KEEP

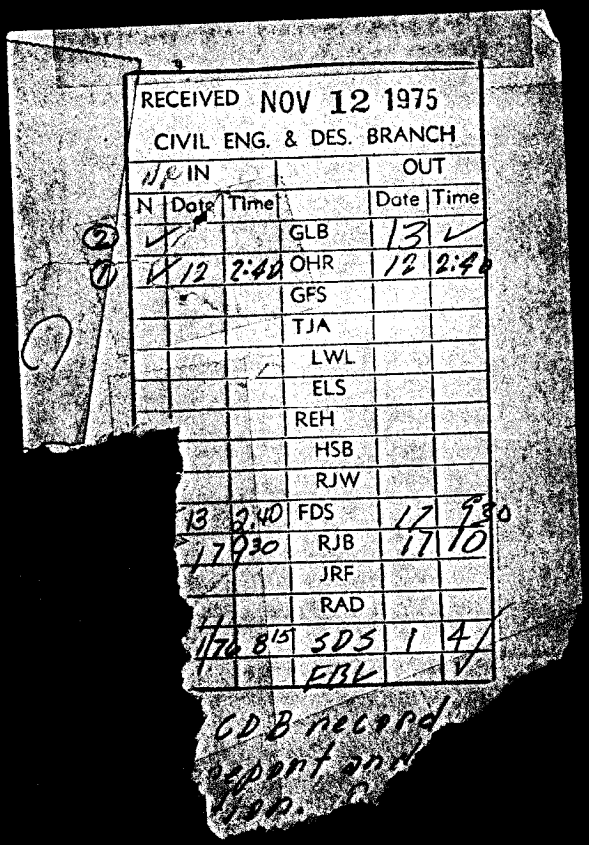
KINGSTON STEAM PLANT

ASH DISPOSAL AREA DIKES RAISING

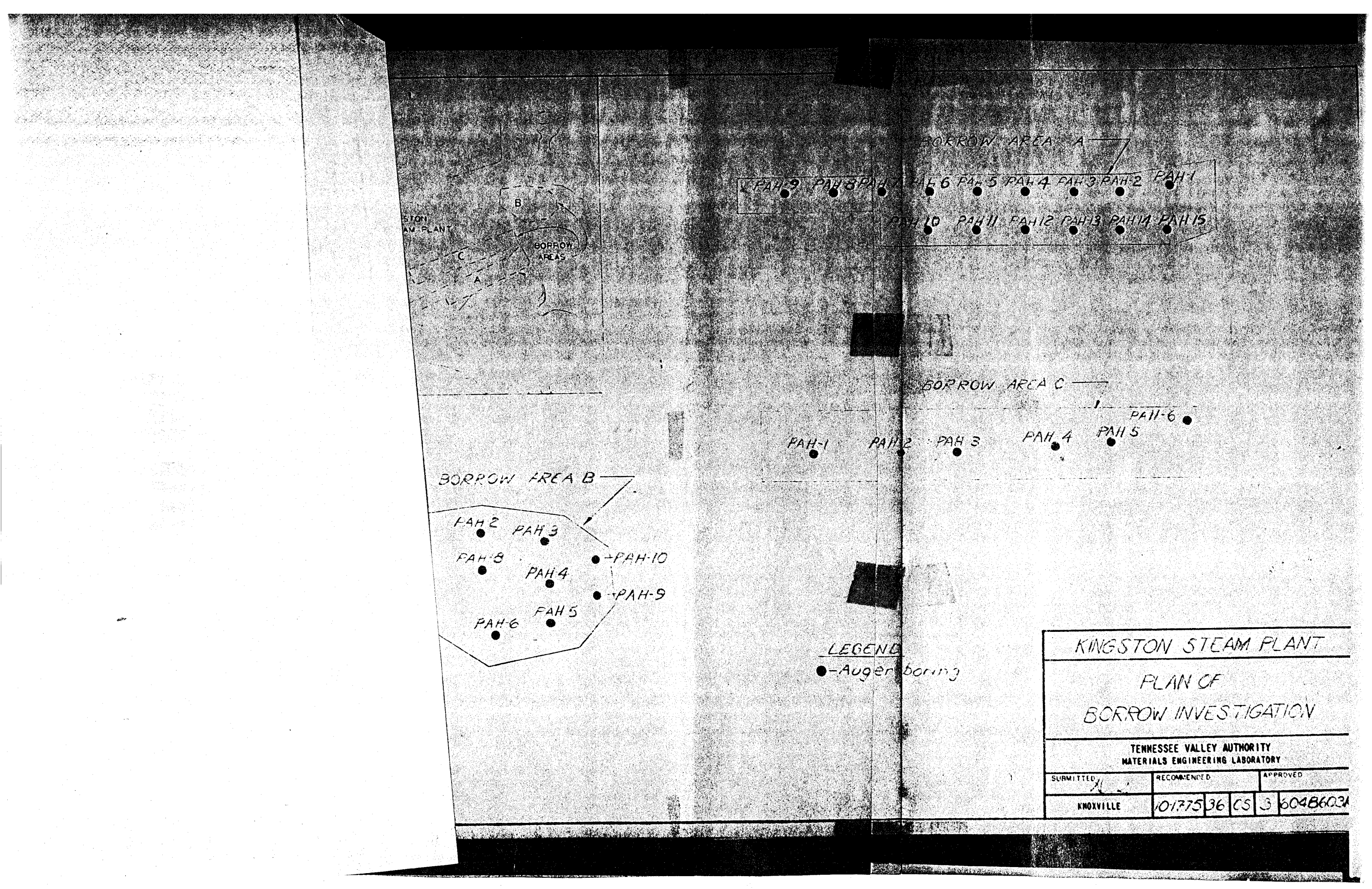
SOILS INVESTIGATION REPORT

DATED 11/3/75 AND EVALUATION OF REPORT

(CDB RECORD COPY)



three other sites, all on the left bank of the Fort Loudoun Reservoir, were investigated and rejected more for economic reasons than for any anticipated foundation defects.



