

AD-A166 493 EMBANKMENT CRITERIA AND PERFORMANCE REPORT CAVE RUN
LAKE LICKING RIVER BASIN KENTUCKY(U) ARMY ENGINEER
DISTRICT LOUISVILLE KY APR 66 F/O 13/

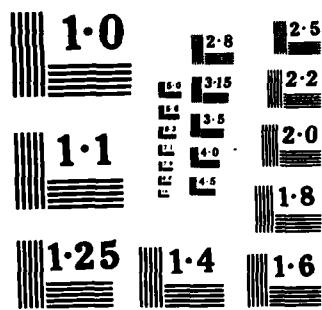
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US Army Corps
of Engineers
Louisville District

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Embankment Criteria And Performance Report

AD-A166 493

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Cave Run Lake
Licking River Basin
Kentucky

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April 1986

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Aerial View of Cave Run Lake

CAVE RUN LAKE, KENTUCKY
EMBANKMENT CRITERIA AND PERFORMANCE REPORT

TABLE OF CONTENTS

<u>Paragraph</u>	<u>Title</u>	<u>Page</u>
	Pertinent Data	a
1	General	1
	a. Authority	1
	b. Project Purpose	1
	c. Project Location	1
	d. History of Construction	1
2	Geology	2
	a. Project Area	2
	b. Damsite	2
	c. Abutments	3
	d. Spillway	3
3	Foundation and Abutment Treatment	3
	a. Right Abutment	3
	b. Flood Plain	3
	c. Left Abutment	3
	d. Grout Curtain	4
4	Embankment	4
	a. General	4
	b. Material Sources	5
	c. Compaction Equipment	5
	d. Materials Placement	6
	e. Seepage Control	7
	f. Shear Strengths	7
	g. Initial Design Stability Analyses	9
	h. Supplemental Design Stability Analyses	10
	i. Construction Stability Analyses	11
5	Construction Sequence	14
	a. First Construction Year (1969)	14
	b. Second Construction Year (1970)	14
	c. Third Construction Year (1971)	14
	d. Fourth Construction Year (1972)	15
	e. Fifth Construction Year (1973)	15
6	Changes in Design and Modifications	15
	a. Borrow-Source Changes	15
	b. Rezoning of Embankment Materials	15
	c. Installation of Vertical Sand Drains and Excessive Water Problems	16
	d. Upstream Stability Berm	16

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TABLE OF CONTENTS (Cont'd)

<u>Paragraph</u>	<u>Title</u>	<u>Page</u>
7	Major Construction Difficulties	17
8	Instrumentation	17
	a. General	17
	b. Piezometers	17
	c. Movement Monuments	18
	d. Settlement Gages	18

TABLES

<u>Number</u>	<u>Title</u>	<u>Page</u>
1	Adopted Shear Strength Design Values	8
2	Initial Design Stability at Station 16+00	9
3	Supplemental Design Stabilities at Station 6+50	10
4	Peak Shear Strength of Cube Sample	11
5	Factors of Safety Using Peak Cube Sample Strengths	11
6	Factors of Safety Using Ultimate Cube Sample Strengths	12

PLATES

<u>Plate Number</u>	<u>Title</u>
1	Reservoir Area
2	General Plan
3-4	Borrow Areas
5-7	Boring Location Plans
8-9	Geologic Profile Dam
10	Construction Procedures
11	Grouting Plan and Profile
12	Drainage System for Horizontal Drains
13	Typical Dam Sections
14	Plan of Embankment Sand Drains
15	Seepage Control Measures
16-26	Adopted Design Shear Strength Envelopes
27-32	Record Samples Shear Strength Envelopes
33-36	Design Stability Analyses Sta. 16+00
37-38	Design Stability Analyses Sta. 6+50
39	Supplemental Design Stability Analyses Sta. 16+00 - Consolidation
40	Supplemental Design Stability Analyses Sta 16+00 - Instantaneous Consolidation
41	Critical Construction Stability Analyses using Peak Strengths
42	Critical Construction Stability Analyses using Ultimate Strengths
43-44	Analyses for Sizing Stability Berm
45-46	Stability Analyses - Weak Material Removal from Upstream Toe
47	Stability Analyses - Selection of Upstream Berm
48	Instrumentation Plan - Piezometers
49	Instrumentation Plan - Movement Monuments and Settlement Gages
50-62	Piezometer Readings 1977-1979
63-76	Movement Monument Readings 1972-1981
77-80	Settlement Gage Readings 1971-1976
81-82	Materials Usage Charts
83	Summary of Field Compaction Control Test Data, and Design Placement Requirements
84-128	Field Compaction Control Test Data Sheets

APPENDIX

A	Photographs
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CAVE RUN LAKE
LICKING RIVER BASIN
EMBANKMENT CRITERIA AND PERFORMANCE REPORT

PERTINENT DATA

1. Authority for Project. Flood Control Act designated as Public Law 738, approved on 22 June 1936, 74th Congress, 1st Session, and Flood Control Act designated as Public Law 761, approved on 28 June 1938, 75th Congress, 3rd Session.

2. Purpose of Project. To furnish flood protection in the valley of the Licking River Basin. The reservoir project is a unit in the general comprehensive plan for flood control and allied purposes in the Ohio River Basin. A secondary purpose of the project is to provide storage for water supply and a pool for recreation and fish and wildlife activities.

3. Location of Project. The project is located in east-central Kentucky, approximately 84 air miles southeast from Cincinnati, Ohio, and about 118 air miles east from Louisville, Kentucky. The damsite is on Licking River, 173.6 miles above its junction with the Ohio River and four miles upstream from Farmers, Kentucky.

4. Drainage Area at Damsite. 826 square miles.

5. Reservoir.

Item	Elevation (feet msl)	Area (acres)	Storage	
			Acre-Feet	Inches Runoff
Minimum Pool	720	6,790	147,300	3.34
Water Quality Pool	724	7,390	175,600	3.99
Seasonal Pool	730	8,270	222,600	5.05
Flood Pool	765	14,870	614,100	13.94
Water Quality Storage	720-724	-	28,300	0.65
Seasonal Storage	724-730	-	47,000	1.06
Flood Storage	724-765	-	438,500	9.95
Seasonal Flood Control	730-765	-	391,500	8.89

6. Dam.

a. Embankment

Type	Earth and rockfill
Top Elevation (msl)	788
Maximum Height, feet	148
Length, feet	2,700
Top Width, feet	30

Side Slopes - Upstream

1V on 2.5H down to elev. 765
 1V on 3H down to elev. 737
 1V on 30H down to elev. 732

- Downstream

1V on 3.5H remainder
 1V on 2.5H down to elev. 765
 1V on 3H remainder

b. Spillway
Type

Open cut through divide ridge
 near left abutment

Crest Elevation (msl)
 Bottom Width, feet
 Side Slopes

765
 650
 1V on 3H in overburden
 (10-foot berm)
 4V on 1H in rock

c. Outlet Works

Conduit Type

Circular, concrete

Conduit diameter, feet

15

Control Gates, number

2

Size of Gates, feet

6.75 x 15

Discharge capacity with:

Minimum Pool, elev. 720, cfs

7,500

Water Quality Pool, elev. 724, cfs

7,800

Seasonal Pool, elev. 730, cfs

8,200

Flood Pool, elev. 765, cfs

10,300

Invert Elevation (msl)

656

7. Land Acquisition

Fee, acres

8,270

8. Relocations

a. State Highways

Kentucky 801
 Kentucky 1274
 Kentucky 519
 Kentucky 1240
 Kentucky 985
 Kentucky 976
 Kentucky 7
 Kentucky 1161

10.5 miles
 24.5 miles
 14.9 miles
 6.1 miles
 7.3 miles
 7.0 miles
 1.5 miles
 3.1 miles

b. County Roads

Morgan County
 Rowan County
 Menifee County

17.3 miles
 3.6 miles
 20.8 miles

c. Forest Service Roads

FSR 16	5.8 miles
FSR 118	1.2 miles
FSR 129	7.7 miles

d. Public Utilities

Electric (Clark RECC)	Relocation	28.5 miles
	Abandonment	23.4 miles
Electric (Licking River RECC)	Relocation	8.6 miles
	Abandonment	8.4 miles
Electric (Grayson RECC)	Abandonment	4.8 miles
Electric (Kentucky Power Co.)	Relocation	2.2 miles
Electric (East Kentucky RECC)	relocation	0.7 miles
Gas (Tennessee Gas Co.)	Abandonment	6.5 miles
Gas (United Fuel Gas Co.)	Relocation	2.8 miles
	Abandonment	2.8 miles
Telephone (Mountain RECC)	Abandonment	12.8 miles
	Relocation	13.1 miles
Telephone (General Telephone)	Abandonment	15.6 miles
	Relocation	3.6 miles

9. Hydroelectric Power. None

10. Construction Time. 5 years.

CAVE RUN LAKE
LICKING RIVER BASIN
EMBANKMENT CRITERIA AND PERFORMANCE REPORT

1. General.

a. Authority. Authority for preparation of the Embankment Criteria and Performance Report for Cave Run Dam is contained in ER 1110-2-1901, dated 1 August 1972.

b. Project Purpose. To furnish flood protection in the valley of the Licking River Basin. The reservoir project is a unit in the general comprehensive plan for flood control and allied purposes in the Ohio River Basin. A secondary purpose of the project is to provide storage for water supply and a pool for recreation and fish and wildlife activities.

c. Project Location. The project is located on Licking River, 173 miles above its junction with the Ohio River and 4 miles upstream from Farmers, Kentucky. It is located about 84 miles southeast of Cincinnati, Ohio, and 118 miles east of Louisville, Kentucky. The reservoir area is shown on Plate 1. The general plan is shown on Plate 2.

d. History of Construction. The Outlet Works, Contract CIVENG 15-029-65-75 for the construction of the operating tower, conduit, and stilling basin was awarded on 27 May 1965 to Markwell and Hartz, Inc., of Memphis, Tennessee, and completed 29 August 1967. Contract DACW 27-69-B-0058 for the construction of the dam and spillway was awarded to Guy H. James Construction Company of Oklahoma City, Oklahoma, on 29 August 1969 and completed on 15 September 1973.

