

Tennessee Valley Authority
Division of Water Control Planning
Geologic Branch

PRELIMINARY GEOLOGIC INVESTIGATIONS
FOR THE JOHN SEVIER STEAM PLANT

John M. Kellberg
Charles P. Benziger

Knoxville, Tennessee
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INTRODUCTION

Location and Scope of the Investigation

Preliminary geologic investigations for a steam plant site near the head of the Cherokee Reservoir were carried on during April and May of 1952. The site examined occupies the left bank of the Holston River from mile 106.1 to mile 106.4. Sixty exploratory holes totaling 2378.8 linear feet were drilled on a 100-foot grid extending for 1600 feet along ranges roughly parallel to the river and 1200 feet back from the bank of the river along sections. Of this drilling 1214.5 linear feet were in overburden and 1164.3 linear feet were in rock (exhibit 1).

General Physiography

The John Sevier site is located in the Valley and Ridge Province of the Appalachian Highlands. This province extends from New York to Alabama and varies in width from 20 to 75 miles. It is bounded on the east by the steep slopes of the Blue Ridge front and on the west by the abrupt escarpment of the Cumberland Plateau. The Appalachian Valley sub-region, confined largely to East Tennessee, but occupying small portions of Alabama and Virginia, extends northeastward across the Tennessee Basin. It has an area of slightly more than 11,000 square miles.

(Physiographically, this sub-region is characterized by long narrow ridges and somewhat broader intervening valleys with a northeast-southwest trend. The ridges are roughly parallel and fairly even topped. They are held up by the resistant sandstones and the less soluble limestones and dolomites. The valleys are excavated on the easily weathered shales and the more soluble limestones.)

The elevation of the ridge summits and valley floors decrease progressively from the northeast to the southwest. In the extreme northeastern portion of the region the valleys are narrow and gorge-like, ranging in elevation from 2000 to 2500 feet in the valley floors up to 4000 to 4500 feet for the summits of the ridges. In the vicinity of the John Sevier site the Holston River flows at an elevation of approximately 1070 feet, while the tributary valleys range in elevation from 1120 to 1300 feet. Comparative elevations become progressively lower to the southwest.

General Geology

The Appalachian Valley is a region of highly deformed but unmetamorphosed sedimentary rocks of Paleozoic age. The rocks consist mostly of limestones, dolomites, and calcareous shales, but arenaceous and argillaceous shales and sandstones are present. They range in age from earliest Cambrian to Pennsylvanian, but Cambrian and Ordovician rocks are by far the most abundant.

The various formations in the valley outcrop at the surface in relatively narrow, linear belts of northeast-southwest trend, each formation being repeated at the surface several times from the southeast to the northwest. This outcrop pattern is the result of the folding and faulting of

originally nearly horizontal strata followed by erosion of the upper portions of the resulting structures. Apparently the strata were folded and faulted by compressive forces acting from the southeast. Individual folds were compressed tightly, then overturned to the northwest and finally broken by faults along their axial planes. The structure of the valley, therefore, is characterized very largely by a series of overlapping linear fault blocks which dip to the southeast. The topographic expression of the structural phenomena is very marked, and any deviation from it is a clue to variations in the geologic structure or the formational sequence.

Joints are abundantly developed in the rocks of the valley. These minor structures are controlled by the major systems of faulting and folding, but they occur in sets and systems, and may be classified generally as strike joints, dip joints, and oblique joints.

DETAILED GEOLOGY

Site Topography and Detailed Physiography

The John Sevier site is located on the left bank of Cherokee Reservoir, approximately five miles below its head, at river mile 106.2. The area for the plant occupies the floodplain and adjacent terrace formed by the present and past channels of the Holston River. The floodplain, composed predominantly of river alluvium, extends the whole length of the site parallel to the river and averages 800 feet in width. It has an average elevation of 1060. Immediately to the southeast of the floodplain an old river terrace rises to an average elevation of 1100 feet and extends for an average width

of 2000 feet southeastward to the base of a ridge of low hills. The old terrace is presently being dissected by tributary streams, but the river edge is a fairly abrupt slope.

Stratigraphy

Three geologic formations are present at or near the surface at the site. These consist of recent deposits of river alluvium; older terrace deposits; and the bedrock formation, the Athens shale. To the northwest the Athens is underlain by the Knox group, while to the southeast it is overlain by the Sevier formation. The Knox group and the Sevier formation are not involved in the foundation of the plant and will not be described. The three formations found at the site are described in detail.

Alluvium and Terrace--The entire site is covered with a mantle of alluvial and terrace deposits. These deposits vary in thickness from nothing in beds of several small creeks where bedrock is exposed, to a maximum of 31 feet encountered in several of the exploratory drill holes. The average depth as determined by the exploratory drilling is 20.2 feet.

The alluvium is composed predominantly of brown, slightly sandy silt containing few interspersed pebbles and cobbles. It occupies the floodplain of the Holston River extending back from the bank an average of 800 feet to the foot of the terrace bench.

The terrace deposits are older and are marked by a topographic bench roughly 800 feet southeast of the present river channel. These deposits consist of light tan clayey silt throughout which are scattered pebbles and cobbles ranging in size up to a maximum of six inches. In both the alluvium and terrace there is a marked lack of coarse sand and

small pebbles, the minimum size of the pebbles seen being in the neighborhood of one inch.