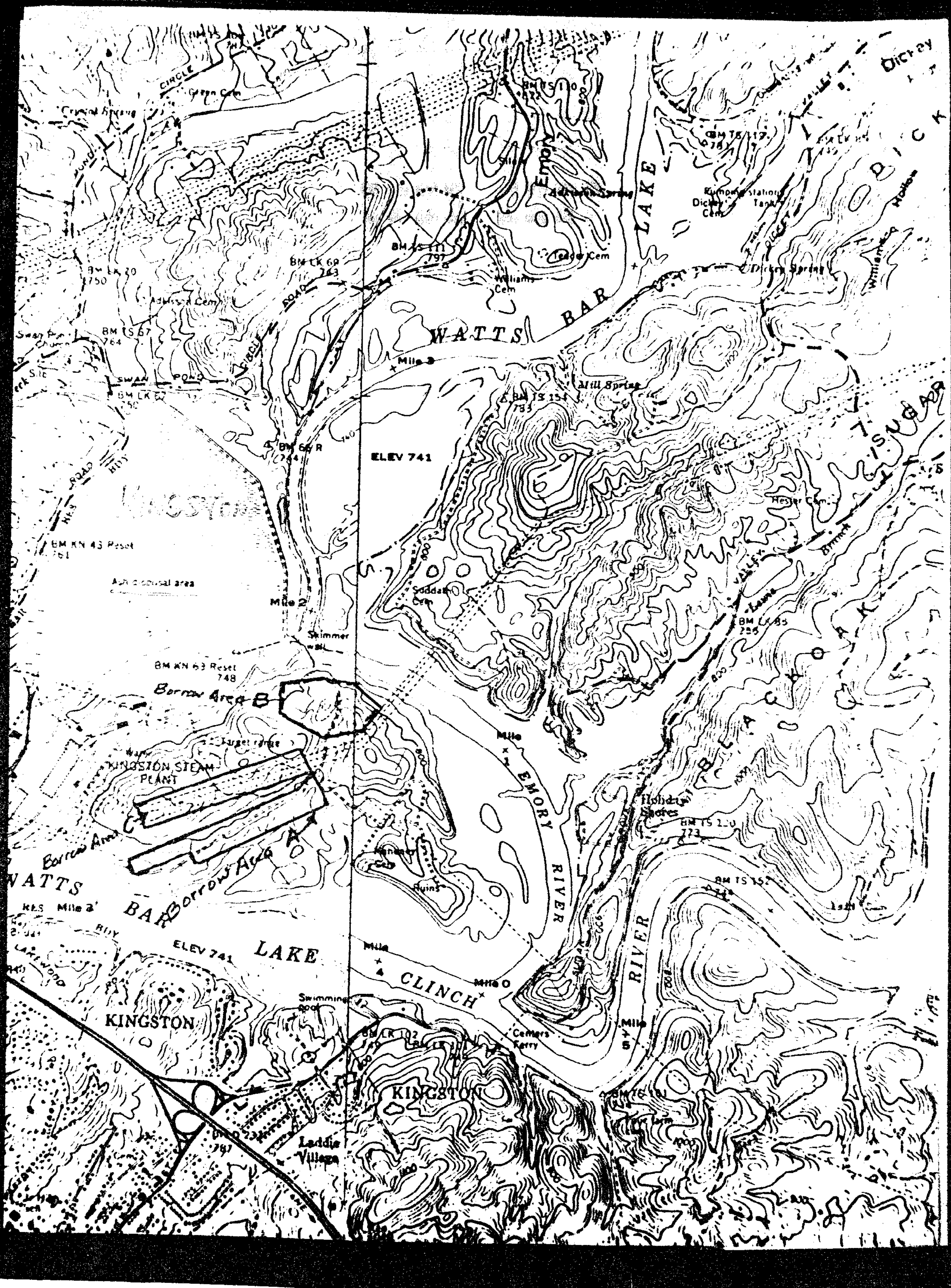
KINGSTON STEAM PLANT

PLAN OF

BORROW INVESTIGATION

TENNESSEE VALLEY AUTHORITY
MATERIALS ENGINEERING LABORATORY

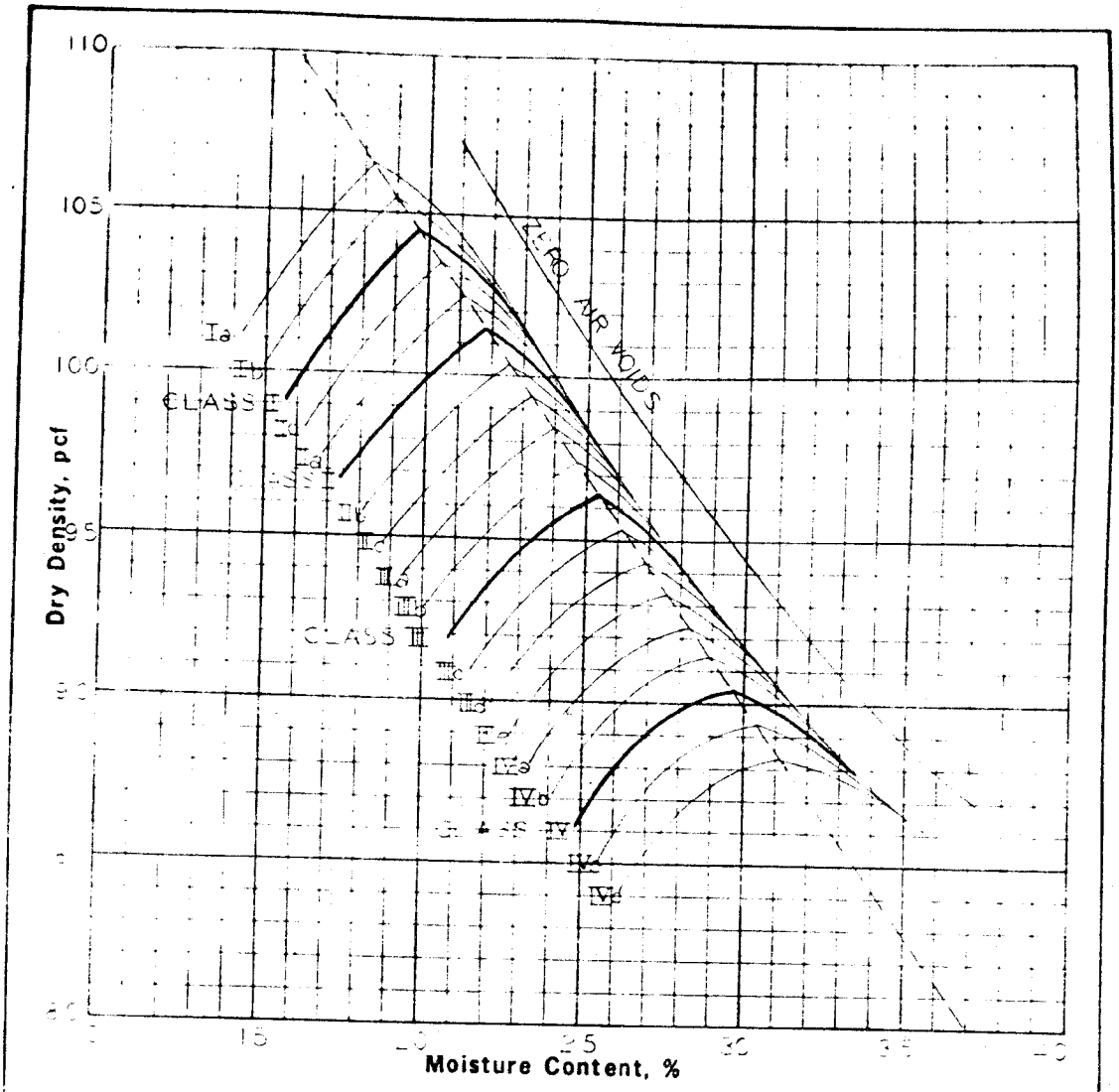
SUBMITTED	RECOMMENDED			APPROVED
KNOXVILLE	101775	36	CS	3 6048603A


WATTS BAR LAKE
ELEV 741
Mile 3
Mile 2
Mile 1
Mile 0
Skimmer wall
Borrow Area B
Borrow Area C
Borrow Area A
Target range
KINGSTON STEAM PLANT
EMORY RIVER
CLINCH RIVER
WATTS BAR LAKE
ELEV 741
KINGSTON
KINGSTON
Laddie Village
Swimming pool
Centers Ferry
Holiday Shores
Mill Spring
Suddath Cem
Williams Cem
Dickey Spring
Dickey Cem
Green Cem
Crystal Spring
SWAN POND
CIRCLE ROAD
SUGAR
BLACK OAK
DICK
Hester Cem
BM KN 63 Reset
748
BM KN 43 Reset
BM LK 69
763
BM TS 154
783

Singleton Lab Microfilm Roll # 7055 Fram # 803

Becky Jemkins

W5B63-Karen Valente



Soil Class	Gravel %	Sand %	Silt %	Clay %	Specific Gravity	LL %	PI %	Optimum Moisture, %	Maximum Density, pcf
[illegible]	0	23	34	43	2.70	42.8	22.8	19.7	104.5
[illegible]	[illegible]	22	26	52	2.73	58.3	32.5	21.8	101.5
[illegible]	[illegible]	18	20	62	2.77	68.5	40.3	25.4	96.4
[illegible]	0	13	14	73	2.76	88.0	54.4	39.6	90.4

Plus No. 4 Specific Gravity, SSD	
Plus No. 4 Absorption, %	

Remarks:

Project KINGSTON STEAM PLANT

Feature BORROW AREAS A, B, C

ASTM Designation D-698

Date Tested 8-21-75

COMPACTION TEST (FAMILY OF CURVES)

Soil Form 14

KINGSTON STEAM PLANT

BORROW AREA A, B, C

SUMMARY OF LABORATORY TEST DATA

BORROW SOIL CLASSES

Class		I	II	III	IV
Symbol		CL	CH	CH	CH
Mechanical and Hydrometer Analysis					
Gravel, percent		0	0	0	0
Sand, percent		23	22	18	13
Silt, percent		34	26	20	14
Clay, percent		43	52	62	73
Atterberg Limits					
Liquid limit, percent		42.8	58.3	68.5	88.0
Plastic limit, percent		20.2	25.8	28.0	33.6
Plasticity index, percent		22.6	32.5	40.5	54.4
Shrinkage limit, percent		--	--	--	--
Standard Proctor Compaction					
Optimum moisture, percent		19.7	21.8	25.4	29.6
Maximum density, pcf		104.5	101.5	96.4	90.4
Penetration resistance, psi		--	--	--	--
Shear Strength at 3% Above Optimum Moisture and at 95% of Maximum Density					
Triaxial Q:	ϕ, degrees	6.2	8.5	8.3	6.0
	c, tsf	1.12	1.25	0.92	1.18
Triaxial R:	ϕ, degrees	18.0	13.6	15.0	14.6
	c, tsf	0.3	0.51	0.44	0.39
Shear Strength at 3% Below Optimum Moisture and at 95% of Maximum Density					
Triaxial Q:	ϕ, degrees	24.7	27.6	17.0	16.0
	c, tsf	1.80	1.80	2.25	1.90
Triaxial R:	ϕ, degrees	13.4	16.4	20.5	12.2
	c, tsf	0.30	0.20	0.00	0.37

To CDB Files

Fr: O. H. Raine

11/12/75

Kingston Steam Plant - Ash Disposal Area Dikes Raising - Soils Investigation Report 11/3/75 and Evaluation

Herewith is the work copy of the report, marked for evaluation, roughly because urgent for design. Soils design values are marked on p. 4 of the report, and were sent to Hwy Group 11/11/75.

Also herewith:

1. Marked copy of the 6/26/74 investigation request. Proposed soil and ash investigation was unusual and notes are made on the parts of the investigation that were not done.

2. Evaluation of the soils report with commentary on the investigation, on investigation results, and on design and construction features. A copy of the commentary was sent to the Hwy Group 11/12/75.

This material is assembled in this binder as the Branch record on the investigation.

Marked by OH Raine 11/7 to 11/11

G. L. Buchanan, Chief, Civil Engineering and Design Branch, 418 UB-K (3)

Gene Farmer, Chief, Construction Services Branch, 305 NB-K

November 3, 1975

KINGSTON STEAM PLANT - ASH DISPOSAL AREA DIKE RAISING - SOIL INVESTIGATION

As requested in a memorandum of June 26, 1974, from W. W. Engle to me, our laboratory has completed sampling and testing for the dike raising at Kingston Steam Plant. The field work was completed between February 18 and March 12, 1975, using a CME-45 and a Mobile B-55 auger drill. Equal portions of the laboratory testing were done by Singleton Materials Engineering Laboratory and the soil laboratory of Law Engineering and Testing Company of Marietta, Georgia.) which ?

Foundation

As shown on laboratory drawing 604B602, a total of 24 standard penetration borings was drilled around the perimeter of the existing dike. The soil profile is shown on drawings 604K604 and 604K605 and reveals overburden depths in excess of 25 feet. In general the profile in the area between borings SS-1 and SS-10 consists of 8 to 26 feet of fill underlain by a stratified alluvium. The fill consists of soil overlain by 2 to 5 feet of ash. In scattered locations ash and soil are blended. Fill soils classified lean to fat clay, CL and CH, and silty to clayey sand, SM and SC. Throughout much of this fill, shaly gravel is interspersed with the fine-grained soils.

top 10'± (above 740)

Standard penetration testing indicates the surficial materials are highly compacted but subsoils weaken as depth increases. In general, at the fill-ground contact, soils are of soft consistency with N≤4. The alluvium beneath the existing dike fill classifies lean to medium clay, CL, and silty clay and silt, ML-CL and ML, along with some silty sand, SM. These materials are of variable consistency with significant weaknesses established in borings SS-1, SS-4, SS-5, SS-6, SS-7, and SS-8 where N values of 4 or less are common. The water table varied between el. 735 and 750 over this portion of the dike.

(inside the North Dike, ash deposit)

In the area between borings SS-11 and SS-16, fill consists almost entirely of ash of silt to silty sand size. This ash is very dense at the surface to a depth of 5 to 8 feet. Below this depth its ~~relative~~ density decreases progressively. Below el. 740, the ash is very soft with N values consistently less than 4 and is underlain by alluvial lean clay, CL, and silty sand, SM. The water table varied between el. 749 and el. 756 ~~in this portion of the dike~~, at top of ash

Only 1' was bored. All that was required.