Significant Contract Dates

15 September 1969	Started clearing outlet channel and damsite.
16 April 1970	Began excavating the cutoff trench on the left bank and finished stripping right abutment to rock.
4 May 1970	Started placing fill in the temporary dike and the left portion of the dam embankment.
10 April 1971	Started installing vertical sand drains.
23 May 1971	Temporary dike was finished.
24 November 1971	The embankment reached elevation 721.

27 October 1972

The embankment reached elevation 740 right of the conduit.

16 July 1973

A rise in piezometer levels with visual and actual recorded movements noted necessitated the halting of the fill placement. An emergency berm was constructed to elevation 737.

15 September 1973

Dam embankment completed.

2. Geology.

a. Project Area. The project area is located along the border of the Blue Grass and Eastern Kentucky Coal Field regions of Kentucky. The topography is characterized by dendritic drainage developed on steep hillside slopes. Relief in the area is approximately 700 feet. The Licking River has developed a broad flood plain below and above the damsite. The flood plain varies from one to two miles wide downstream from the dam to 1/2 mile to 1 mile upstream to the junction of Bath, Menifee and Rowan Counties. This flood plain has been developed on the Ohio Black Shale. Above the junction of the three counties, the flood plain narrows to 400 to 600 feet in width. The narrow flood plain has developed in the New Providence sandstone and shales. Structurally, the area is located on the east flank of the Cincinnati Arch. The geologic formations encountered are the New Providence, Sunbury, and Bedford formations of the lower Mississippian and Ohio Black Shale of Devonian Age. The regional dip is 30 feet per mile to the southeast. Dominant joint patterns recorded are N85W, N30W, N10E and N45E. The site is considered quiescent and no earthquake shocks are known to have occurred which would have caused an intensity greater than VII (modified Mercalli scale) at the damsite. The maximum intensity was associated with 1811-1812 earthquakes near New Madrid, Missouri.

b. Damsite. There is considerable lithologic variation in the bedrock strata at the damsite. A general description of the rock in this area is given below in descending order.

- (1) Lower New Providence Formation. This formation caps the hills in the immediate damsite area. Lithologically, the formation consists of gray soft silty shale; interbedded sandstone and shale; gray fine grained fairly well cemented sandstone with thin interbedded gray shale; and gray medium hard sandy shale at the base.
- (2) Sunbury Shale. A black, fissile, hard carbonaceous shale which is very similar to the Ohio Black Shale which is described below. This shale is usually fairly highly-jointed and varies in thickness from 14 to 16 feet.

- (3) Bedford Shale. A light gray to gray medium hard shale with white calcareous sandy seams and laminae which separates the Sunbury and Ohio Black Shale and has a thickness of approximately 26 feet.
- (4) Ohio Black Shale. A black, hard, fissile, carbonaceous shale with some pyrite nodules and thin limestone seams.

The geologic profile of the dam axis is shown on Plates 8 and 9. For reference, boring location plans are presented on Plates 5 through 7.

c. Abutments. The dam abutments are composed of the lower New Providence formation, Sunbury Shale, Bedford Shale, and upper Ohio Black Shale. There is approximately 0 to 8 feet of clay on the side slopes overlying sandstone and weathered shale. At the toe of the right abutment is 28 feet of colluvium (clay with soft weathered shale and sandstone fragments and boulders). The left abutment has overburden varying from 3 feet of residual clay overlying the New Providence formation to 12 feet of weathered sandstone boulders and clay rubble. When not protected by the overlying formations, the Bedford Shale is highly weathered and soft.

d. Spillway. The spillway cut is in the lower portion of the New Providence formation. The crest is in a medium-hard to hard, fine grained, fairly well cemented sandstone with 1.0' - 2.0' bedding. Overburden which is basically a clayey sand and the top 6 feet of rock which is a highly weathered, soft shale, is cut on 3 horizontal to 1 vertical slopes. There is a 10-foot berm at the base of highly weathered shale below which the rock is cut on 1 horizontal on 4 vertical slopes.

3. Foundation and Abutment Treatment.

a. Right Abutment. The entire right abutment was stripped to rock from station 5+30 to the end of the embankment to remove colluvial material. A special treatment area 30 feet wide was hand cleaned before placement of the embankment materials.

b. Flood Plain. A cutoff trench was excavated to unweathered rock from station 5+30, which was roughly the right bank of the original river channel, to station 28+00. The cutoff trench had a bottom width of 50 feet, 1V on 2H side slopes, and averaged 30 feet in depth. The trench was backfilled with impervious material to provide a positive cutoff in the pervious foundation layers. The remainder of the foundation was stripped of topsoil.

c. Left Abutment. An inspection trench with a bottom width of 10 feet and 1V on 1H side slopes was excavated 6 feet deep from dam station 28+00 to the end of the embankment. The remainder of the foundation was stripped of topsoil.

d. Grout Curtain. A single line grout curtain extended from station 2+63 to 30+00. These holes were drilled a maximum depth of 55 feet into the foundation rock and were initially located 20 feet apart. The holes were split spaced as close as 2.5 feet on centers as required to assure a tight foundation. It was thought that only the top 10 to 20 feet would be jointed and therefore take any grout. In practice, it was found that the upper zone was relatively tight and that the lower zone experienced some large grout take from station 14+00 to 21+00. The total amount of grout hole drilling was 16,658 linear feet. The total amount of grout used was 4,290 cubic feet. The grouting plan and profile are shown on Plate 11. A more detailed description of the grouting is contained in the Foundation Report.

4. Embankment.

a. General. The embankment section utilized the suitable required excavation from construction and borrow from the designated areas. The embankment was constructed to elevation 788 for a maximum height of 140 feet above the streambed. Crest width is 30 feet. The length of the dam is 2,700 feet at the crown.

The embankment is constructed of compacted impervious fill with 1V on 3.5H slopes. The inclined drain of crushed limestone is 5 feet in width and extends from natural ground to elevation 765 on a 1 on 1 slope. The inclined drain connects to a horizontal drain 25 feet in length and 3 feet in thickness that connects to 3-foot thick finger drains which are 10 feet in width and spaced on 50-foot centers extending to the downstream toe of dam. The finger drains are located from station 6+00 to 25+00 and were installed under a contract modification to reduce the quantity of drain material. The right abutment to station 6+00 has a continuous horizontal blanket drain. Rock excavation from the spillway was placed downstream of the inclined drain to the downstream toe of dam. The random rock was placed to elevation 700± except in the river channel area which was filled to approximately elevation 735. Vertical sand drains 12 inches in diameter and spaced on 12-foot equilateral triangle pattern were installed from station 10+30 to 23+00 starting 75 feet upstream of centerline to a minimum of 20 feet from the upstream toe of dam.

A compacted impervious core with 2V on 1H slopes was constructed to elevation 740. The embankment upstream and downstream of the core is compacted random earth fill. Above elevation 740± compacted impervious fill extends to elevation 785 with a 20-foot top width and 9V on 1H slope upstream and downstream. The remainder of the embankment is constructed of compacted random earth fill. A 50-foot bottom width cutoff trench was provided from station 5+40 to 28+00. An inspection trench 6 feet in depth and 10-foot bottom width was excavated from station 28+00 to the end of dam.

The upstream slope is protected by 180-pound maximum size stone on a 9-inch bedding from elevation 715 to 732 and elevation 737 to top of dam. The top of berm from elevation 737 to 737 is protected by a 2-foot thickness of shale.

A toe drain was installed at the downstream toe of the dam from station 5+50 to 15+00 and station 18+00 to 23+00. Horizontal drains with 1-1/2-inch diameter screens were installed in the upstream embankment on 25-foot centers from station 4+23 to 23+00 with additional drains installed at 12.5-foot centers in the vicinity of stations 6+50, 11+00 and 16+25. The typical dam sections are shown on Plate 13. Details of the drainage system for the horizontal drains are shown on Plate 12.

b. Material Sources. Approximately 4,100,000 cubic yards of impervious earth, random earth and random rock drainage and transition material, and protection stone were required in the dam section. The material used to construct the primary embankment zones is presented below.