Athens Shale--The bedrock at the site is the Athens shale of Ordovician age. In this area the Athens consists of a dark gray to black, slightly calcareous shale, with thin interbeds of limestone ranging from three or four inches in thickness to less than a tenth of an inch thick. Unidentified graptolites were seen on some of the bedding planes in the shale, while some of the limestone beds contain brachiopods and ostracods. There is a slight development of pyrite along some of the bedding planes and joints.

Two variations from the normal lithology were encountered in a few of the exploratory holes. One phase consisted of black, massive shale containing tabular, rounded limestone nodules up to four inches in their maximum dimension. The other phase is made up of breccia-like, angular limestone fragments in a shale matrix. The present drilling program was not carried on in sufficient detail to prove whether or not these two different rock types would serve as key horizons which would be useable in determining the detailed geologic structure.

Structure

The belt of outcrop of the Athens shale on which the steam plant will be located extends in width from the right bank of the Holston River southeastward well beyond the limits of the general site area. In length, the formation extends for several miles both to the northeast and the southwest parallel to the axis of the Valley of East Tennessee.

The attitude of the bedrock varies from place to place over the

site. In general, the strike is northeast-southwest and the dip is to the southeast. However, there is evidence of much minor folding and some faulting. In the present drilling program the exploratory holes were not spaced on close enough centers to develop all the structural details known to be present. It is expected that the geologic structure exposed in construction excavations will be very similar to that exposed in the foundations at the Kingston Steam Plant consisting of many small, tightly folded, steeply pitching anticlines and synclines. Such folds have little influence on the bearing strength of the rock.

In some of the drill cores small faults were noticed intersecting the bedding at various angles. These faults are the result of shearing along the limbs of the small folds during periods of regional deformation. These faults and shears are all ancient structures and have been recemented with calcite until they are as strong as the surrounding rock. There is no reason to anticipate further movement along any of these structures.

Foundation Conditions

When exposed, the Athens shale weathers rapidly, due in large part to the effects of alternating cycles of freezing and thawing. As a result, surface outcrops are found only in comparatively recent road cuts and in the beds of streams. The shale portion breaks down into thin, buff-colored, platy chips, while the more resistant limestone beds are less affected. However, when the surface is protected, as at the John Sevier site, by a mantle of terrace and alluvial deposits, the shale is not subjected to the intermittent frost action and, therefore, is not weathered to any great extent.

It is believed that during the drilling operations the fishtail bit, in most holes, penetrated a foot or slightly more of weathered shale before encountering material too hard to be drilled in this manner. In the geologic sections (exhibits 2,3,4, and 5) this weathered material is lumped in with the overburden. In normal construction procedures this weathered shale could be removed by pans in the same manner as the overlying material.

The results of the exploratory drilling show that, in general, the rock surface follows the contours of the land. Under the floodplain, from Ranges N northward to Range G (see exhibit 1) the top of bedrock has an average elevation of 1064 (exhibits 2,3,4, and 5). Under the higher topographic bench southward from Range N to Range T the top of bedrock has an average elevation of 1074.5. There is a slight tendency for the rock surface to become lower towards Range T as the surface drops into the valley of the small spring branch in this vicinity.

In order to check the character of the rock surface underlying the topographic break along the front edge of the river terrace several supplemental fishtail holes were drilled to the top of rock on Section 32+00 between Ranges N and O (exhibit 2). These holes showed that the slope of the bedrock surface had the same general configuration as did the ground surface.

Very little evidence of serious weathering was apparent in any of the drill cores. In a few instances some of the thin limestone interbeds within a foot or two of the top of rock had been dissolved and were represented by small clay filled cavities, but, in general, evidences of weathering were limited to a few rusty beds and joints occurring in the top

few feet of the core. The top of rock as shown on the accompanying exhibits 2, 3, 4, and 5 will correspond very closely to the top of sound rock suitable for foundation purposes.

Physical Character of the Rocks

No compressive strength determinations have been made on rock samples taken from this site. However, when fresh and unweathered, all the bedrock material is capable of supporting any of the intended loads. One precaution will have to be taken in foundation preparation. The Athens shale will tend to disintegrate upon prolonged exposure to air; therefore, either the final cleanup should be made immediately prior to the pouring of concrete, or the cleaned area should be protected by a thin coating of grout as was done at the Kingston Steam Plant to prevent undue slaking of the shale.

Constructions Materials

No specific search was made at this time for supplies of suitable construction materials for the project. There are, however, areas in the Knox outcrop belt on the north side of the Holston River which would provide adequate quarry sites both as to quantity and quality of materials available. The rock formations on the south side of the river consist mostly of interbedded shales, siltstones, and thin sandstones which would not provide aggregate of suitable quality.

The alluvial and terrace materials should be subjected to laboratory tests to prove whether or not they would be suitable for rolled fill. From superficial appearance it seems possible that there might not be sufficient clay in them to give the desired compaction.