G. L. Buchanan
November 3, 1975

KINGSTON STEAM PLANT – ASH DISPOSAL AREA DIKE RAISING – SOIL INVESTIGATION

Borings existing Dike C and Road Dike SS-17 through SS-24 were drilled in ash fill along the inside of the ~~dike~~ as shown on drawing 604B602. These standard penetration borings indicate the fairly coarse ash to be generally quite soft or loose with N values between 0 and 4. See drawing 604K606. This ash, being 4 to 24 feet thick, overlies the alluvial silt, silty sand, and lean clay, ML, SM, and CL. However, in borings SS-22 and SS-23, the ash and original ground were separated by 13 to 16 feet of soil fill. Groundwater in top of ash.

Undisturbed samples were obtained of both the fill and foundation soils at of Dike C and Road Dike borings SS-1 and SS-7 for detailed testing. As shown on the attached "Summary of Laboratory Test Data" soils generally are of medium to high dry density. The natural moisture content mostly exceeds the plastic limit, and in some cases, approaches the liquid limit, accounting for the low penetration resistance.

Natural moisture Q
Unconsolidated-undrained triaxial compression tests disclose a wide range of strengths with the upper soil layers being of greater strength than the underlying materials. For those fine-grained soils with N values of 4 or less, a strength range of 2 to 5 degrees friction and 0.2 to 0.4 tsf cohesion was established. Consolidated-undrained triaxial compression tests at natural moisture content performed on foundation soils revealed medium to high strength with friction angles between 19 and 33 degrees and cohesion of 0.12 to 1.12 tsf. Back-pressure saturated triaxial compression R tests performed on fill soils were of medium shear strength. An exception is noted in boring US-1 at el. 739 where 16 degrees friction and 0.14 tsf cohesion was obtained.

Do not use.

Borrow

As shown on drawing 604B603, three areas designated A, B, and C were explored east of the plant. Profiles are presented on drawings 604K607, 604G608, 604K609, and 604G610. Each of these areas can supply from 10 to 25 feet of lean to fat clay, CL and CH, as well as a small amount of highly plastic silt, MH. Overall, about two million cubic yards of suitable fill material is available.

Laboratory compaction testing, in accordance with ASTM D698, established four soil classes as shown below:

Class I, representing 22 percent of the total borrow, classified sandy lean clay, CL, with an optimum moisture content of 19.7 percent and a maximum density of 104.5 pcf. The average natural moisture content of this material was 24.6 or 4.9 percent above optimum.

G. L. Buchanan
November 3, 1975

KINGSTON STEAM PLANT - ASH DISPOSAL AREA DIKE RAISING - SOIL INVESTIGATION

Class II, amounting to 22 percent of the total borrow, classified sandy medium clay, CH, with an optimum moisture content of 21.8 percent and a maximum density of 101.5 pcf. The average natural moisture content of this material was 27.5 percent or 5.7 percent above optimum.

Class III, accounting for 27 percent of the total classified fat clay, CH, with an optimum moisture content of 25.4 percent and a maximum density of 96.4 pcf. The average natural moisture content of this material was 29.1 or 3.7 percent above optimum.

Class IV, totaling 29 percent, also classified fat clay, CH, with an optimum moisture content of 29.6 percent and a maximum density of 90.4 pcf. The average natural moisture content of this material was 35.1 or 5.5 percent above optimum.

Each soil class was remolded to 95 percent of maximum density at 3 percent above and below optimum and subjected to triaxial compression Q and R tests. Results of these tests are presented in the attached "Summary of Laboratory Test Data - Borrow Soil Classes."

Summary

This investigation has shown the existing dike fill at Kingston Steam Plant to consist of ash and soil which are usually of stiff to hard consistency at the surface but are softening with increased depth. Below a depth of 10 feet, soils and ash often become soft with standard penetration blow counts of 4 or less. Portions of the underlying alluvial foundation soils are equally weak.

Sufficient quantities of impervious fill materials are available from the three borrow areas investigated east of the plant. While the investigation was carried out during a very wet period, it is likely borrow clays will require some drying prior to placement.

The following test values, based upon detailed laboratory testing are recommended for design purposes:

G. L. Buchanan
November 3, 1975

Do not use

KINGSTON STEAM PLANT - ASH DISPOSAL AREA DIKE RAISING - SOIL INVESTIGATION

① Natural Moisture contents

	γ_w	Triaxial Q ϕ deg.	Triaxial Q c tsf	Saturated Triaxial R ϕ deg.	Saturated Triaxial R c tsf	NMC Triaxial R ϕ deg.	NMC Triaxial R c tsf
Foundation	125 ✓	5 ✓	0.4 ✓	17 ✓	0.4 ✓	25	0.5
Embankment	120 ✓	6 ✓	1.0 ✓	15	0.4	—	—

② Use $\phi = 15°$, $c = 0.3$ tsf

Not required

Gene Farmer

WHC:PO
Attachments
CC (Attachments):
R. O. Lane, SME-K
H. H. Mull, 707 UB-K
Lamar Parker, Tellico Dam

The strength values checked are acceptable.

① Do not use the natural moisture R. The old fill and fdn of Dike C and Road Dike will have to be assumed saturated. The tests demonstrate the weakening effect of saturation of the soil with time as pondwater seeps into and saturates the formation.

② Do not use the lab values $\phi = 15$ and $c = 0.4$ for fill. These values are from lab tests 3% wet. Lab tests 3% dry demonstrate erratic strengths (see more closely with evaluation) of dry-side compaction. Wet-side compac demonstrates more uniformity.
Use $\phi = 15°$, $c = 0.3$ tsf for general coverage of fill.

copy of marked sheet to Stevens 11/11/75

11/11/75

KINGSTON STEAM PLANT

ASH DISPOSAL DIKE

SUMMARY OF LABORATORY TEST DATA

Foundation DD.

Elevation	Soil Symbol	Nat. Moist. %	Nat. Moist. % Sat.	Std. Penetr.	Grain-Size Analysis Gravel %	Sand %	Silt %	Clay %	D_{10} mm	Atterb. Limits Liq. Limit %	Plastic. Index %	Dry Dens. pcf	Void Ratio	Vane Shear tsf	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 US-1, Surface El. 751.9																						
748.9-747.9	GC	14.4	72.3	29	35	29	21	15	--	35.8	12.8	111.2	0.550						CL 25.0	0.25	32.0	0.0
745.9-743.9	CL	14.8	93.0	16	0	33	37	30	--	30.3	14.5	118.5	0.423									
742.9-740.7	CL	16.3	94.5	12	0	28	44	28	--	26.0	10.1	113.4	0.454		CL 30.9	0.10			CL 18.0	0.99	32.0	0.0
739.9-738.7	GC	21.3	93.1	7	43	22	16	19	--	36.7	16.4	106.1	0.631						CL 16.0	0.14	31.5	0.0
736.9-736.5	CL	18.5	86.3	3	0	39	34	27	--	37.4	18.2	106.2	0.576									
733.9-732.7	SM-SC	22.7	95.7	4	0	55	27	18	--	23.9	4.7	102.8	0.640				S 34.0	0.12				
732.7-731.6	CL	28.4	90.3	4	0	15	59	26	--	30.0	11.5	90.5	0.836									
730.9-728.6	ML	16.0	93.4	3	9	28	47	16	--	16.8	2.1	114.4	0.456	0.21			ML 33.5	0.50				
727.9-726.2	CL	18.9	91.7	12	0	18	47	35	--	35.9	18.9	107.3	0.549		CL 14.0	0.68	18.7	0.45				
724.9-723.3	GC	16.2	--	29	49	25	15	11	.0042	29.8	12.1	--	--									
Boring US-7, Surface El. 750.7																						
748.7-748.0	GM	11.7	--	50+	51	31	15	3	.033	21.8	0.5	--										
744.7-742.3	SM	17.7	94.3	21	0	55	31	14	--	N.P.	N.P.	111.1	0.501		SM 16.0	0.60			SM 30.5	0.50	31.0	0.3
741.7-740.1	G-SM	23.3	73.5	7	28	32	25	15	--	44.7	16.2	92.9	0.896		SM 12.5	1.00						
738.7-736.8	CL-ML	18.0	95.1	4	0	41	37	22	--	21.7	5.4	112.7	0.518						CL-ML 23.0	0.85	32.[illegible]	0.1
735.7-734.1	CL	19.1	89.1	3	0	44	33	23	--	24.2	7.5	106.9	0.577		CL 5.0	0.42			CL 16.6	0.38	2[illegible].5	0.3
726.7-724.3	SM-SC	17.7	84.9	2	0	52	33	15	--	21.2	4.3	106.2	0.553				S 31.5	0.48				
720.7-719.9	CL	24.3	95.6	2	0	33	44	23	--	25.6	8.0	99.9	0.683									
719.9-718.3	SM	16.8	78.8	2	0	57	32	11	.003	18.5	0.9	106.4	0.579		CL 5.0	0.39						
717.7-716.5	CL	24.3	96.8	1	0	30	49	21	--	26.8	7.8	99.6	0.667		CL 2.0	0.21						
716.5-715.2	SM	23.2	94.4	1	0	63	25	12	.0036	19.6	0.5	101.1	0.656				SM 20.0	0.70				
708.7-707.7	SM	17.1	90.2	1	0	61	28	11	.004	N.P.	N.P.	110.7	0.506		SM 12.0	0.60	30.5	1.12				

In spite of the low penetr, densities are good.

Fdn / Old fill

Least dense. Not tested for satur R. Lab agrees it should have been tested.

For satur R: "Similar" to 7-735-73[illegible]. [illegible] Not very similar. Similar to 7-744.7-742. Indicates more saturated R tests have been made. Use conservative design values.