<u>Material</u>	<u>Source</u>
Impervious earth	Borrow areas
Random earth	Borrow areas
Random rock	Spillway
Stability berm	Borrow areas
Filter sand	Borrow areas
Graded aggregate	Commercial
Bedding	Commercial
Riprap	Commercial

The Materials Usage Charts are shown on Plates 81 and 82.

c. Compaction Equipment. The following rollers were used in compacting the embankment materials:

Tamping Rollers:
Ferguson SP-120D

- (1) Drum
 - a. Number - 2
 - b. Diameter - 60 in.
 - c. Length - 60 in.
- (2) Tamping Foot
 - a. Base Area - 11.5 in. ².
 - b. Length - 7 in.
 - c. Number/wheel - 120
 - d. Shape - rectangular
- (3) Roller Weight
 - a. Empty - 32,920 lbs.
 - b. As used - 44,500 lbs.
- (4) Foot Pressure
 - a. Empty - 295 psi
 - b. As used - 393 psi

Ferguson SP-120B

- (1) Drum
 - a. Number - 2
 - b. Diameter - 60 in.
 - c. Length - 60 in.
- (2) Tamping Foot
 - a. Base area - 9.5 in. ²
 - b. Length - 9 in.
 - c. Number/wheel - 120
 - d. Shape - Circular
- (3) Roller Weight
 - a. Empty - 28,170 lbs.
 - b. As used - 38,370 lbs.
- (4) Foot Pressure
 - a. Empty - 168 psi
 - b. As used - 228 psi

Vibratory Rollers:
Hyster C250A

- (1) Drum
 - a. Number - 1
 - b. Diameter - 60 in.
 - c. Length - 68 in.
- (2) Static roller weight - 21,500 lbs.
- (3) Dynamic pressure - 49,000 lbs.
- (4) Vibrating frequency - 1,200 vpm

Pneumatic-Tired Rollers:
W. E. Grace Mfg. Co. Model W18R

- (1) Tires
 - a. Number - 4
 - b. Size - 18.00 x 25
 - c. Ply rating - 24
 - d. Spacing - 28 in.
- (2) Roller width, weight and tire pressure
 - a. Width - 108 in.
 - b. Weight - 50 tons
 - c. Tire pressure - 45 to 85 psi
- (3) Contact pressure - 125 psi

d. Materials Placement:

(1) Impervious Zone. This material was spread in 6-inch loose lifts and compacted by 6 complete passes with either a Ferguson SP-120D or Ferguson SP-120B tamping roller. The moisture content permitted by the specifications was between plus or minus 2 percentage points of optimum.

(2) Random Earth. This material was spread in 6-inch loose lifts and compacted by 6 complete passes with either Ferguson SP-120B or Ferguson SP-120D tamping roller. The moisture content permitted by the specifications was between plus or minus 2 percentage points of optimum. The W. E. Grace Model W18R 50 ton rubber-tired roller was used on some of the more granular random earth materials.

(3) Random Rock. This material was spread in 24-inch loose lifts and compacted by 4 complete passes with a W. E. Grace Model W18R 50-ton rubber-tired roller.

(4) Filter Sand. This material was spread in 12-inch loose lifts and compacted by 4 completed passes with a Hyster C250A vibratory roller. No moisture control was required on these zones.

(5) Graded Aggregate. This material was spread in 12-inch loose lifts and compacted by 4 complete passes with a Hyster C250A vibratory roller. No moisture control was required on these zones.

A summary of field compaction control test data and design placement requirements for the dam is shown on Plate 83. Field Compaction Control Test Data Sheets are shown on Plates 84 through 128.

e. Seepage Control. To insure watertightness in the foundation, a single line grout curtain was constructed along the centerline of the dam. This grout curtain was 55 feet in depth and penetrated into sound rock. In addition, a cutoff trench to rock was also provided. The cutoff trench was backfilled with impervious material. A strip of sand was placed on the side slopes of the cutoff trench between the foundation and the impervious material to both control seepage in the trench during construction and prevent the possibility of piping. Design seepage computations through the impervious zone were based upon a permeability coefficient of 0.0013×10^{-4} feet per minute based upon a test of composite samples from the borrow areas. The site plans for the borrow areas are shown on Plates 3 and 4. Based on the design and the low permeability of the soil, seepage through the dam is not considered a problem. Any seepage through the dam will be intercepted by the inclined drain, finger drains, and right abutment blanket drain. A perforated pipe drain is installed along the downstream toe of the dam to collect seepage from the finger drains and intercept seepage from the foundation. Details of the internal drainage system for the embankment are shown on Plates 14 and 15.

f. Shear Strengths. Laboratory soil test data was studied to select shear test values which most nearly approximated the prototype conditions which were expected to exist at various stages of the project construction. Data was grouped by depth, location, classification and usage. The valley foundation was divided into two primary classifications: plastic and nonplastic. The embankment was treated as a homogenous material. Adopted soil design values are presented in Table 1. The laboratory and adopted design strength envelopes are shown on Plates 16 through 26.

TABLE 1
ADOPTED SHEAR STRENGTH DESIGN VALUES

Material	γ_m	γ_{sat}	γ_{sub}	Test	Shear Values	
					Tan ϕ	c Tons/ft ²
Embankment (Impervious)	127.8	130.4	68.0	Q	0.00	1.10
				R	0.51	0.40
				S	0.57	0.00
Foundation (Valley Clay Rt. of Conduit)	124.4	127.4	65.0	Q (Upper)	0.00	0.80
				Q (Lower)	0.05	1.05
				R	0.42	0.20
				S	0.50	0.00
Foundation (Valley Clay Lt. of Conduit)	124.4	127.4	65.0	Q	0.00	0.80
				R	0.42	0.20
				S	0.50	0.00
Foundation (Weak stratum of silty sand & sandy silt)	119.4	122.4	60.0	Q	0.04	0.40
				R	0.50	0.20
				S	0.60	0.00
Foundation (Shale)	147.1	148.4	86.0	Q	0.60	0.00
				R	0.24	0.43
				S	0.60	0.00

(1) Plastic Foundation. The clays over the nonplastic foundation contain varied amounts of silt and sand. Because of the difference in Q strength for the material from the right abutment to station 14+00, the clay was considered as two strata. The Q strength values for the upper stratum (silty clay) compare well with the plastic foundation (sandy clay) from station 14+00 to the left abutment. The Q shear strength for the lower stratum, consisting of lean clays and silty clays, was considerably higher. Q strength values for the lower stratum were derived from tests on materials below 8 feet in depth. The R strength values for all the materials compared reasonably well. The minimum Tan ϕ value for all materials was selected on the basis of a pure numerical average of the five available tests, since all tests were similar.

(2) Nonplastic Foundation. The Q strength for the weak stratum was determined from the five low test values. The adopted Q value for the stronger material was selected from available tests. The adopted R and S values were selected on the basis of a numerical average of all tests available.

(3) Embankment. The R and S strengths were selected by taking a pure numerical average of the available test results. The Q strength is based on a composite of samples at optimum plus 2 percent which is considered a realistic average placement moisture content.

g. Initial Design Stability Analyses. The embankment section at station 16+00 has been subjected to analysis by the circular arc and sliding wedge and block methods. The adopted shear test values were used in the analysis. The methods used in the analysis follow the procedures outlined in Appendix IV, EM 1110-2-1902, published 27 Dec 1960. The slopes were analyzed for end of construction, steady seepage, partial pool and sudden drawdown. Since the damsite is not located in an area of seismic activity, no earthquake analysis was considered. A summary of safety factors is presented below in Table 2.

TABLE 2
INITIAL DESIGN STABILITIES AT STATION 16+00

<u>Case</u>	<u>Slope</u>	<u>Minimum Safety Factor</u>	<u>Required Safety Factor</u>
End of Construction	D.S.	1.31	1.30
Sudden Drawdown	U.S.	1.51	1.20
Partial Pool	U.S.	1.74	1.50
Steady Seepage	D.S.	1.69	1.50

End of Construction. Q shear strengths are applicable for this case. A minimum factor of safety of 1.31 was obtained for this case.

Sudden Drawdown. R shear strengths are applicable for this case. The upstream slope was analyzed for drawdown from spillway crest to a minimum pool for a maximum drawdown of 45 feet. Full uplift was assumed with saturated weights utilized below the saturation line. A drawdown flow net was not assumed. A minimum factor of safety of 1.51 was obtained.

Partial Pool. R shear strengths are applicable for this case. The pool elevations considered were spillway crest elevation, seasonal pool elevation and minimum pool elevation. Full uplift was utilized with horizontal saturation lines. A minimum factor of safety of 1.74 was obtained for the minimum pool elevation.

Steady Seepage. R and S strengths are applicable for this case. The internal drainage system was considered operative. The embankment was considered to be saturated to spillway crest upstream of the incline drain. No tailwater was considered. A minimum average factor of safety of 1.69 was obtained.

The stability analyses for the above-described conditions are presented on Plates 33 through 36.

h. Supplemental Design Stability Analyses. During the course of review of the Design Memorandum for the Dam and Spillway, it was pointed out by the Ohio River Division Office that the dam should also be analyzed between stations 5+50 and 6+50 because of the height of the embankment in this area. The stabilities were done and the stability analyses summaries are presented on Plates 37 and 38. A summary of the safety factors is presented in Table 3.