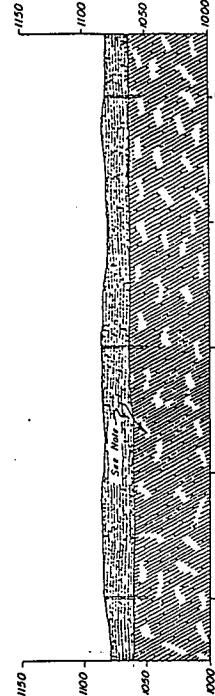
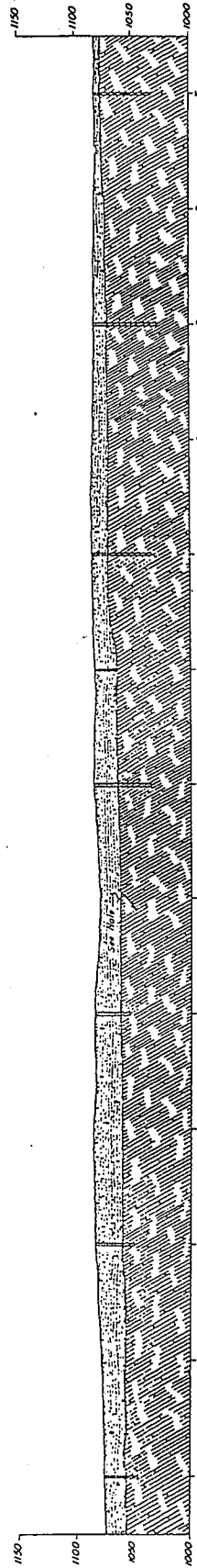
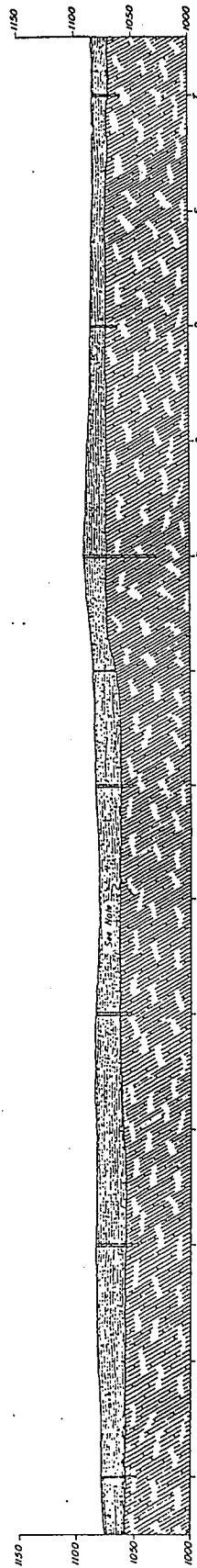
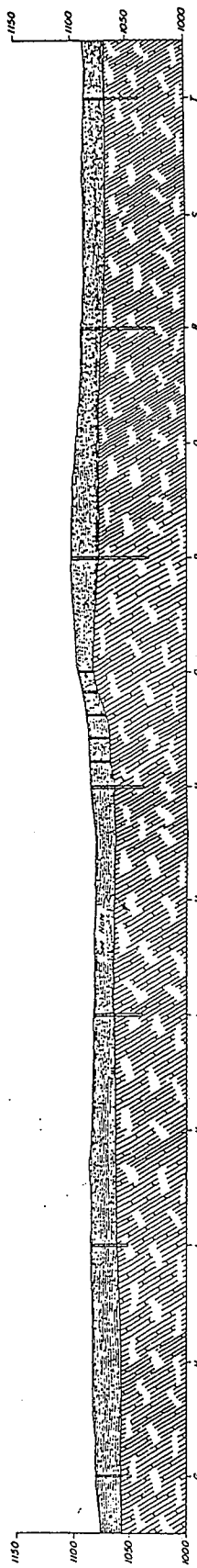
CONCLUSIONS

The exploratory drilling program over a relatively large area at the John Sevier Steam Plant site has resulted in the delineation of an area of suitable size for the plant structures that appears to be free from serious foundation defects. The overburden is comparatively tight and serious leakage through it is not expected.

Further investigations will have to be made to locate possible sources of construction materials.

ACKNOWLEDGEMENTS

All geologic work connected with the preliminary investigations of the John Sevier Steam Plant site was done by the writers under the direct supervision of Berlen C. Moneymaker, Chief Geologist, and the general supervision of Mr. James S. Bowman, Chief Water Control Planning Engineer.



SCALE:



LEGEND:

- Overburden - Soil, sand, and cobbles. Finer and other deposits.
- Dots gray in block, granular, with iron beds.
- Almost black, gray-gray sandstone.

NOTES:

The details of the geologic structure in this area could not be determined due to the irregularity of the bedding and the wide variation of dip. The structure is generally similar to that in the southwest, however, the strata are intricately folded and faulted.