(Pencil from other [illegible])

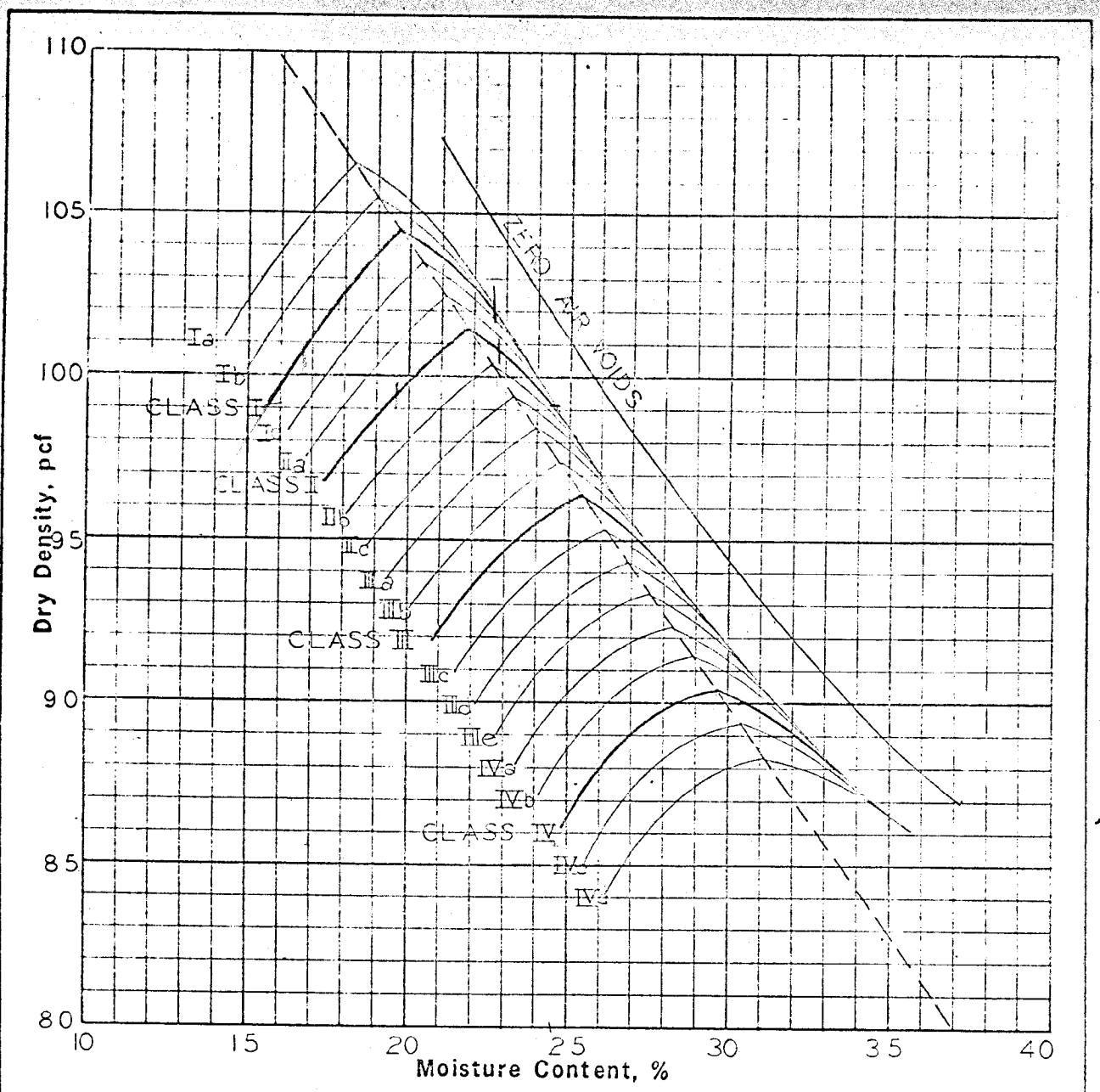
KINGSTON STEAM PLANT

BORROW AREA A, B, C

SUMMARY OF LABORATORY TEST DATA

BORROW SOIL CLASSES

Class	I	II	III	IV
% of total borrow	22%	22%	27%	29%
Symbol	CL, S	CH, S	CH	CH
Natural moist	24.6	32.5	39.1	35.1
Mechanical and Hydrometer Analysis				
Gravel, percent	0	0	0	0
Sand, percent	23	22	18	13
Silt, percent	34	26	20	14
Clay, percent	43	52	62	73
Atterberg Limits				
Liquid limit, percent	42.8	58.3	68.5	88.0
Plastic limit, percent	20.2	25.8	28.0	33.6
Plasticity index, percent	22.6	32.5	40.5	54.4
Shrinkage limit, percent	--	--	--	--
Standard Proctor Compaction				
wf - wo (wet)	4.9	5.7	6.9	5.5
Optimum moisture, percent	19.7	21.8	25.4	29.6
Maximum density, pcf	104.5	101.5	96.4	90.4
Penetration resistance, psi	--	--	--	--
Shear Strength at 3% Above Optimum Moisture and at 95% of Maximum Density				
Triaxial Q: ϕ, degrees	6.2	8.5	8.3	6.0
c, tsf	1.12	1.25	0.92	1.18
Triaxial R: ϕ, degrees	18.0	13.6	15.0	14.6
Saturated c, tsf	0.3	0.51	0.44	0.39
Shear Strength at 3% Below Optimum Moisture and at 95% of Maximum Density				
Triaxial Q: ϕ, degrees	24.7	27.6	17.0	16.0
c, tsf	1.80	1.80	2.25	1.90
Triaxial R: ϕ', degrees	13.4	16.4	20.5	12.2
Saturated c, tsf	0.30	0.20	0.00 ?	0.37



Soil Class	Gravel %	Sand %	Silt %	Clay %	Specific Gravity	LL %	PI %	Optimum Moisture, %	Maximum Density, pcf
I-CL	0	23	34	43	2.70	42.8	22.6	19.7	104.5
II-CH	0	22	26	52	2.73	58.3	32.5	21.8	101.5
III-CH	0	18	20	62	2.77	68.5	40.5	25.4	96.4
IV-CH	0	13	14	73	2.76	88.0	54.4	29.6	90.4

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

Remarks:

Project KINGSTON STEAM PLANT

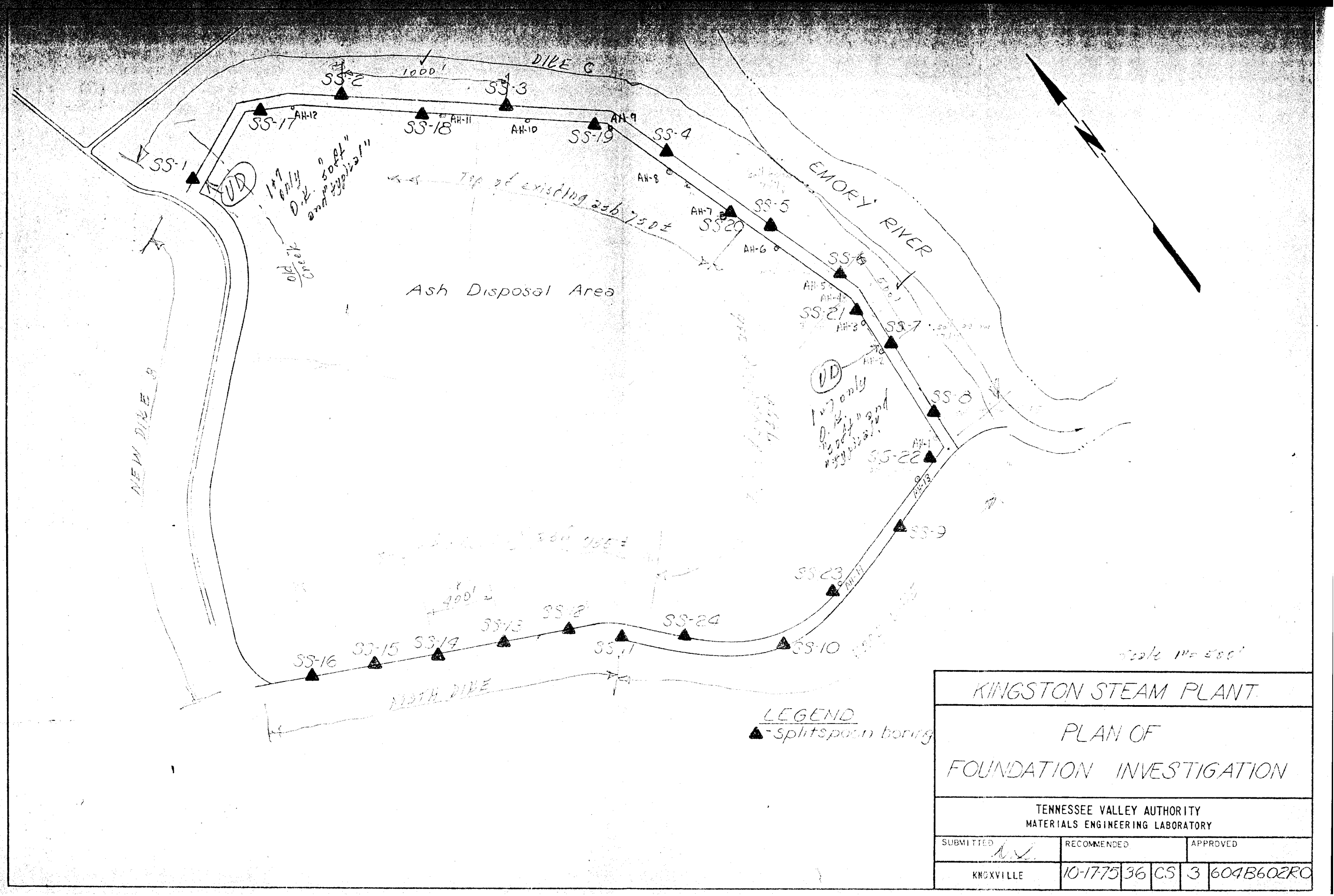
Feature BORROW AREAS A, B, C

ASTM Designation D-698

Date Tested 8-21-75

COMPACTION TEST (FAMILY OF CURVES)