TABLE 3
SUPPLEMENTAL DESIGN STABILITIES AT STATION 6+50

<u>Case</u>	<u>Slope</u>	<u>Minimum Safety Factor</u>	<u>Required Safety Factor</u>
End of Construction	U.S.	1.32	1.30
End of Construction	D.S.	1.76	1.30
Sudden Drawdown	U.S.	1.71	1.20
Partial Pool	U.S.	1.93	1.50
Steady Seepage	D.S.	1.69	1.50

It was also recommended by the Ohio River Division Office that the End of Construction Case at station 16+00 be analyzed again using R strengths in the pervious strata with Q strengths for embankment and foundation clays. The stability was done and the neutral block was founded in the pervious strata. The analysis is presented on Plate 39. A minimum safety factor of 1.41 was obtained for this condition. Another End of Construction Analysis was made assuming the pervious

layer to consolidate instantaneously and the neutral block was through the weaker clay strata. The analysis is presented on Plate 40. A minimum safety factor of 1.11 was obtained for this case. However, since it would take two seasons to construct the embankment, it was concluded that the clay would consolidate sufficiently to produce the required safety factor of 1.3 for End of Construction.

i. Construction Stability Analyses. During an inspection of embankment placement on 26 October 1970 by personnel from ORD, ORLCD-L, and ORLED-G, it was observed that loaded scrapers caused excessive rutting in the upstream section of the embankment between stations 12+00 and 14+00. Therefore, numerous borings were made and cube samples were also taken to determine shear strength values for the embankment. (A detailed description of this work is contained in "Report on Cave Run Embankment" dated July 1971.) The laboratory shear strength test parameters on the embankment record samples are shown on Plates 27 through 32. The laboratory test results for the cube samples are as follows:

TABLE 4
PEAK SHEAR STRENGTH OF CUBE SAMPLES

<u>Sample No.</u>	<u>Sample Elev.</u>	<u>Cohesion (T.S.F.)</u>	<u>Tan ϕ</u>
1	683.5 - 682.5	1.33	0.134
2	682.5 - 681.5	0.58	0.034
3	681.5 - 680.5	0.60	0.088
4	680.5 - 679.5	0.71	0.098
5	679.5 - 678.5	0.84	0.000

Stability analyses were performed using the above values for calculating forces acting on the central block, and test values from the Feature Design Memorandum were used for calculating the forces acting on the active wedge. The elevation at the base of the central block is the same as the elevation of the cube sample. The results of the stability analyses using peak strengths are given below for the End of Construction Case.

TABLE 5
FACTORS OF SAFETY USING PEAK CUBE SAMPLE STRENGTHS

<u>Elev. of Base Central Block</u>	<u>Slope</u>	<u>Cube No.</u>	<u>Cohesion (T.S.F.)</u>	<u>Tan ϕ</u>	<u>Safety Factor</u>
682	U.S.	2	0.58	.034	1.29
681	U.S.	3	0.60	.088	1.45
680	U.S.	4	0.71	.098	1.57
679	U.S.	5	0.84	.000	1.40
* 681	D.S.	3	0.60	.088	1.15

The critical stability is presented on Plate 41.

*The stability for the downstream section was performed using conservative values on the theory that possibly a weak layer existed in the impervious embankment below the random rock fill. Borings along the downstream toe indicate that the embankment is properly compacted and no weak zone exists; therefore, the stability is over-conservative.

The shear values presented in Table 4 were based on peak strengths and OCE felt that ultimate strengths may be more applicable. The cube sample test results were reanalyzed and the stress-strain curves projected to develop ultimate strengths. These strengths were used along the base of the central block and the same embankment values as presented in the Feature Design Memorandum were used to recalculate the upstream stabilities. The results of the stability analyses for the End of Construction Case using ultimate strength were as follows:

TABLE 6
FACTORS OF SAFETY USING ULTIMATE CUBE SAMPLE STRENGTHS

<u>Elev. of Base</u> <u>Central Block</u>	<u>Slope</u>	<u>Cube No.</u>	<u>Cohesion (T.S.F.)</u>	<u>Tan ϕ</u>	<u>Safety</u> <u>Factor</u>
682	U.S.	2	0.50	.035	1.21
681	U.S.	3	0.45	.089	1.31
680	U.S.	4	0.65	.043	1.36
679	U.S.	5	0.65	.000	1.36

The critical stability is presented on Plate 42.

OCE felt that the test results obtained from the cube samples were not representative of the actual strength due to the high pore pressures indicated by the piezometers. OCE felt that the effective stress was somewhere between 0.14 TSF and 0.32 TSF and recommended a value of 0.25 TSF be used for the weak material to compute stabilities for discussion. Using this value along the base of the central block, a 625-foot long berm to elevation 740 would be required for a factor of safety of 1.30. By removing waste material upstream of the embankment toe and using the combination of 0.25 TSF and 0.80 TSF along the base of the central block, the berm length is reduced to 260 feet. These two stability analyses are presented on Plates 43 and 44. The stability of the embankment section was analyzed by excavating the weak material from the upstream toe toward the centerline. Using the wedge method of analysis, removal of material for 165 feet from the upstream toe toward the centerline was required for a safety factor of 1.30. Calculating the lateral earth pressure for full embankment height and using an at-rest pressure coefficient of 0.5 required the removal of material for 171 feet from the upstream toe for a safety factor of 1.30. The depth of excavation was assumed to be in the order of 17-20 feet. The preceding stabilities are presented on Plates 45 and 46.

The main area of concern was upstream of the centerline on each side of the conduit. The area downstream of the centerline was considered adequate due to the finger drains and random rock fill. Three solutions were possible for increasing the stability of the embankment:

(1) Construct a 260-foot long berm to elevation 740. This would require removal of approximately 50,000 cubic yards of waste, additional borrow, and construction of an outlet works entrance channel through the berm. The cost was estimated at \$493,000.

(2) Remove the weak material from the upstream toe toward the centerline for a minimum depth of 17-20 feet. Removal and replacement of material would require additional borrow and delay the contract. The cost was estimated at \$393,000.

(3) Install vertical sand drains in the upstream section of the embankment. This plan would minimize the delay on the contract and would not influence the schedule for closure. The cost estimate was \$198,000 for 12-inch diameter drains on 12-foot centers.

The following remedial measures were derived from meetings which analyzed fill investigations, test data, stability analyses, and piezometer observations.

(1) Obtain the remainder of the borrow from the high borrow areas in the abutments to avoid moisture problems.

(2) Install vertical sand drains 12 inches in diameter on 12-foot centers in an equilateral triangle pattern on the upstream side of dam from station 9+00 to 23+00. Bottom the drains out in the sand and silty sand of the foundation. Have a horizontal sand drain 24 inches in width and depth, connect the top of each vertical drain in line, and discharge toward the upstream embankment slope. Place additional Casagrande type piezometers at the center of the equilateral triangle formed by 3 vertical sand drains to check the effects on pore pressures as the embankment construction proceeds. Sand drain details and piezometer locations are shown on Plate 14.

(3) Place additional movement markers, two lines on the upstream slope and two lines on the downstream slope of the embankment, to check horizontal and vertical movement of fill during and after construction. The locations of all movement markers are shown on Plate 49.

(4) Reduce the impervious core slopes to 1 horizontal to 2 vertical to better utilize material as it comes from the borrow areas.

After installation of the vertical sand drains within the embankment in the spring of 1971, the stability of the embankment was continually evaluated until completion of the project. Stability analyses for the end of construction case were performed using unit shearing strengths developed from the effective normal stress within the embankment and an angle of internal friction based on recommended values from the design

memorandum along with results from test on undisturbed samples obtained from the embankment during November 1970. See paragraph 6d for more discussion on the stability berm.

The location and size of the upstream stability berm was determined by running the set of stability analyses presented on Plate 47. After completion of the embankment pore pressures dissipated.

5. Construction Sequence.

a. First Construction Year (1969). A late award date of 29 August 1969 permitted only stripping of the dam foundation on the left riverbank and part of Borrow Area 2. Excavation for the cutoff trench or the temporary dike for flood protection was not accomplished this year.

b. Second Construction Year (1970). The cutoff trench on the left bank was completed and graded to approximate dam station 8+40 and the right abutment was stripped to rock. Early in the spring, the temporary dike was constructed to elevation 680 and embankment placement was started left of the outlet works contract had dried out and collapsed in the impervious core section due to lack of support. This material was removed and replaced as the impervious fill section of the embankment was raised. A portion of the intake and retreat channels was excavated and part of the riprap and bedding materials upstream of station 31+00 was placed in the dry, but not completed. The specified minimum fill height of elevation 705 was not attained across the entire embankment due to embankment material problems, late start due to delays in the cutoff trench work, and adverse weather conditions. The minimum elevation right of the conduit was approximately 690. The shore arms of the diversion dam were not constructed. However, a portion of the temporary dike was raised and was later incorporated into the diversion dam, left bank shore arm.

c. Third Construction Year (1971). During the winter close-down period, December 1970 through March 1971, the embankment placed during construction year 1970 was investigated using ORLED-G drill rigs. In April 1971, the contractor by contract modification began installing vertical sand drains in the embankment and foundation. This work was completed on 10 June 1971. Excavation of the retreat channel and placement of slope protection in the dry to station 31+00 was essentially complete by June 1971. The contract specifications stipulated that the stream portion of the barrier dam not be started prior to 1 June 1971, and then only when weather and river conditions were favorable. Specifications permitted placing the channel portion of the diversion dam without dewatering, but the construction of the closure section was accomplished in the dry in lieu of the wet condition; thereby, permitting better cleaning of the foundation and a more stable embankment. The river was diverted on 24 May 1971 and construction of a low water crossing approximately 350 feet upstream of the barrier dam. After this crossing was made, a concentrated effort was made to strip the required area at the right abutment and construct the right bank shore arm. The diversion dam was constructed in the dry. Weather and wet conditions

continued to plague the operations, including excavating and grouting the remaining portion of the cutoff trench, river channel, and right abutment. With the cutoff trench excavation and backfill operations delayed, the required embankment height of elevation 721 was not reached across the entire embankment, but rather a berm was constructed along the upstream slope. Winter close-down occurred on 24 November 1971 with the lowest point of the embankment crest at elevation 721.

d. Fourth Construction Year (1972). The construction schedule was to complete the embankment to full height, section and length not later than 1 November 1972. Again, weather and embankment conditions were not conducive to completing the embankment as required. The borrow source was changed from the low borrow to high borrow for more suitable moisture. Early winter halted embankment operations on 27 October 1972 with an average elevation of 740 right of the conduit.

e. Fifth Construction Year (1973). Borrow operations were shifted to Borrow Area 3 and the embankment was completed on 15 September 1973.