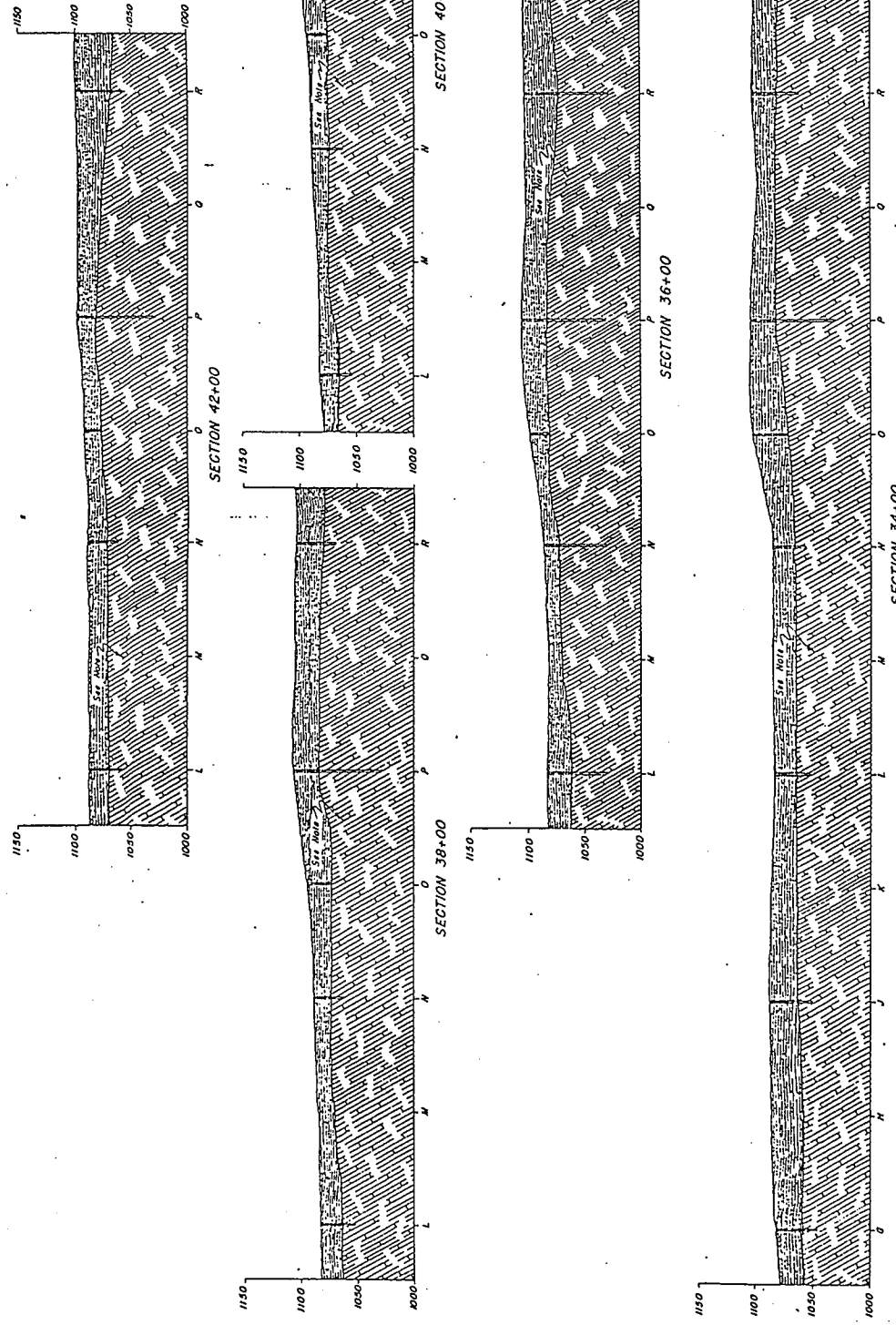
The top of each of them in the sections all correspond closely to the top of the rock, but the thickness of the strata at these hills weathering was found in any of the drill cores.

For other geologic sections see companion drawings at SEC. 222, K. 114E, 114S, and 114S.

For locations of drill holes see drawing at SEC. 222, N. 112E.




FOUNDATION	EXPLORATION
GEOLOGIC SECTIONS	
SECTIONS 26+00 THROUGH 32+00	
JOHN SEVIER STEAM PLANT TENNESSEE VALLEY AUTHORITY	
DESIGNED BY H. H. H. H.	APPROVED BY H. H. H. H.

DATE	BY	CHKD.	APP.



SCALE: 0 50 100 Feet

LEGEND:

-  - Overburden - Silt, sand, and cobble - Terrace and alluvium
-  - Silty Sand - Thin beds of light gray limestone
-  - Dark gray to black, argillitic, with chert nodules

NOTES:

The dip of the geologic structure in this area could not be determined due to the homogeneity of the lithology and the wide spacing of the drill holes. The general dip is 50° to 70° to the southeast, however the strata are intricately folded and faulted.

The top of rock as shown on the sections will correspond closely to the top of sound rock suitable for foundation purposes, as very little weathering was found in any of the drill holes.