Soil Form 14



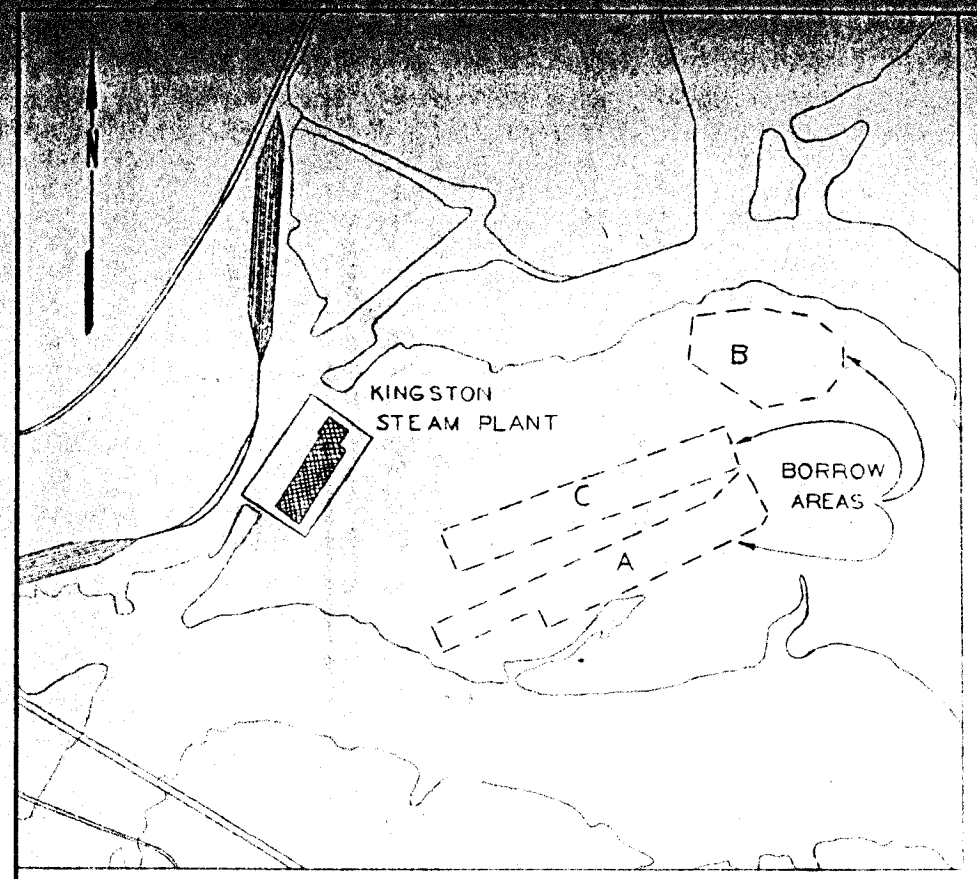
KINGSTON STEAM PLANT

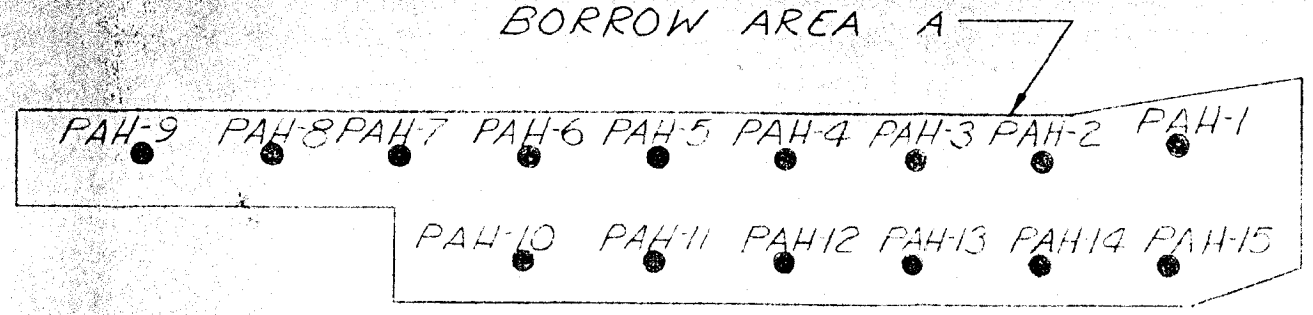
PLAN OF
FOUNDATION INVESTIGATION

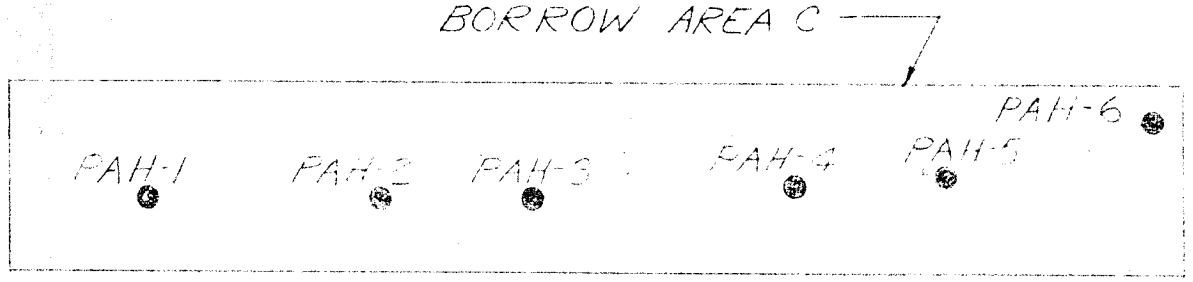
TENNESSEE VALLEY AUTHORITY
MATERIALS ENGINEERING LABORATORY

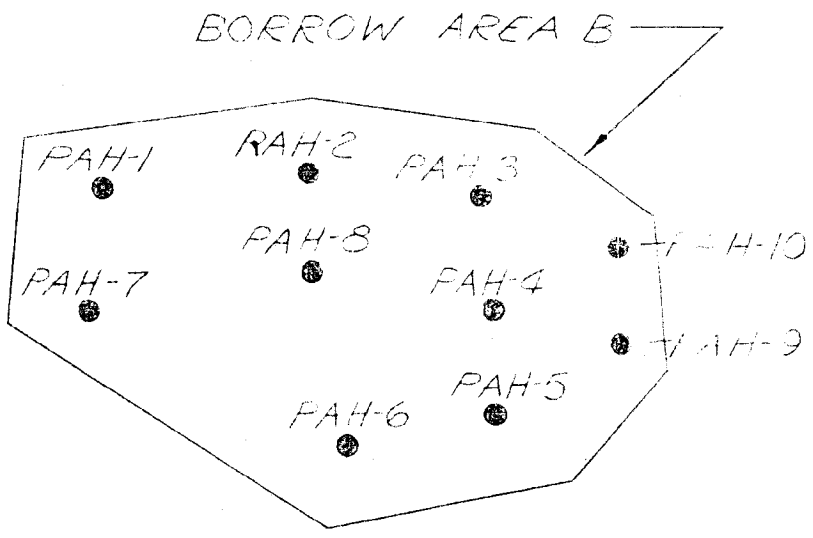
SUBMITTED	RECOMMENDED			APPROVED	
KNOXVILLE	10-17-75	36	CS	3	604B602RO

TVA-00000191









LEGEND

●–Auger boring

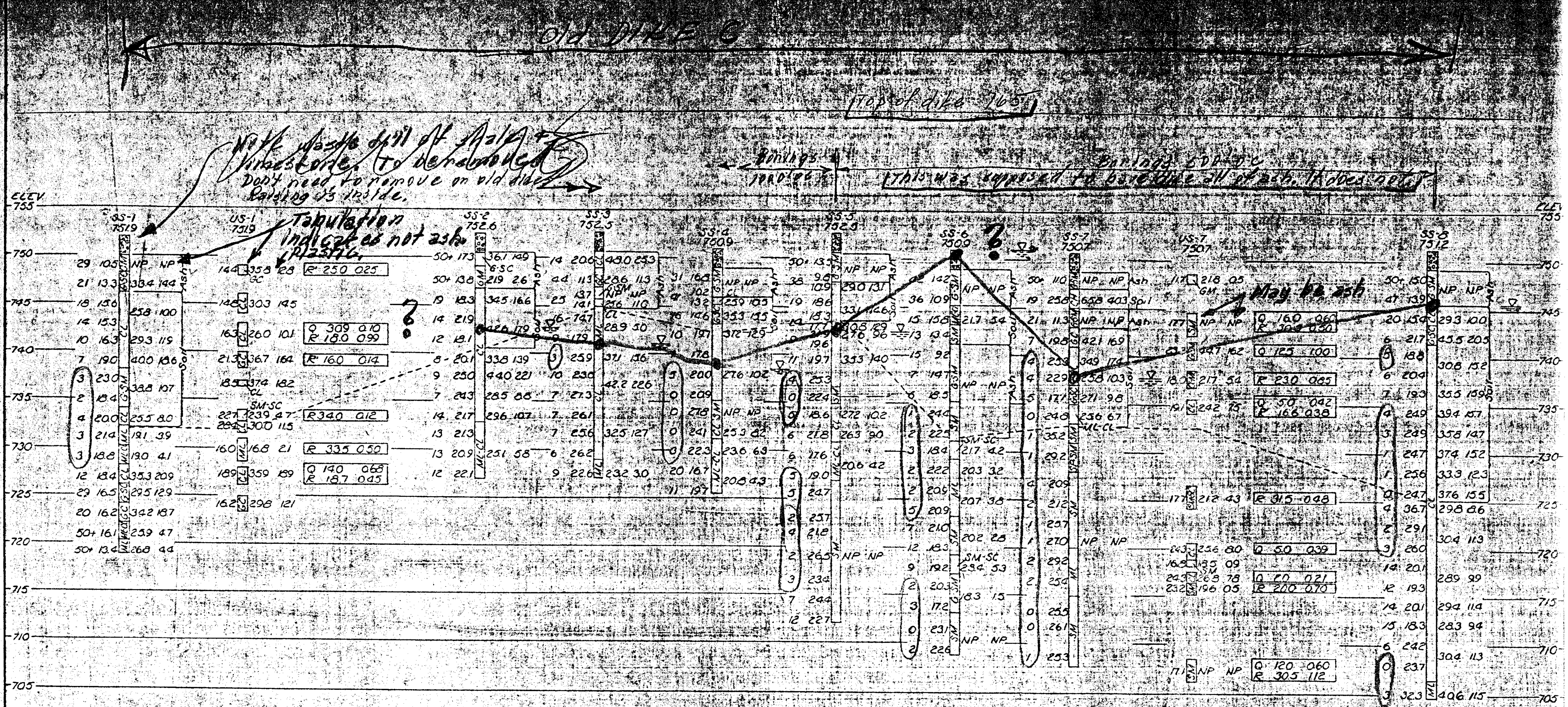
KINGSTON STEAM PLANT

PLAN OF

BORROW INVESTIGATION

TENNESSEE VALLEY AUTHORITY
MATERIALS ENGINEERING LABORATORY

SUBMITTED	RECOMMENDED	APPROVED



SYMBOLS

- Waste Fill (Shale and Limestone)
- Ash
- Q – Unconsolidated undrained triaxial
- R – Consolidated undrained triaxial compression test at natural moisture
- R' – Consolidated undrained triaxial compression test saturated
- Fill / Original ground
- Water table