The sequence of construction procedures is shown on Plate 10.

6. Changes in Design and Modifications.

a. Borrow-Source Changes.

(1) During initial embankment construction materials were taken from Borrow Area 2 on the Licking River flood plain, as required by the contract specifications. During the late summer of 1970 it was recognized that the Borrow Area 2 materials had a high silt content and high in situ moistures. This material was very sensitive to moisture and lacked sufficient shear strength to hold up the hauling equipment at the top of the specified moisture range. It was determined that better material was available on the abutments, so borrow operations were moved to Borrow Areas 1 and 4 on the left abutment.

(2) By late 1972 the available impervious material in Borrow Areas 1 and 4 was exhausted. A haul road was cut into the right abutment area and Borrow Area 3 was opened. The embankment was completed with materials from Borrow Area 3.

b. Rezoning of Embankment Materials.

(1) The move from Borrow Area 2 to the upland borrow area restricted the quantity of impervious material available. To conserve impervious material, the embankment above that placed during the 1970 season was rezoned. The impervious zone was cut down to a central core 30 feet wide at the top with 1 horizontal to 2 vertical slopes. The outer shell was constructed of random earth materials. A further change in late 1971 allowed the contractor to place more pervious, sandy materials in the upstream random section and the downstream random section outside of the inclined drain, so long as the downstream random section outside of the inclined drain, so long as the upstream and

downstream slopes were faced with a more plastic, erosion-resistant material.

(2) After borrow Areas 1 and 4 were exhausted in 1972, investigations indicated that Borrow Area 3 had somewhat less good impervious material than had been anticipated, but contained a large quantity of borderline impervious-random material. To insure an intact impervious core and better utilize the available material, the embankment was rezoned again for the start of the 1973 construction season. The impervious core was rezoned to a 20-foot top width with 1 horizontal to 9 vertical slopes, using the most select impervious material available. The rest of the embankment section, except for the inclined drain and a small random rock section, was constructed of random earth. The last usable random rock from the spillway excavation was placed in a 20-foot wide zone on the upstream slope under the riprap. The bedding layer was deleted where the riprap was backed up by random rock.

c. Installation of Vertical Sand Drains and Excessive Water Problems. During construction, moisture control was a constant problem on the embankment. Pumping, rutting, and heaving were often evident at moistures near the top of the allowable upper limits. During late 1970 and early 1971 it was determined that moisture contents in the upstream portion of the embankment from station 10+50 to approximately station 23+00 were high enough to develop excessive pore pressures. A system of vertical French drains was drilled into the underlying alluvial overburden and were connected by a series of sand laterals at the existing top of the embankment. During the 1971 season when the embankment was extended across the river to the right abutment after several feet of fill was placed, high moisture contents were detected in the impervious material in the cutoff trench. Investigation indicated the water was coming from the sand and gravel deposits overlying the foundation rock. The material was removed and the reach from station 8+75 to station 5+50 was regrouted. The water in the excavation was controlled by sandbagging and using sumps. The embankment material was then replaced. During the latter portion of the 1972 season, pumping and heaving was noticed in the impervious zone from about station 15+00 to the left abutment. Investigations indicated that an intermittent 2-foot zone of wet material had been placed in the impervious section about 5 to 7 feet below the existing surface. This material was removed and replaced. At the same time, free water was found to be ponded in the pervious, sandy random section. This problem appeared to be more prominent in the downstream random section. Several gravel-filled windows were cut through the impervious, erosion-resistant face along the base of the pervious, sandy zone on the downstream slope of the dam. During the 1973 season, free water was found in the upstream sandy pervious section. An extensive system of low angle, PVC screened drain holes were drilled into this section to drain off free water.

d. Upstream Stability Berm. In July 1973, when the embankment had been completed to approximate elevation 760 (top of dam elevation 785), certain piezometric levels changed rapidly. An inspection of the upstream face of the dam uncovered a developing shear over-thrust surface at about elevation 705 between stations 5+00 and 11+00 with an

apparent movement of about 0.3 foot. The upstream movements of monuments on a line 230 feet upstream from the centerline indicated horizontal movements of 1.08 feet. A 150-foot wide emergency berm was constructed to elevation 737 sloping to elevation 732 with a system of horizontal 1-1/4-inch diameter PVC drains to drain the pervious random fill placed upstream of the impervious core in a zone varying between elevations 720± and 704±. The extent of the failure was not determined. No positive shear plane could be defined on top. Another line of monuments was established 140 feet upstream from the centerline of the dam. Construction of the embankment was resumed and in an effort to level the top of the embankment some areas were built up quite rapidly to approximately elevation 775. Increased pore pressures resulted particularly in the previously delineated failure area and the monuments 140 feet upstream indicated general upstream movement of 0.65 foot maximum. After investigation revealed no surface failure, placement was resumed at a rate not to exceed 2 feet per day. The embankment was completed without further incident.

7. Major Construction Difficulties. Most of the major construction difficulties have already been discussed in previous paragraphs. However, the problem that has not been covered yet was the flooding threat. In July 1971 after the river had been diverted and the barrier dam completed, a severe flooding situation developed when 7 inches of rain fell in the drainage basin. The barrier dam was temporarily raised to elevation 696.5 under emergency conditions and overtopping was prevented. The construction schedule was altered to provide a high enough diversion dam to resist overtopping until the embankment could be raised to sufficient height.

8. Instrumentation.

a. General. The embankment and foundation are monitored by piezometers, settlement plates, and movement markers. Instrumentation, plans, details and sections are shown on Plates 48 and 49.

b. Piezometers. Initially plans called for installing 11 Casagrande type and 29 air-actuated piezometers with 16 piezometers located in the embankment and 24 piezometers placed in the foundation. During construction, with the development of high pore pressures within the embankment, 23 additional Casagrande type and 31 wellpoint piezometers were installed in the embankment. Two additional Casagrande type and 1 wellpoint piezometers were installed in the foundation. Hall gas-actuated piezometers were installed in lieu of air-actuated piezometers as indicated in the contract plans.

Pressures read higher than the embankment in the core area during part of the construction. These excessive pressures were the reason that first, vertical sand drains were installed and later it was necessary to add a stability berm. These excessive pressures dissipated with time.

Piezometers located in the foundation and embankment section upstream of the core now react and read slightly below the pool. Piezometers within the core read slightly higher than the pool upstream of centerline with

a significant drop downstream of centerline. Piezometers located downstream of the core are dry or have low readings which reflect the effectiveness of the impervious core cutoff, internal drainage system and free draining random rock toe. The piezometer plots are shown on Plates 50 through 62. All of the readings are within the range of pressures expected.

c. Movement Monuments. Eight rows of movement monuments are installed on the embankment at the following locations:

<u>Row Number</u>	<u>Distance from Centerline (ft.)</u>
1	235 upstream
1A	145 upstream
2	85 upstream
3	15 downstream
4	150 downstream
5	270 downstream
6	330-390 downstream
7	280 upstream

Initially the contract plans required a row of movement monuments located at the downstream crest, upstream toe, and downstream toe of dam. As a result of high pore pressures within the embankment, five additional rows of movement monuments were installed. Progressive horizontal movement of monuments in row number 1 resulted in the installation of the upstream stability berm. All movement monuments in row number 1 were covered by the stability berm which was completed in August 1973. Recent readings indicate that along the crest and upstream slope of the embankment very minor horizontal and vertical movement is still occurring. The downstream portion of the embankment has moved slightly. Row 1A located 145 feet upstream of centerline has recorded the maximum horizontal movement of 0.82 foot upstream, and row 2 located 85 feet upstream of centerline has recorded the maximum vertical movement of 0.68 foot. The row 1A movement monuments located 145 feet upstream of centerline are underwater. The horizontal and vertical movement plots are shown on Plates 63 through 76. All of the movements are within the range of movement expected.