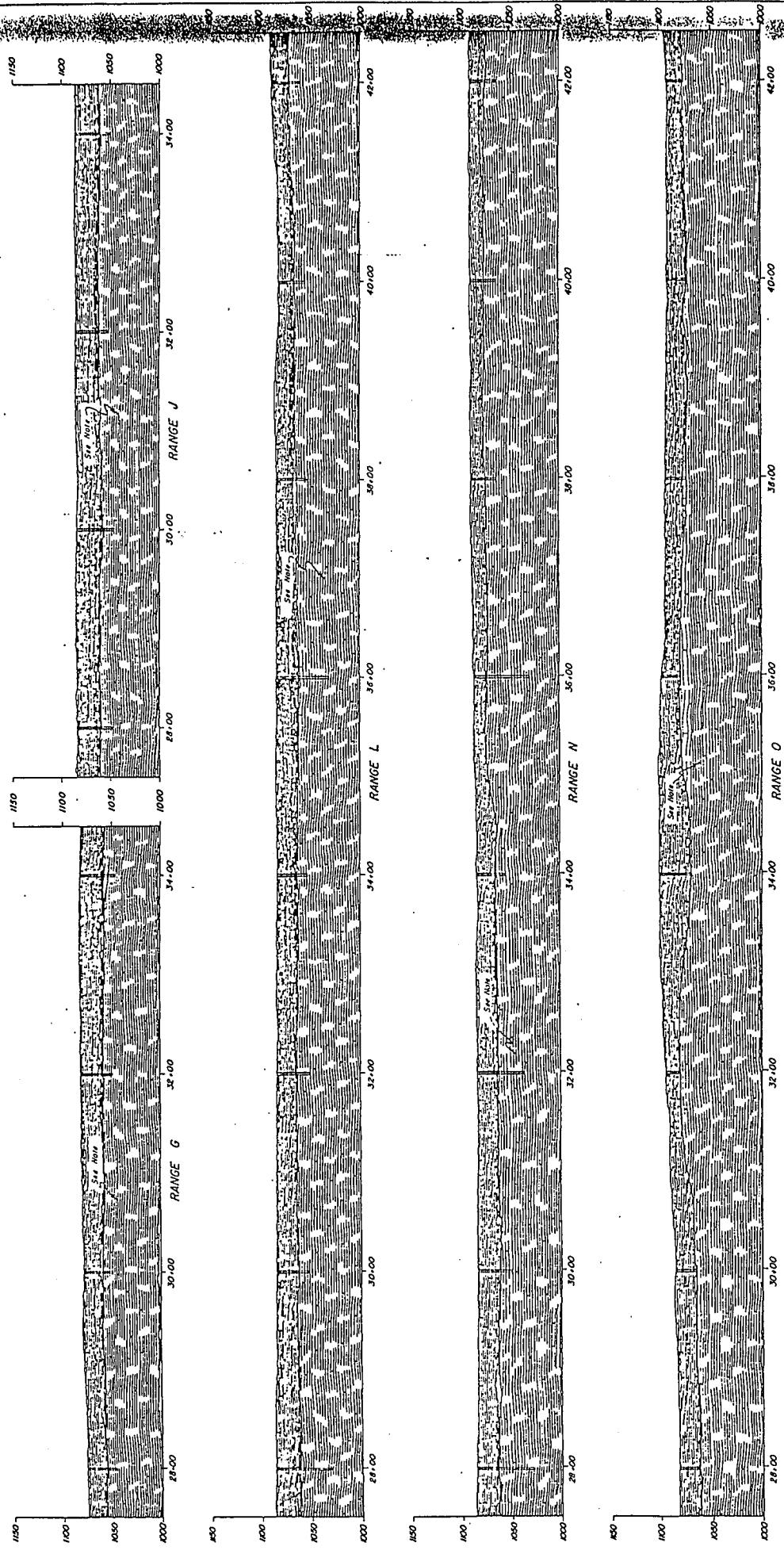
For other geologic sections see companion drawings 41 GE 1 822 K 1146, 1148, and 1145.

For location of drill holes see drawing 41 GE 1 822 M 1151.

FOUNDATION	EXPLORATION
GEOLOGIC SECTIONS	
SECTIONS 34+00 THROUGH 42+00	
JOHN SEVIER STEAM PLANT TENNESSEE VALLEY AUTHORITY	
APPROVED	DATE
<i>[Signature]</i>	11/15/51
RECOMMENDED	DATE
<i>[Signature]</i>	11/15/51

NO.	DATE	BY	CHKD.	APP.
1	11/15/51	J. H. [unclear]	[unclear]	[unclear]
2				
3				
4				

Exhibit A



SCALE: 50 0 50 100 Feet

LEGEND:

Overbanks - Silty sand, and cobbles - Terrace and alluvium

Dot gray to black, granitic, with
Others Shale - thin beds of light gray limestone.

NOTES:

The details of geologic structure in this area could not be determined due to the homogeneity of the lithology and the wide spacing of the well holes. The general dip is 50° to 70° to the southwest; however, the strata are intricately folded and faulted.

The top of rock as shown on the sections will correspond closely to the top of sand rock suitable for foundation purposes, as very little weathering was found in any of the drill holes.