Not used on this sheet

LEGEND

Boring No. / Elevation

Blows*	Natural Moisture Content	Classification	Liquid Limit	Plasticity Index	Type Test	Friction Angle (degrees)	Cohesion (tsf)

*Blows per foot with a 140 lb. hammer and a 30 inch drop on a 2 inch OD splitspoon sampler

Borings 1–8 are old DIKE C

SCALE: 1"=10'

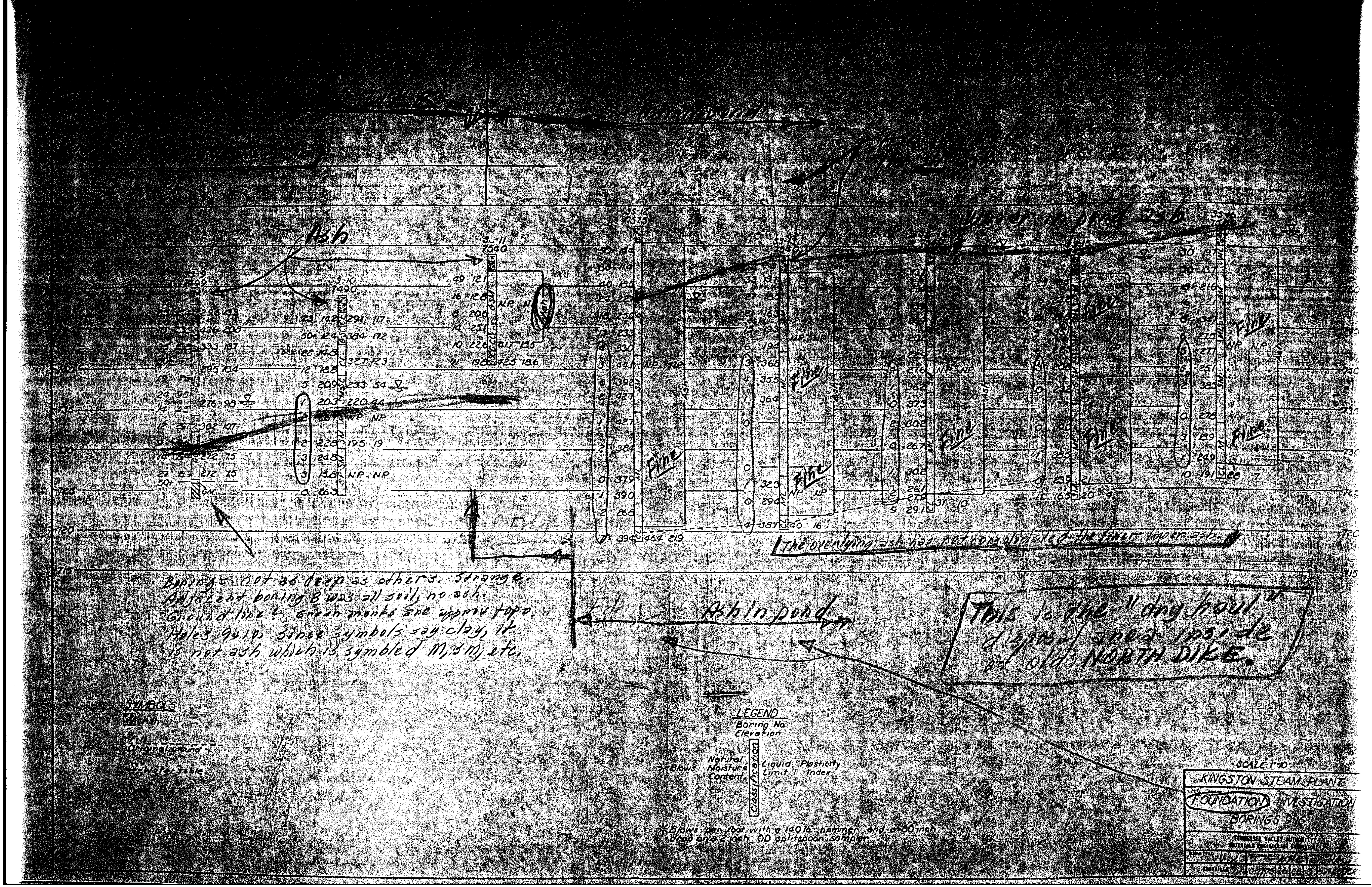
KINGSTON STEAM PLANT

FOUNDATION INVESTIGATION

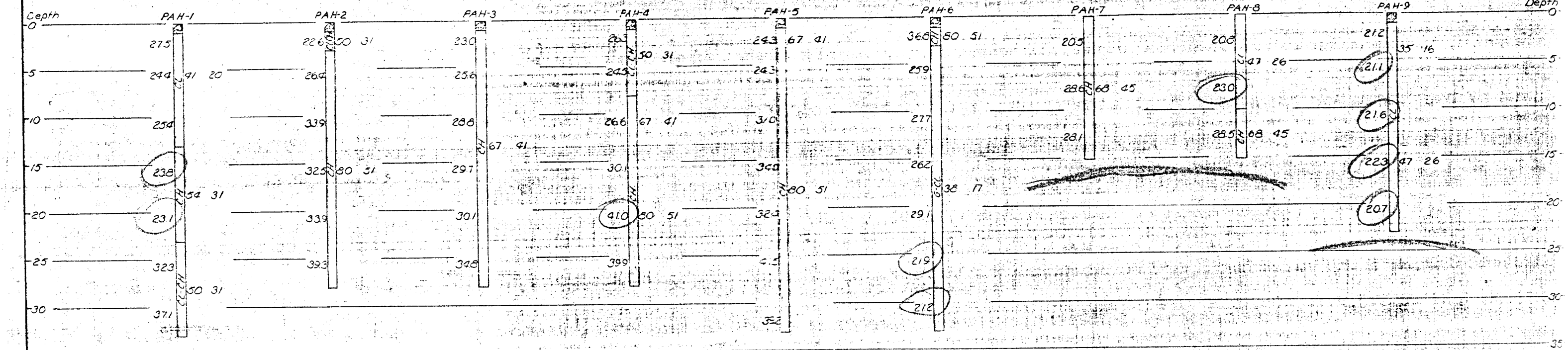
BORINGS 1-8

TENNESSEE VALLEY AUTHORITY
MATERIALS ENGINEERING LABORATORY

SUBMITTED A.J. RECOMMENDED WHG APPROVED Rw



Plot is depth.
No indication of topo re high and low areas
effect on moisture. CL+CH so probably little effect anyway.



Area A is apparently somewhat less CH, and somewhat drier than Areas B+C.

Classes III + IV CH
Opt moisture 25 to 30.

Classes I + II CL + sandy CH
Opt moisture 20 to 22.

Indications also: Area A 15' plus to wet borrow.
Area B 20' " " " " ?
Area C, partly 10' " " " " ?

No obvious stratifications.
Moisture content fairly consistent.
Apparently generally drier than Areas B+C.

Groundwater in borrow areas?

Phone with lab (Childres) 11/11/75
Effort was not made to locate groundwater as such.
The "high borings" were terminated when soil became obviously wet.

SYMBOLS
Topsoil

LEGEND
Boring No.
Natural Moisture Content | Classification | Liquid Limit | Plasticity Index

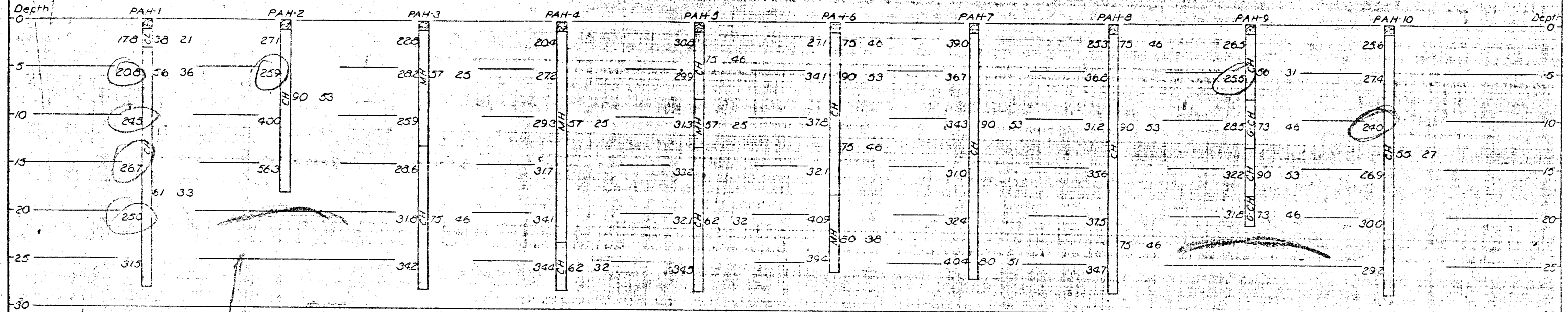
SCALE 1"=10'

KINGSTON STEAM PLANT
BORROW INVESTIGATION
AREA A
BORINGS 1-9

TENNESSEE VALLEY AUTHORITY
MATERIALS ENGINEERING LABORATORY

SUBMITTED	RECOMMENDED	APPROVED
CL	WHC	RAP

KNOXVILLE	10-17-75	36	CS	3	KINGSTON



Groundwater ?

See dwg 607.

No obvious stratification.
Mostly highly plastic CH
Moisture contents fairly consistent.

Area A is less CH.
Area C is all CH and
moisture variable.

SYMBOLS

TS - Topsoil

LEGEND

Boring No.

Natural Moisture Content | Classification | Liquid Limit | Plasticity Index

SCALE: 1" = 10'

KINGSTON STEAM PLANT					
BORROW INVESTIGATION AREA B					
TENNESSEE VALLEY AUTHORITY MATERIALS ENGINEERING LABORATORY					
SUBMITTED	RECOMMENDED	APPROVED			
KNOXVILLE	12-17-75	36-05	3	604K609	

R

Ash Inside
Old DIKE C

Ash Inside
Old ROAD DIKE

Soil Request says borrow ash only above El 746. There is little. But request says take UD for density and strength in-situ. This was not done.

Water in pond ash.