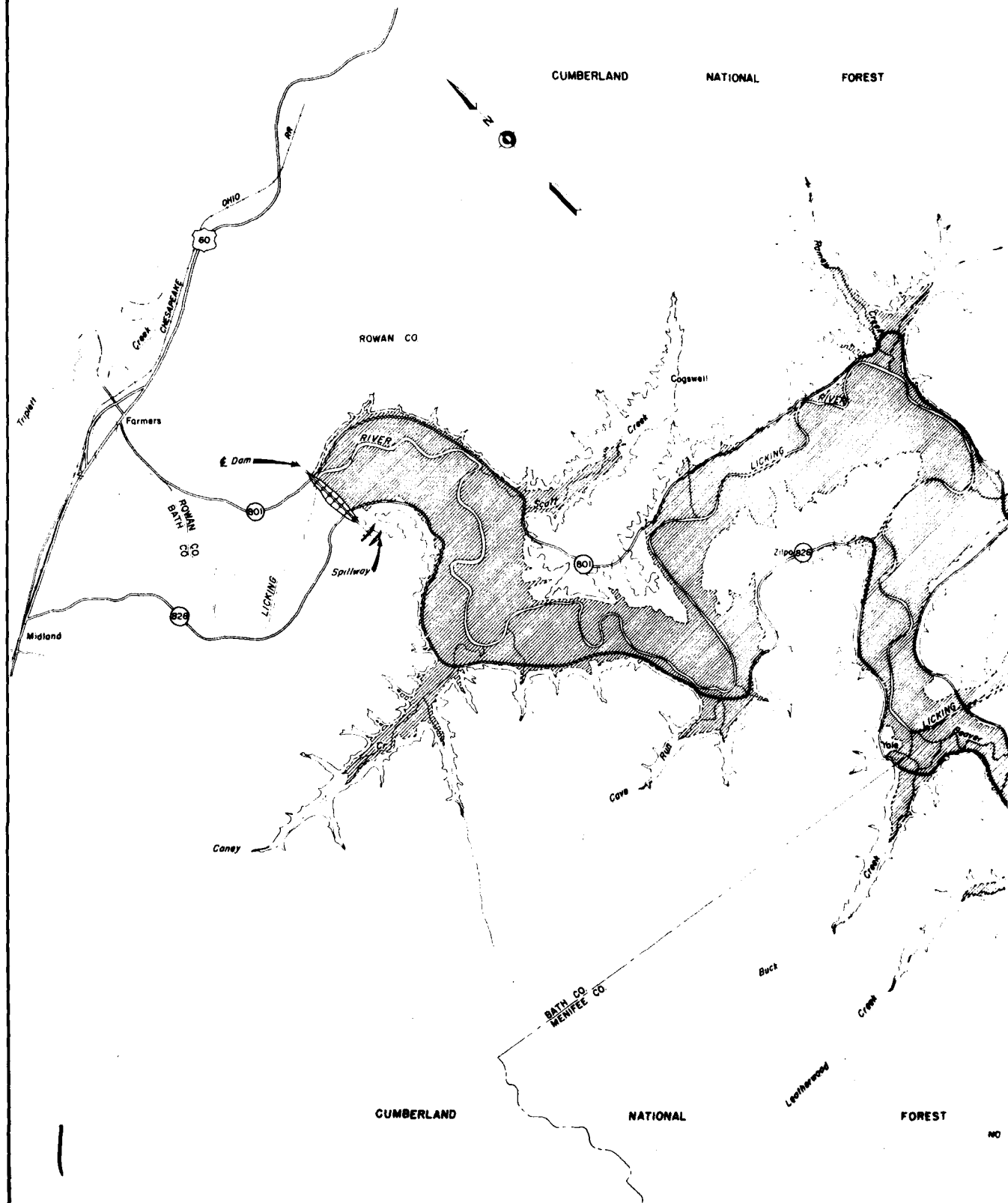
d. Settlement Gages. Four settlement gages were installed in the foundation prior to placing fill for the embankment. The locations are as follows:

<u>Gage Number</u>	<u>Station</u>	<u>Distance from Centerline (ft.)</u>
1	11+00	100 upstream
2	11+00	100 downstream
3	18+00	100 upstream
4	18+00	100 downstream

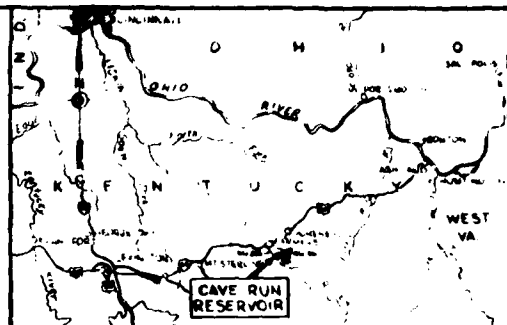
The maximum settlement to date of the foundation has been 1.18 feet. The settlement gage plots are shown on Plates 77 through 80. All of the settlements are within the range of movement expected. All settlement has essentially stopped.

PLATES

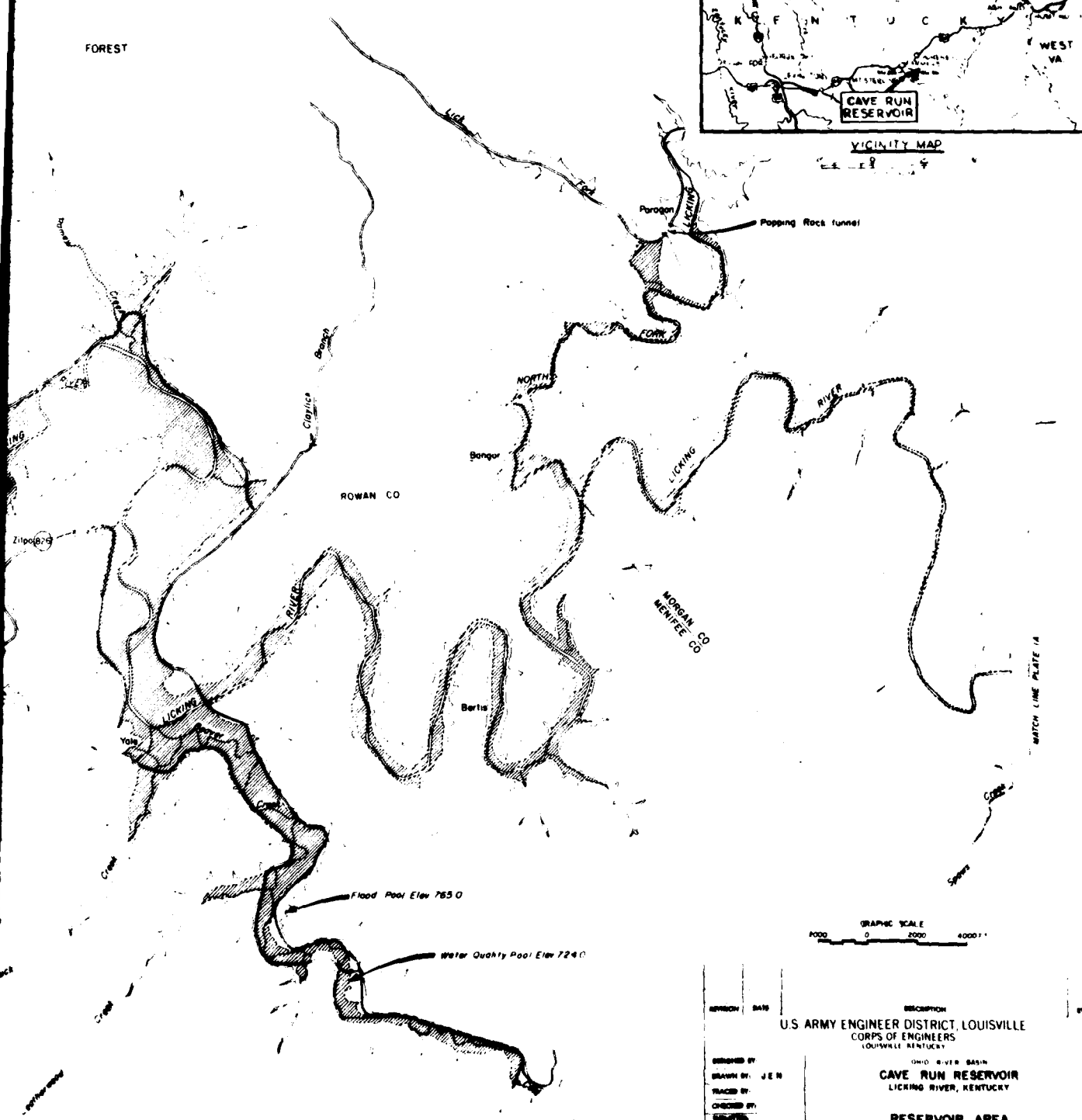
CORPS OF ENGINEERS



U.S. ARMY

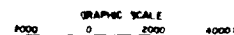


VICINITY MAP



FOREST

NOTE Seasonal Pool at Elevation 7300 not shown
 Seasonal Pool at Elevation 7200 not shown

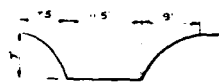
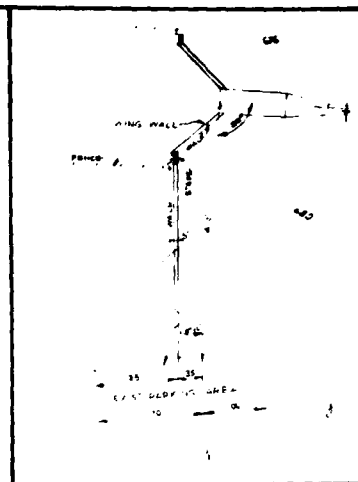


REVISION	DATE	DESCRIPTION
U.S. ARMY ENGINEER DISTRICT, LOUISVILLE CORPS OF ENGINEERS LOUISVILLE, KENTUCKY		
OHIO RIVER BASIN CAVE RUN RESERVOIR LICKING RIVER, KENTUCKY		
RESERVOIR AREA		
DESIGNED BY		
DRAWN BY	J. E. N.	
TRACED BY		
CHECKED BY		
APPROVED BY		
DATE		
SCALE	1" = 2000'	
DRAWING NUMBER	LR-174-12.2/2	