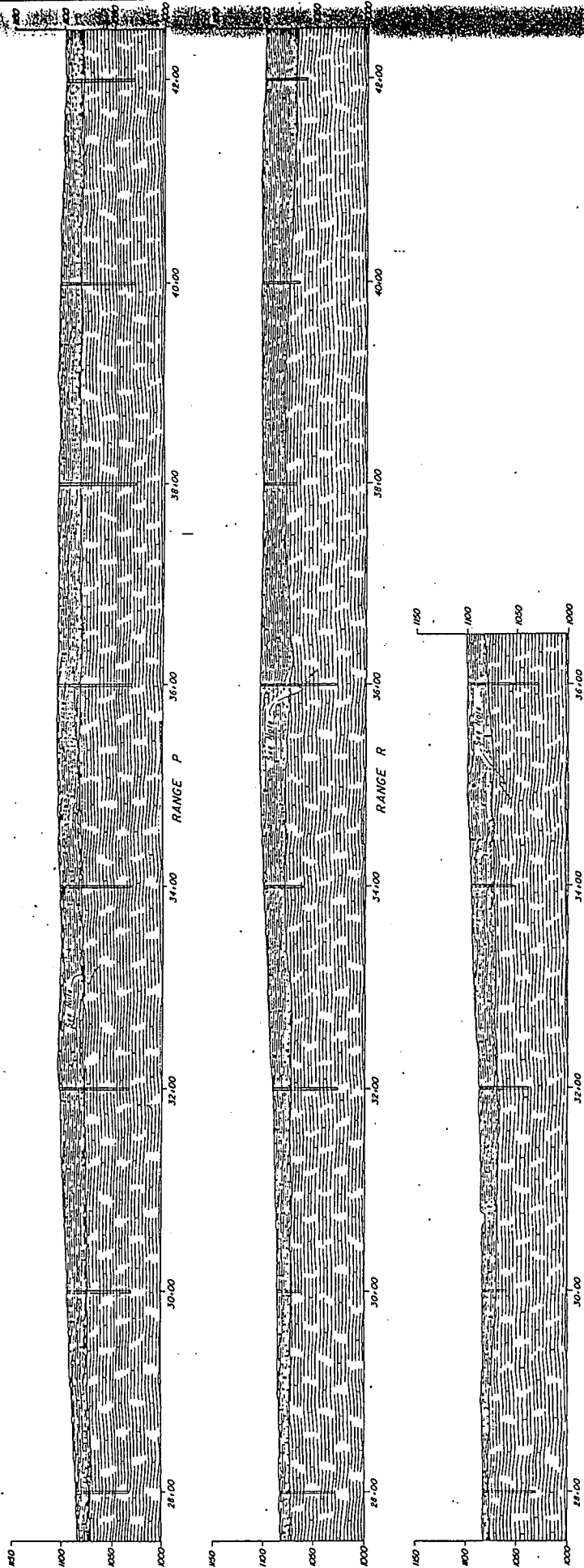
See other geologic sections and comparison drawings at BE 7 822 R 1146, 1147, and 1149 For details of drill holes see Appendix

FOUNDATION EXPLORATION



GEOLOGIC SECTIONS
RANGES G, J, L, N, AND O

JOHN SEVIER STEAM PLANT
TENNESSEE POWER AUTHORITY

DATE: 7/27/54
DRAWN BY: [Name]
CHECKED BY: [Name]
APPROVED BY: [Name]



LEGEND:

-  - Overlooked - Silt, sand, and cobbles - Tyrone and alluvium
-  - Athens Shale - thin beds of light gray limestone

NOTES:

The details of the geologic structure in this area could not be determined due to the homogeneity of the lithology of the rocks. The dip of the strata in this area is 50° to 70° to the northwest. However, the strata are intricately folded and faulted.

The top of rock at them on the sections will correspond closely to the top of the rock in the field. The dip of the strata is very little weathering was found in any of the drill holes.

For other geologic sections see companion drawings 41 621 022 R (196), 194, and 194B.

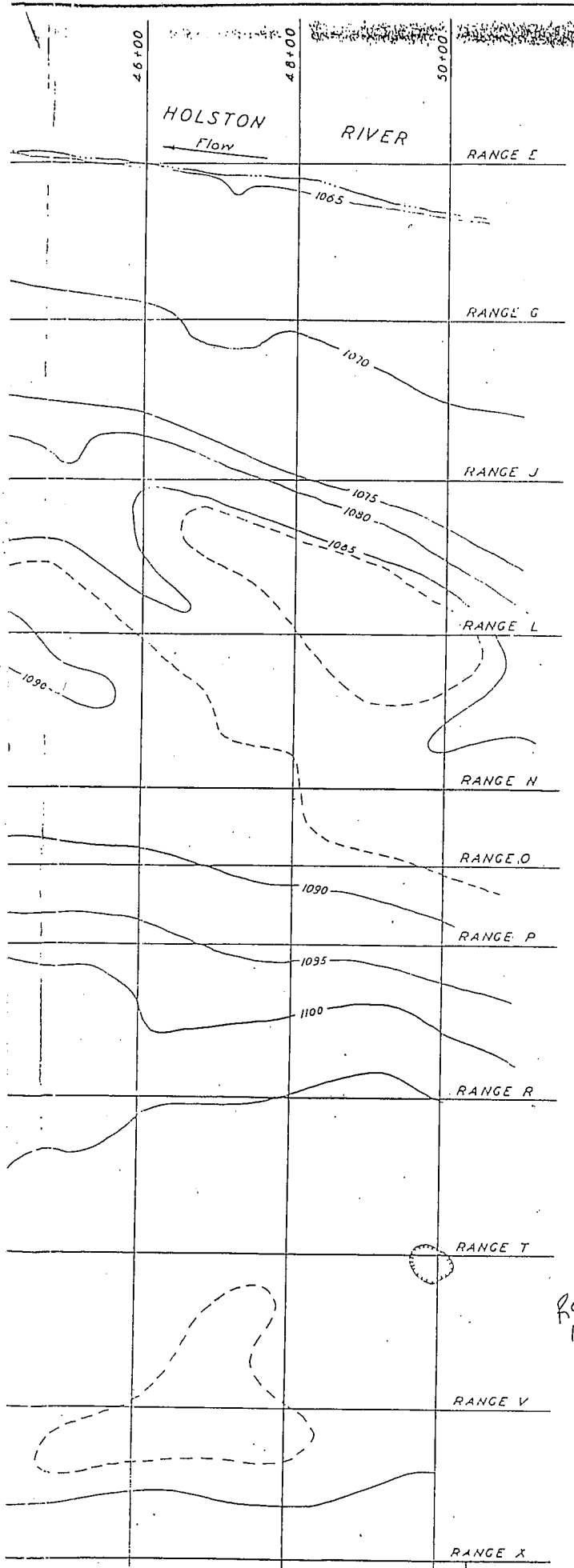
For location of drill holes see drawing 41 621 022 M (13)