SS-17 750.2 | SS-18 750.4 | SS-19 749.5 | SS-20 749.8 | SS-21 747.7 | SS-22 747.9 | SS-23 749.0 | SS-24 748.5

CCEV 755

750 745 740 735 730 725 720

SYMBOLS
- Ash
- Fill
- Original ground
- Water table

LEGEND
Boring No
Elevation
*Blows | Natural Moisture Content | Classification | Liquid Limit | Plasticity Index

*Blows per foot with a 140 lb. hammer and a 30 inch drop on a 2 inch OD splitspoon sampler

These are borings of ash in pond along old DIKE C and ROAD DIKE

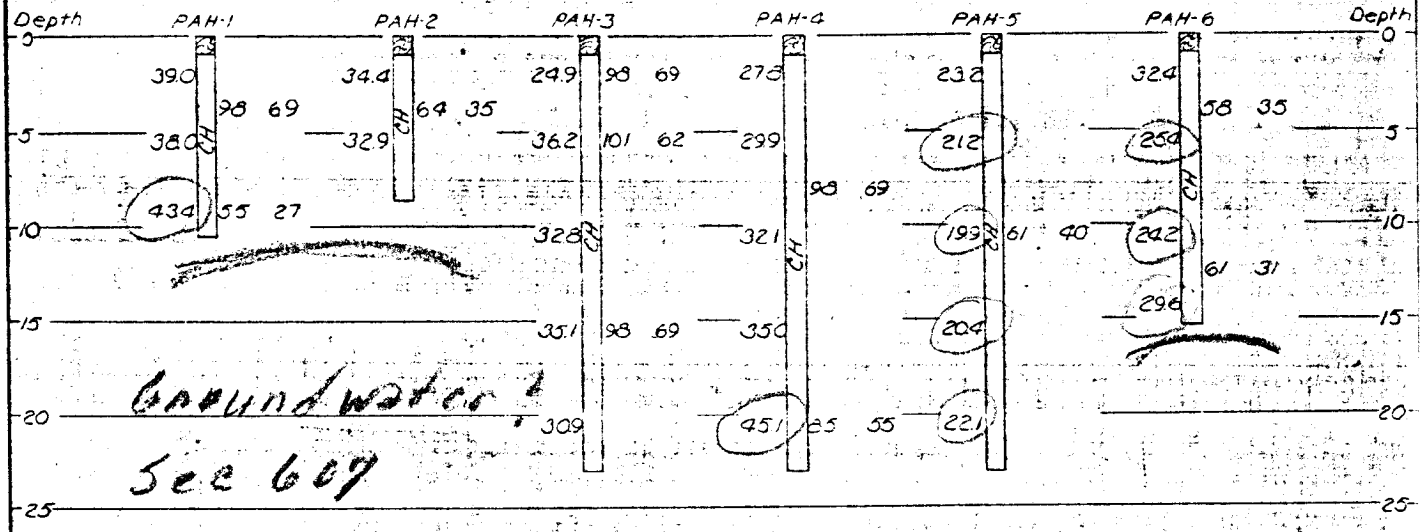
Not foundation Ash in pond.

SCALE: 1"=10'

KINGSTON STEAM PLANT
FOUNDATION INVESTIGATIO
BORINGS 17-24

TENNESSEE VALLEY AUTHORITY
MATERIALS ENGINEERING LABORATORY

SUBMITTED	RECOMMENDED	DATE	APPROVED
KNOXVILLE	017-75	36	CS	3	604.6



No obvious stratification.
All high plastic CH.
Moisture contents variable.
Area B is less CH.

SYMBOLS

TS - Topsoil

LEGEND

Boring No.

Classification | Natural Moisture Content | Liquid Limit | Plasticity Index

SCALE: 1" = 10'

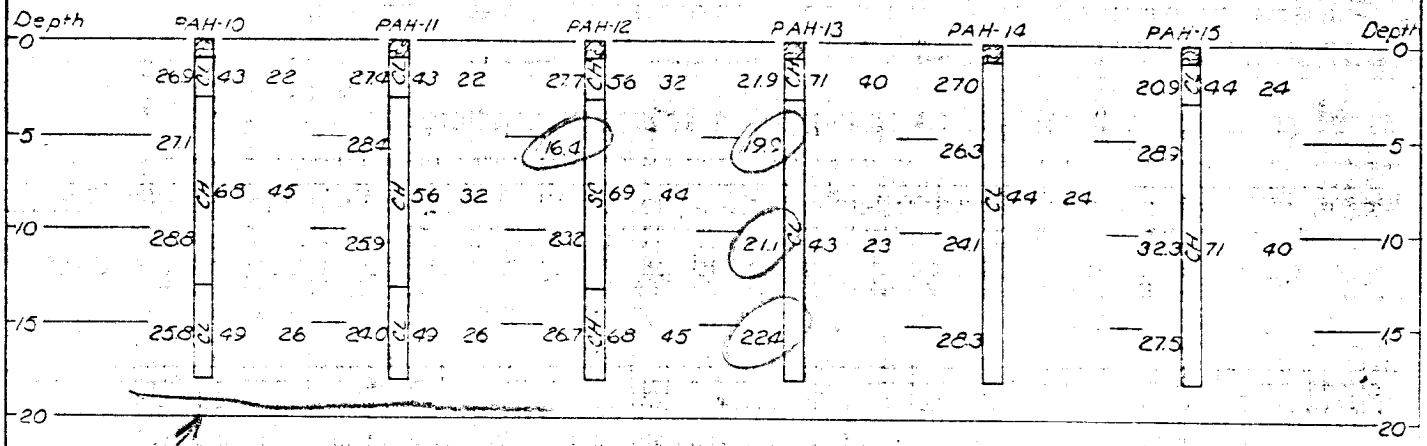
KINGSTON STEAM PLANT

BORROW INVESTIGATION

AREA C

TENNESSEE VALLEY AUTHORITY
MATERIALS ENGINEERING LABORATORY

SUBMITTED	RECOMMENDED	APPROVED
KNOXVILLE	10-17-75	



Groundwater ~ 2
See dwg 607

No obvious stratification, moisture contents fairly consistent

SYMBOLS

CL – Topsoil

LEGEND

Boring No.

Classification | Natural Moisture Content | Liquid Limit | Plasticity Index

SCALE: 1"=10'

KINGSTON STEAM PLANT

BORROW INVESTIGATION
AREA A
BORINGS 10-15

TENNESSEE VALLEY AUTHORITY
MATERIALS ENGINEERING LABORATORY

SUBMITTED	RECOMMENDED	APPROVED
	WHB	DV

KNOXVILLE	9-17-75	24	25	3	45-083

Gene Fo[illegible]er, Chief, Construction Services Branch, 305 NB-K (4)

W. W. Engle, Chief, Civil Engineering and Design Branch, 401 UB-K

June 26, 1974

KINGSTON STEAM PLANT - ASH DISPOSAL AREA DIKE RAISING - SOILS EXPLORATION AND TESTING

We request that you arrange for the Materials Laboratory to make soil explorations and laboratory tests for the proposed raising of the dikes around the ash disposal area. Attached are three prints of study drawing 10SN100 which shows the ash disposal area. The road dike and dike "C" are to be raised while dike "B" will be new construction.

Road Dike and Dike "C"

The road dike and dike "C" existing fill and foundation are to be investigated by standard penetration split-spoon borings spaced approximately 1000 feet on centers. The locations of these borings are to be adjusted or additional borings made so the area where the former Swan Pond Creek channel underlies dike "C" will be explored. Also, the borings should be about 500 feet on centers along the southern portion of dike "C" that was originally built with ash (indicated on drawing 10SN100). All borings are to extend into the dike foundation a minimum depth equal to one-half the height of the overlying raised dike above the original ground, unless bedrock is encountered sooner. One undisturbed boring is to be made five feet from the split-spoon boring which penetrated the "softest" dike fill composed of earth. One undisturbed boring is to be made five feet from the split-spoon boring which penetrated the "softest" dike fill composed of ash. Another undisturbed boring is to be made five feet from the split-spoon boring that penetrated the "softest" dike foundation material. Regarding all the undisturbed borings, if the "softest" material is isolated, at the creek crossing or elsewhere, additional undisturbed borings are also to be made to sample more typical material. The "softest" and more typical are to be tested. These undisturbed borings are to extend into the foundation to the same elevation as the companion split-spoon borings. Undisturbed samples are to be taken the full depth of the borings.

Visual classification is required on all samples. Index tests are to be made on representative split-spoon and undisturbed samples. Triaxial compression Q and R tests are to be made on representative undisturbed samples as follows:

KINGSTON STEAM PLANT - ASH DISPOSAL AREA DIKE RAISING - SOILS EXPLORATION AND TESTING

1. All foundation borings (earth). Two Q and two R tests on each soil type at natural moisture content. *Done.*

2. Existing dike fill (earth and ash). If materials are reasonably uniform, three Q tests at natural moisture content and three R tests saturated prior to shear. If materials are variable, a minimum of two Q and two R tests on the major material types. *Done. There was no significant ash.*

All borings should be made at the inside shoulder of the original dike. All holes created by borings should be backfilled with tamped earth.

Dike "B" Foundation

Dike "B" will be parallel to Swan Pond Road, and it will be constructed in the wet on previously deposited ash. Due to the above conditions, foundation sampling and testing would be very difficult to perform; therefore, we are not requesting the foundation of dike "B" to be investigated.

The dike stability will be assisted by buttressing by the existing road fill shown on 10SH100, section E-E.

Borrow

1. Earth. Approximately 450,000 cubic yards of earth borrow will be required to raise the road dike and dike "C" to elevation 765. An additional 450,000 cubic yards of earth borrow will be required to construct dike "B" if ash of sufficient quality and quantity is not available. Please determine if this quantity of suitable earth borrow can be obtained from borrow areas located on the Kingston Steam Plant Reservation. *see * on p. 2*

   The earth borrow materials are to be grouped by soil type. Each soil type is to have routine index tests and control curves for standard compaction. Each soil type is to have a minimum of two Q and two R triaxial shear tests. The "as molded" sample conditions should be at or very near 95 percent maximum dry density and at water contents approximately 3 percent above and 3 percent below optimum water content. R test specimens should be saturated prior to shear. *Done*

Gene Farmer
June 26, 1974

KINGSTON STEAM PLANT - ASH DISPOSAL AREA DIKE RAISING - SOILS EXPLORATION AND TESTING

2. Ash. If ash of sufficient quality and quantity is available, the base of dike "B" will be constructed of ash, and approximately 310,000 cubic yards of ash borrow will be required. The borrow areas for ash are located north of and adjacent to the north dike and on the inside of the road dike and dike "C." For the areas inside the road dike and dike "C," only that ash above elevation 746 and that ash which lies beyond the limits of the raised dike foundation will be available for borrow.