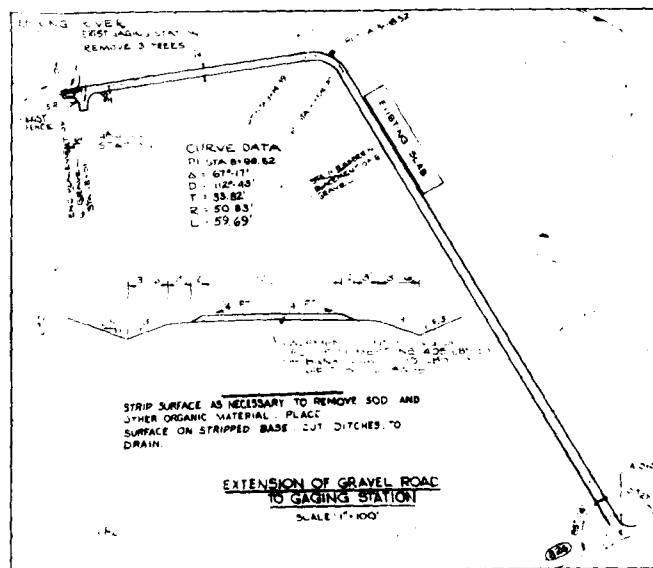
RECORD DRAWING - AS BUILT

PLATE 1

U.S. ARMY



TYPICAL SECTION
OUTLET WORKS CONTRACTOR'S DRAINAGE DITCH



5 SHEETS REV'D PER AMDT NO. 5 DATED 24 JULY 1960		U.S. ARMY
18 MAY 60 REVISED PER AMEND. NO. 2		248
SECTION	DATE	DESCRIPTION
U. S. ARMY ENGINEER DISTRICT, LOUISVILLE		
CORPS OF ENGINEERS		
LOUISVILLE DISTRICT		
DESIGNER	CHEROKEE BASIN	
DRAWN	CAVE RUN RESERVOIR	
TRACED	LOCKING RIVER, KENTUCKY	
ORIGINAL	GENERAL PLAN	
REVISION	DATE	
1. R.H.H.	12-174-12-2/3	

NOTES:
1. DOWNSTREAM SEEDING TURF ON DAM TO BE MAINTAINED BY CONTRACTOR UNTIL ALL OTHER WORK ITEMS ON PROJECT HAVE BEEN COMPLETED AND ACCEPTED. THIS INCLUDES NECESSARY WATERING TO PROMOTE SOD GROWTH AND RESTORATION OF ANY SURFACE WASHING OR BREAKS IN THE SOD COVER.

2. N.T.C. INDICATES NOT IN CONTRACT.

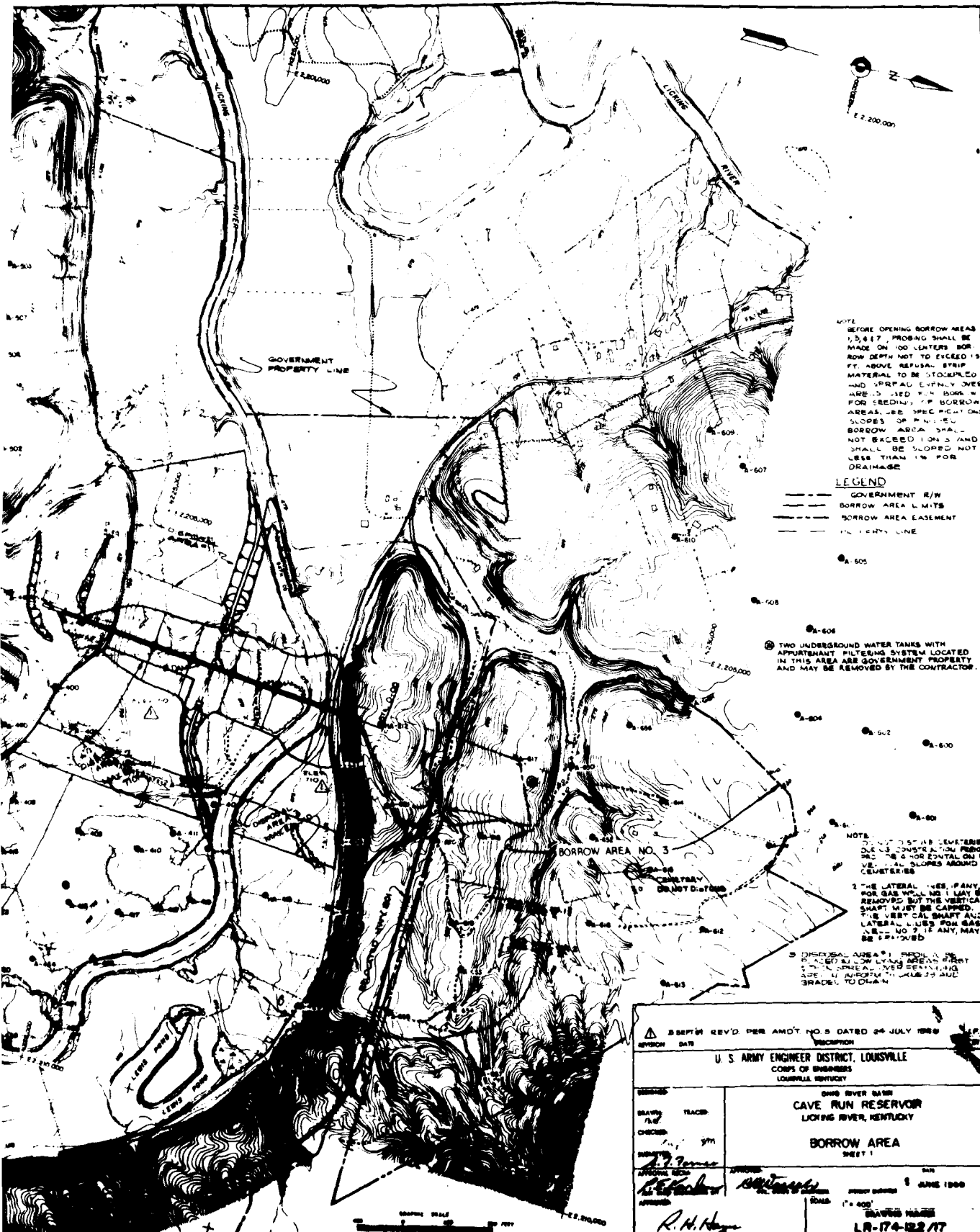
THE FOLLOWING TO BE GROWN VETCH SEEDING: SLOPES OF THE DAM ACCESS ROAD, DAMP SOD AND SPILLWAY. THE FOLLOWING TO BE PLAIN SEEDING: POND AND SPILL AREA ABOVE EL. 720, DISPOSAL AREA 1, AND DOWNSTREAM BLANKET.

THE FOLLOWING TO BE MACH SEEDING: DAM SLOPES.

CONTRACTOR WORKING LIMITS TO SANDY CRISTA CRUISING

CORPS OF ENGINEERS





BEFORE OPENING BORROW AREAS
1,5,6,7, PROBING SHALL BE
MADE ON 90 DEGREES BOR-
ROW DEPTH NOT TO EXCEED 15
FT. ABOVE REFUSAL STRIP
MATERIAL TO BE STOCKED ON
AND SPREAD EVENLY OVER
AREAS. SEE PLAN BOOKS
FOR SEEDING. IF BORROW
AREAS ARE SPECIFIED ON
SLOPES OF CHANNEL
BORROW AREA SHALL
NOT EXCEED 1:0.45 (AND
SHALL BE SLOPED NOT
LESS THAN 1:1 FOR
DRAINAGE

--- GOVERNMENT R/W
 --- BORROW AREA LIMITS
 --- BORROW AREA EASEMENT
 --- 1/4 CORNER LINE

② TWO UNDERGROUND WATER TANKS WITH APPURTENANT FILTERING SYSTEM LOCATED IN THIS AREA ARE GOVERNMENT PROPERTY AND MAY BE REMOVED BY THE CONTRACTOR.

NOTE:
DO NOT DISTURB CEMETERIES
OR CONSTRUCTION PERIOD
PROHIBITED FOR ZONAL ON I
VERTICAL SLOPES AROUND
CEMETERIES

2. THE LATERAL LINES, IF ANY,
FOR GAS SHALL NOT BE
REMOVED BUT THE VERTICAL
SHAFT MUST BE CAPPED.
THE VERTICAL SHAFT AND
LATERAL LINES FOR GAS
ARE -- NO 2 IF ANY, MAY
BE FOLLOWED

5 DISPOSAL AREA #1 SHOULD BE PLACED IN LOW LYING AREAS FIRST TO SPREAD OVER DRAINAGE AREAS IN ORDER TO PREVENT GRAVEL TO CLAY

[illegible]

This is a detailed topographic map of a borrow area. The map features contour lines indicating elevation, with specific points marked as 500, 520, 540, 560, 580, and 600. A prominent feature is a large, irregularly shaped area labeled "BORROW AREA NO 7". To the right of this area, there is a section labeled "INSERT 'A'", which shows a different topographic profile. A dashed line labeled "GOVERNMENT PROPERTY LINE" runs across the map. Other labels include "BORROW AREA LIMITS" and "APPROXIMATE MATCH SHEET 1". The map is oriented with a north arrow pointing towards the top right. Elevation markers such as "E 2,197,000" and "E 2,202,000" are visible along the top and right edges. The map is drawn with thick black lines for contours and property boundaries, and thinner lines for other features.