SCALE: 50 100 200 Feet

FOUNDATION	EXPLORATION
GEOLOGIC SECTIONS	
RANGES P, R, AND T	
JOHN SEVIER STEAM PLANT TENNESSEE VALLEY AUTHORITY	
APPROVED	DATE
<i>[Signature]</i>	1/15/60

DATE	BY	CHKD	APP'D
1/15/60	[Signature]	[Signature]	[Signature]

SUMMARY OF CORE DRILLING

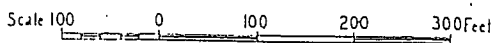


HOLE NUMBER	ELEVATION			
	SURFACE	TOP OF ROCK	BOTTOM OF SERIOUS WEATHERING	BOTTOM OF HOLE
G- 29+00	1076.2	1056.4	1055.0	1045.7
G- 30+00	1079.0	1058.6	1058.6	1048.4
G- 32+00	1140.6	1057.8	1057.8	1047.8
G- 34+00	1080.5	1057.5	1057.5	1045.5
J- 28+00	1081.4	1020.3	1060.3	1048.5
J- 30+00	1081.6	1057.1	1055.6	1046.6
J- 32+00	1085.0	1061.7	1058.5	1051.7
J- 34+00	1086.1	1061.7	1061.7	1050.5
L- 26+00	1081.1	1060.4	1060.4	1049.1
L- 28+00	1081.9	1061.6	1061.6	1029.9
L- 30+00	1081.6	1063.0	1063.0	1052.9
L- 32+00	1083.9	1064.4	1064.4	1039.6
L- 34+00	1082.7	1062.9	1062.9	1052.1
L- 36+00	1083.3	1061.8	1060.3	1030.7
L- 38+00	1081.4	1063.8	1063.8	1052.4
L- 40+00	1081.0	1065.2	1065.2	1054.6
L- 42+00	1077.4	1070.0	1065.2	1059.3
N- 26+00	1086.4	1064.1	1062.1	1053.9
N- 28+00	1085.1	1064.1	1064.1	1028.4
N- 30+00	1083.8	1061.1	1061.1	1050.8
N- 32+00	1084.2	1063.0	1063.0	1037.2
N- 34+00	1084.4	1065.2	1065.2	1055.5
N- 36+00	1085.9	1073.3	1073.3	1029.9
N- 38+00	1085.6	1073.6	1073.6	1062.9
N- 40+00	1089.9	1074.3	1073.0	1063.1
N- 42+00	1089.3	1073.8	1073.8	1062.9
N-20-32+00	1085.0	1085.0	20.0	1065.0
N-40-32+00	1086.5	1065.8	20.7	1065.8
N-60-32+00	1088.5	1070.0	18.5	1070.0
N-80-32+00	1092.0	1078.2	14.8	1078.2
O- 28+00	1083.9	1063.7	20.2	1063.7
O- 30+00	1085.3	1065.3	20.0	1065.3
O- 32+00	1095.1	1080.0	15.1	1080.0
O- 34+00	1101.5	1070.5	31.0	1070.5
O- 36+00	1098.4	1080.2	17.2	1080.2
O- 38+00	1094.8	1073.5	21.3	1073.5
O- 40+00	1093.0	1074.5	17.5	1074.5
O- 42+00	1092.3	1075.6	16.7	1075.6
P- 26+00	1082.7	1064.3	1062.7	1052.7
P- 28+00	1085.3	1071.3	1071.3	1032.0
P- 30+00	1094.8	1073.8	1073.8	1029.9
P- 32+00	1103.2	1078.2	1078.2	1032.8
P- 34+00	1103.1	1080.4	1075.0	1030.8
P- 36+00	1105.6	1082.6	1082.6	1030.1
P- 38+00	1106.2	1082.3	1085.7	1028.7
P- 40+00	1105.2	1084.2	1084.2	1029.4
P- 42+00	1097.8	1081.4	1081.4	1028.4
R- 28+00	1083.7	1072.1	1072.1	1027.4
R- 30+00	1086.3	1072.5	1072.5	1062.0
R- 32+00	1091.5	1072.0	1072.0	1026.5
R- 34+00	1101.0	1079.7	1079.7	1061.5
R- 36+00	1104.6	1073.6	1066.1	1028.0
R- 38+00	1103.0	1079.5	1076.5	1069.3
R- 40+00	1104.1	1076.2	1076.2	1066.0
R- 42+00	1100.9	1069.9	1069.9	1059.6
T- 28+00	1083.1	1076.6	1076.6	1030.1
T- 30+00	1084.3	1070.0	1070.0	1059.3
T- 32+00	1088.1	1069.1	1069.1	1037.8
T- 34+00	1086.3	1073.1	1073.1	1054.3
T- 36+00	1100.6	1080.7	1080.7	1029.0

NOTES:
 Topography by plane table. Contour interval 5 feet.
 Half interval contours shown by dashed lines.
 For geologic sections see drawings 41-62-1-822K1146 thru 1149.