The ash is to be investigated by standard penetration split-spoon borings spaced approximately 1000 feet on centers along the road dike and dike "C" and approximately 400 feet on centers along the north dike. The spacings may be varied if necessary to more adequately cover the borrow areas. These borings are to extend to the original ground surface. | 1000' done | 400' done | Done

Since the ash fill base for dike "B" will be placed in the wet, final in-place densities are now uncertain. It is assumed that the ash fill base will be built by end dumping to minimum depth and compacting with tracked equipment. Therefore, in-place density tests are to be made on existing ash fills inside of dike "C" which have been constructed with comparable materials and by similar placement methods. These in-place density tests should be made in areas that have not been heavily traveled and at or below the saturation line in the ash. Density tests should be made in several locations to test various types of ash and can be done by undisturbed sampling or in open excavations. Laboratory permeability and shear tests are to be made on samples remolded to the low average density determined from these existing ash fills. Nothing in pipe See *

Each ash type is to have routine index tests, permeability tests, and a minimum of two Q, two R, and two S shear tests. The Q and R tests are to be made using the largest triaxial testing machine currently available at the Materials Laboratory. The S tests are to be made using the largest direct shear box currently available at the Materials Laboratory. The maximum ash particle size should be no more than 1/6 the diameter or thickness of the shear test specimen. All test specimens are to be saturated prior to shear.

These tests will provide information not only on the ash as borrow, but also on the present ash foundations of the road dike and dike "C" raising. inside the present dikes. (density, strength, perm) **

* Phone with Job (Childress) 11/10/75. Field men Connell and Hwy Group decided since plenty of earth is available for borrow and "ash is of poor quality," Dike B will be built all earth and ash borrow tests will not be made.

** UD samples from borings UD-1 and UD-7 were all earth. Results show there are no density or strength tests of ash foundation under DIKE C or ROAD DIKE raising, or replaced some tests for ash as possible base for DIKE B.

Gene Farmer
June 26, 1974

KINGSTON STEAM PLANT - ASH DISPOSAL AREA DIKE RAISING - SOILS EXPLORATION AND TESTING

Graphic logs of all borings are to be prepared. Ground water, if encountered, is to be indicated on the logs. Grain size curves on ash are to be submitted, including those on shear test specimens that may have been altered to suit the laboratory equipment. A brief description of the methods used to determine in-place densities for the ash and the size of the shear testing equipment used on the ash are to be included in the report.

Costs for this work are to be charged to DPP suborder number 82-330.

If assistance is needed at the steam plant, please contact L. B. Kennedy, Assistant Superintendent at Kingston Steam Plant.

If unusual or unforeseen conditions develop, please contact the Civil Engineering and Design Branch (R. J. Bowman, telephone extension 2738).

The report of the soils investigation is scheduled to be completed by January 1, 1975, as outlined in the memorandum from you to Roy H. Dunham dated March 12, 1974.

Original Signed By
W. W. Engle

W. W. Engle

Report is dated 11/3/75. Delayed by more urgent N.P. work.

JPHS:SDS:BLH
Attachments
CC: E. R. Brabham, 611 UB-K
I. L. Burroughs, 507 UB-K
R. G. Domer, 104 UB-K
Roy H. Dunham, 505 UB-K
B. S. Montgomery, 401 AB-K
H. H. Mull, 707 UB-K

6/26/74--RHD:PKM
CC: E. F. Thomas, 716 EB-C (2)

D.W. Gagne
11/12/75 1/7

Kingston Steam Plant - Ash Disposal Area Dike Raising - Soils Report 11/3/75 - Evaluation

Reference Study Dwg 36-C-4-105N100 with 6/26/74 soils investigation request.

1. Existing Dike C and Road Dike. Dikes to be raised on existing ash in the pond inside the dikes.
   a. Investigation was done in accord with 6/26/74 request re concerns existing fdn and fill of dam dikes. The request emphasized testing for and testing the "softest" soil, and testing more typical soil also. Penetration tests showed generally similar and generally "soft" soils in the existing dikes fdn and some in the existing fill. Inasmuch as the emphasis was on soft soils done in borings 1 and 7 of the 10 core holes is sufficient.
   b. The request included information that the south 2000'± of existing Dike C was built with ash. Test of three 500'oc borings showed mostly soils material; 10 samples comp 7. No tests were made in ash.
   c. 5th power borings were made in the new dikes on the inside of Dike C and Road Dike as requested. Penetration values show the soil to be mostly silt size (mean 0.074 mm) and almost uniformly soft. See also 2.c.

2. New Dike B. "Inside" of existing county road embankment. To be built on existing ash in pond.
   a. Request said that since the area has present ash low and is under water, "test" exploration and testing is not requested. Instead,
   b. The request expected that "heavy ash" would be used as fill as "foundation" for Dike B to get above water, then complete dike with earth fill. The request asked for exploration and testing of ash above El 746 along the inside of Dike C and Road dike as "borrow," and to indicate extent along the "inside" of existing North Dike where dry hauled heavy ash has reportedly been deposited.

Std penetration borings were made as requested along these areas. Part of the area inside existing Dike C and Road Dike has 1 or 2 feet of apparently coarse ash on top. There is little ash above El 746; it is reported as silty sand size (minus 3/16"). Pond water is at top of ash. Along the inside of existing North Dike, the dry haul deposits, two feet of coarse ash is indicated on top. Top is El 750 to 757. Water is at top of ash; does not drain out. About 10' is reported as silty sand size. Below

2. b. (cont)
this the ash is reported as mostly silt size, and soft by the low penetr values.
[The upper ash has higher penetr values, is therefore firm and more dense; but its weight has evidently not consolidated the finer lower ash under submerged conditions. The same applies along the inside of Dike C and Road Dike].

c. The request asked for in-place density tests of ash along the inside of Dike C and Road Dike, then strength tests of the ash. These would serve as strength tests for the "borrow" ash to be used under new Dike B, and strength tests of ash under Dike C and Road Dike raising. These tests were not made.

In phone discussion with SME it is stated that the field exploration crew discussed the ash exploration with Hwy Group personnel. The request said that ash "of suitable quality" would be used for Dike B fdn borrow, assuming that heavy ash would be found in the explored areas. Since the explored ash was of sand and smaller size, they

2.c. (cont)
decided that it could not be used for placing in water for Dike B foundation.

The decision included elimination of strength testing of the in-place ash along the inside of Dike C and Road Dike as foundation for raising these dikes.

So no ash has been tested anywhere.

5. Earth Borrow.

Three borrow areas were explored east of the plant. With estimated 2 million c.y. available for the request's estimated 900,000 c.y. required if Dike B is all earth without heavy ash base.

a. All borrow is reported averaging 40% to 50% wet of optimum, mostly CH, some CL.

b. Groundwater was not definitely established in borrow areas. But lab says borings were stopped when down to too wet soil.

c. Preference of borrow areas seems to be in order - A, B, C.

(1) A is somewhat drier than B and C, and somewhat less CH.

3.c. (cont)

(2) A has 15' to 30' depth to too wet soil.
B " 15' to 25' " " " " " "
C has 3 of 6 holes only 10' to 15' to too wet soil.

(3) Report logs are depth not elevation, so I have no conception of the topo as regards borrow feasibility.

4. Design.

I am told that dikes design and construction is already very late. Design will have to proceed with present info.

a. Dike and Road Dike

(1) Use soil design values below

KINGSTON STEAM PLANT – ASH DISPOSAL AREA DIKE RAISING – SOIL INVESTIGATION

p. 4 of soils report

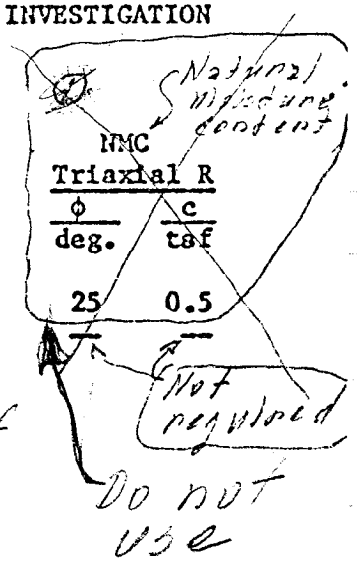
Lab Recommended Design Values

	γ_w	Triaxial Q ϕ deg.	Triaxial Q c tsf	Saturated Triaxial R ϕ deg.	Saturated Triaxial R c tsf	NMC Triaxial R ϕ deg.	NMC Triaxial R c tsf
Foundation	125 ✓	5 ✓	0.4 ✓	17 ✓	0.4 ✓	25	0.5
Embankment	120 ✓	6 ✓	1.0 ✓	15	0.4	—	—

✓ = O.K.

Use $\phi = 15^\circ$ c = 0.3 tsf

Gene Farmer



WHC:PO
Attachments

4.a. (cont)

The change in embankment saturated R cohesion is to account for soil drier than 3% wet of optimum, which may be encountered. Admittedly it may not be important; the number will be used ① for main "outslope" stability circle which only cuts up thru the new fill for a short part of its arc with most of arc in old dike fdn, and ② "inslope" circle on existing ash which has not been tested.

(2) Assume no strength in existing ash under dike raising. Assuming computer analysis, use "peculiar circles" to cover the slip possibilities on the "outslope." I see no sensible design for the "inslope" of new dike on ash. If it can be built it will have a safety of 1+ from vibration of earth hauling and compacting equipment. It can be improved by excav ash deeper than 746, placing fill, then "piling" ash along the inside to help support it. Can we assume the area has had traffic from ash haul and dump inside the dike? The top ash is firm.

4. (cont)
b. Dike B.

J.P.H. Stivers says the layout of Dike B is being studied again. It may be moved "out" to incorporate present county road embankment. There are exterior drainage problems the Hwy Group is struggling with. The soil in the road embankment and its foundation have not been tested.

The ash under presently proposed or under the above move is unknown. See 2. b. & c.

I make no suggestion on Dike B design. The problem of placing its base in water still exists. The explored ash inside Dike C, Road Dike and North Dike is probably too fine for placing in water. Is there not bottom ash or other "heavy" ash available in the original ash disposal area south of the North Dike?

Some of the preceding comments could deserve recognition or notes on dwgs.

Copy sent to
Hwy Group (Stansberry)
11/12/75
CMQ