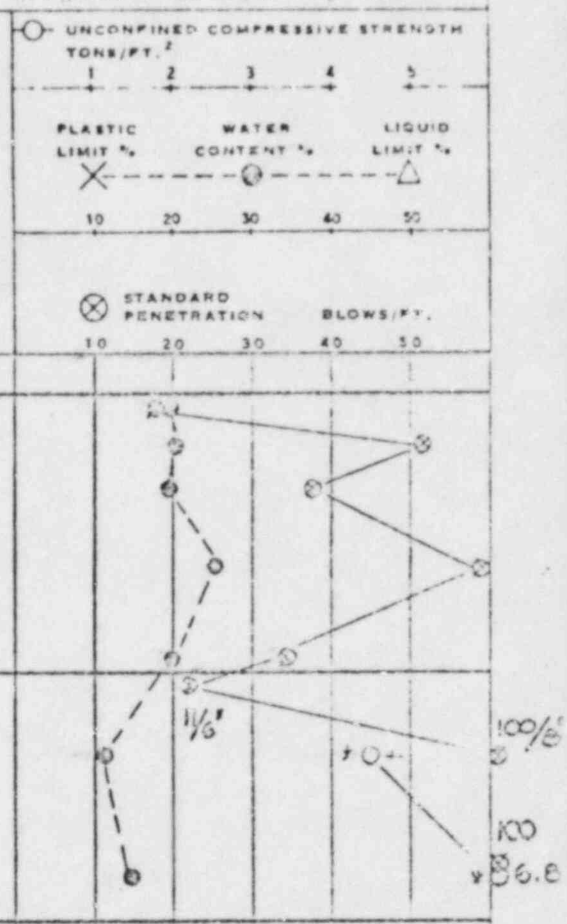
THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDRY LINES BETWEEN ...

WL	WS or WD	BORING STARTED	3-5-73
WL BCR	ACR	BORING COMPLETED	3-6-73
WL 5.9' on 3/6/73, 7:30 AM		RIG B-12	FOREMAN JF

BRAIDWOOD - FSAR
FIGURE Q362.5-5
LOG OF BORING DSS-69
(SHEET 2 OF 2)

OWNER: Commonwealth Edison Co.	LOG OF BORING NUMBER: DSS-70
PROJECT NAME: Braidwood Power Station	ARCHITECT-ENGINEER: Sargent & Lundy, Engineers
SITE LOCATION: Braidwood, Illinois	

ELEVATION / DEPTH	SAMPLE NO.	SAMPLE TYPE	DESCRIPTION OF MATERIAL (SURFACE ELEVATION)	UNIT DRY WT. LBS./FT.³
		RB	No Sample	
	1	SS	Fine sand, trace silt - brown to light gray - moist to wet - dense (SP)	
	2	SS		
	3	SS		
10.0	4	SS		
	5	SS		
20.0	6	SS	Silty, sandy & gravelly clay - gray - hard (CL)	
	7	SS		
30.0			Greenish gray limestone	
	Run 1	DB	Greenish gray soft clayey shale with limestone from 30' to 31'2" Recovery = 93%, RQD = 7?%	
40.0	Run 2	DB	Greenish gray soft shale Recovery = 100%, RQD = 88%	
50.0	Run 3	DB	Light gray fine grained sandstone interbedded with laminations of dark gray shale becoming dark gray shale @ 45' Recovery = 100%, RQD = 10%	
60.0	Run 4	DB	Light gray fine grained sandstone interbedded with thin laminations of dark gray shale Recovery = 95%, RQD = 50%	
65.0				



(Contd. on Sheet 2)

BRAIDWOOD - FSAR
FIGURE Q362.5-6
LOG OF BORING DSS-70
(SHEET 1 OF 2)

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU, THE TRANSITION MAY BE GRADUAL.

Commonwealth Edison Co.	LOG OF BORING NUMBER DSS-70 (Contd.)
Braidwood Power Station	ARCHITECT-ENGINEER Sargent & Lundy, Engineers
Braidwood, Illinois	

DESCRIPTION OF MATERIAL

UNIT DRY WT. LBS./FT.³

UNCONFINED COMPRESSIVE STRENGTH TONS/FT.² 1 2 3 4 5

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT % 10 20 30 40 50

STANDARD PENETRATION BLOWS/FT. 10 20 30 40 50

SURFACE ELEVATION

(Contd. from Sheet 1)

...t gray fine grained sandstone ...rbedded with thin laminations of dark gray shale

Recovery = 100%, RQD = 51%

End of Boring

*Calibrated Penetrometer

Casing used: 29' of NX
12' of 4"

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SO...

WL	WS or WD	BORING STARTED	3-2-73
WL	BCR Surface ACR	BORING COMPLETED	3-2-73
WL		RIG 12A	FOREMAN CB

BRAIDWOOD - FSAR
FIGURE Q362.5-6
LOG OF BORING DSS-70
(SHEET 2 OF 2)