SYMBOLS:
 ○ Holes drilled to top of rock
 ● Holes drilled into rock

Reduced -
 1"=200'
 USE 20 scale



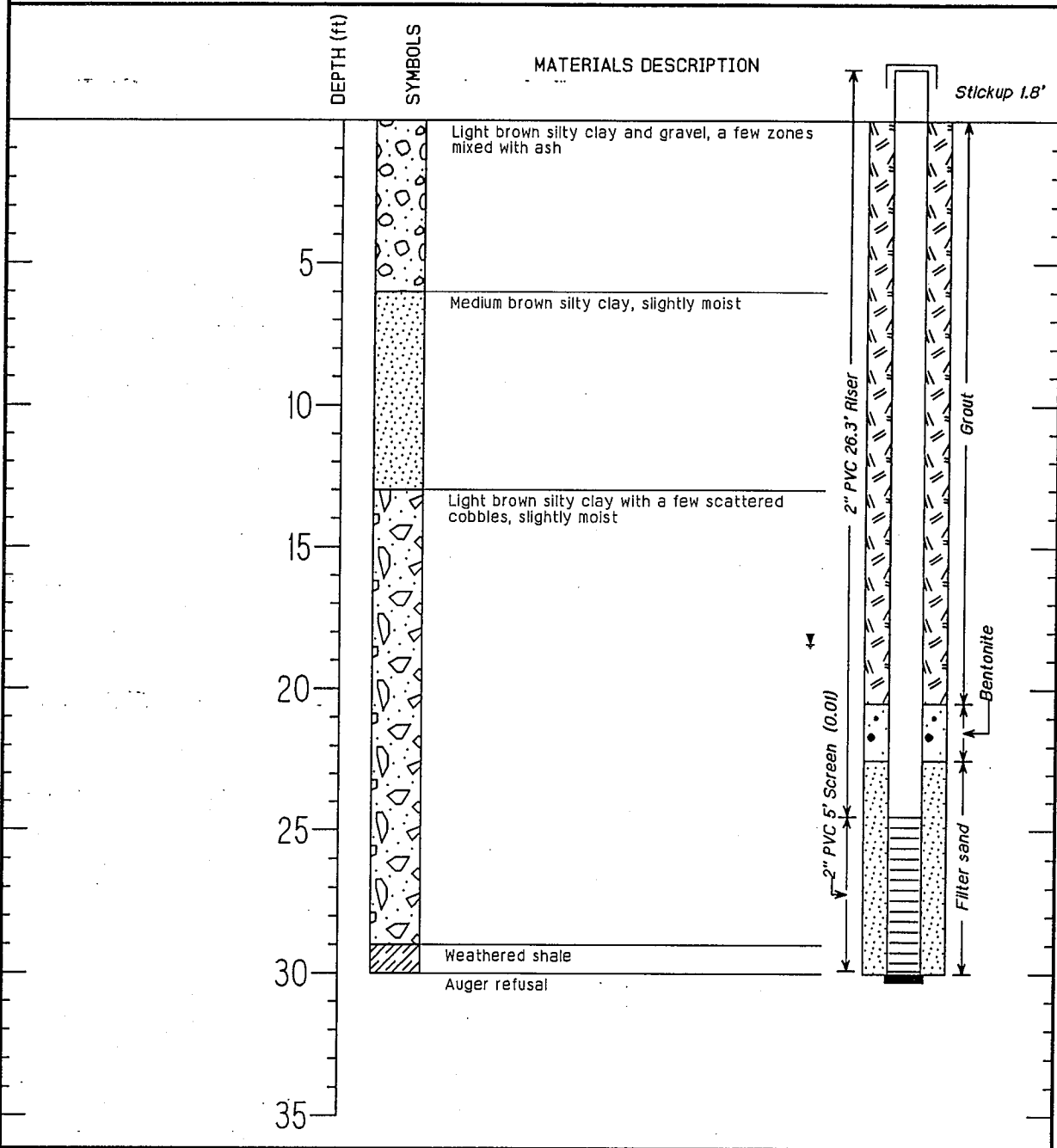
FOUNDATION EXPLORATION		
LOCATION AND SUMMARY OF CORE DRILLING		
ROGERSVILLE STEAM PLANT TENNESSEE VALLEY AUTHORITY DIVISION OF WATER CONTROL PLANNING		
SUBMITTED <i>J. M. Miller</i>	RECOMMENDED	APPROVED <i>B. L. M...</i>

200 feet to Southern Railway

Tennessee Valley Authority

MONITORING WELL W-5

WELL CONSTRUCTION DETAIL



PROJECT	John Sevier Steam Plant	DRILLING COMPANY	
LOCATION	John Sevier	DATE DRILLED	November 20, 1986
DRILL RIG	Hollow Stem Auger	SURFACE ELEVATION	1113.4 feet-msl
LOGGER/ENGINEER		T.O.C. ELEVATION	feet-msl
WATER LEVEL (INITIAL)		WATER LEVEL (24-HOUR)	18.4 feet