NOTES:
L RESTORATION OF BORROW AREA USED ABOVE EL. 725 SHALL BE IN ACCORDANCE WITH NOTE ON SHEET 17

- 2 * * RM EV LHS DURN NUTRITION EMER
 IN JDS - STB? MTL A CPT AL " OF

1

60604000 92.00.00

Order Code RS-98-067

U.S. ARMY

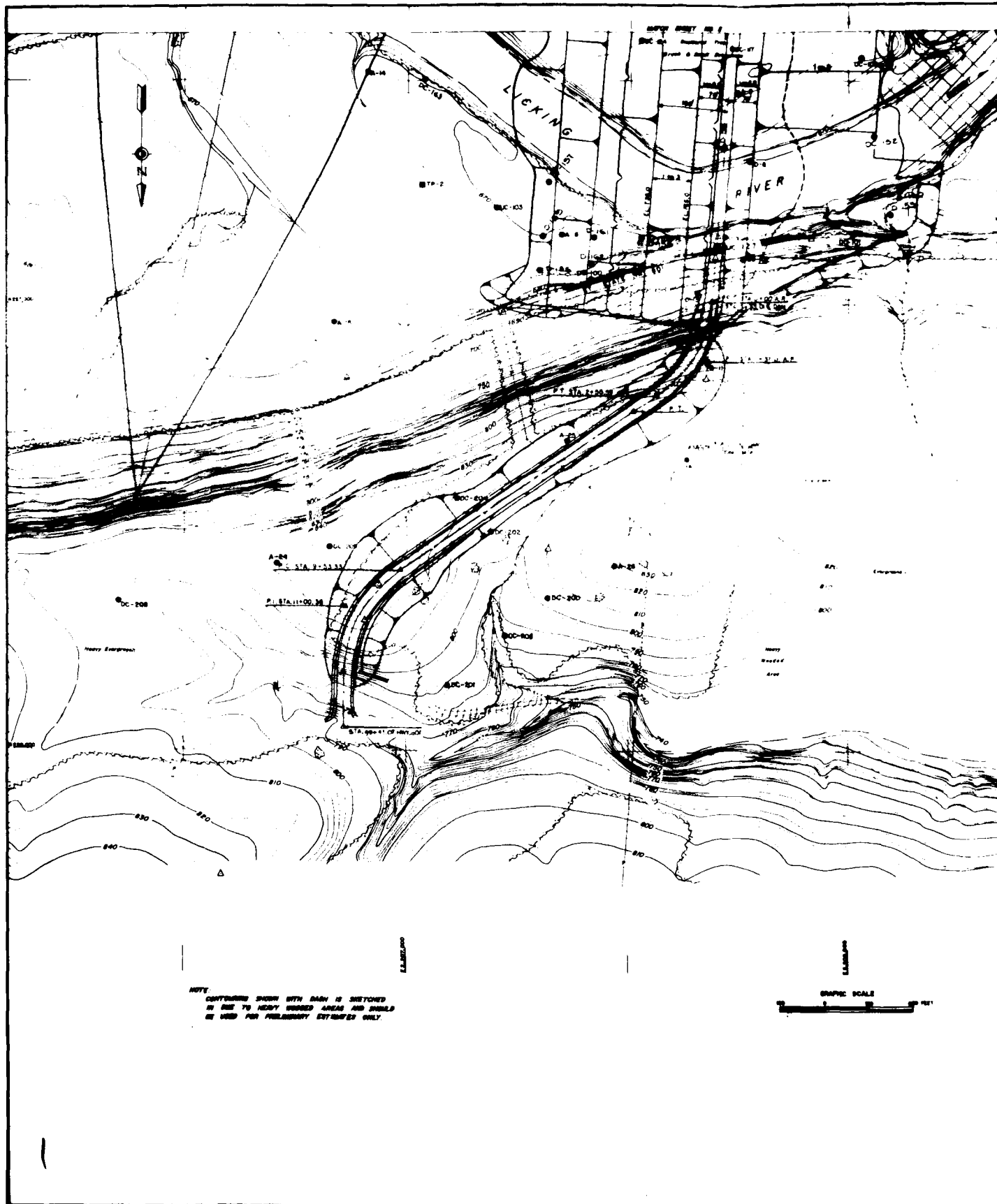


2

DESIGNED	U. S. ARMY ENGINEER DISTRICT, LOUISVILLE CORPS OF ENGINEERS LOUISVILLE, KENTUCKY	
DRAWN BY CHECKED BY	TRACED BY	OHIO RIVER BASIN CAVE RUN RESERVOIR LICKING RIVER, KENTUCKY BORROW AREA SHEET 2
APPROVAL TECH R. E. Farnham	APPROVED R. E. Farnham	DATE JUNE 20 1943
APPROVED R. H. Hays	SCALE	BLANKED NUMBER LR-174-2270

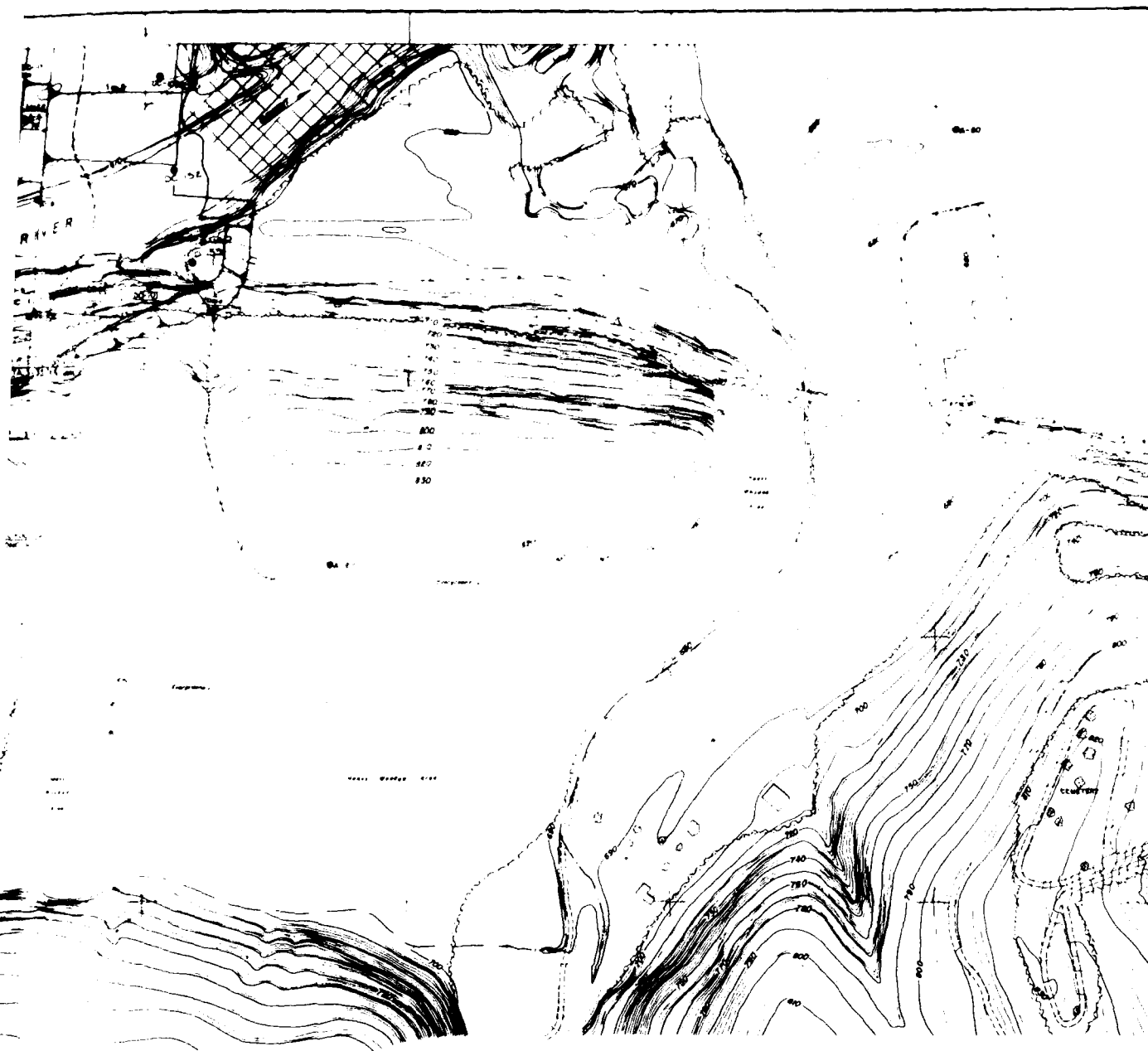
PLATE 4

CORPS OF ENGINEERS



NOTE:
CONTOURS SHOWN WITH DASH IS SKETCHED
IN DUE TO HEAVY WOODS AREAS AND SHOULD
BE USED FOR PRELIMINARY ESTIMATES ONLY

GRAPHIC SCALE
0 100 200 300 400 500 600 700 800 900 1000

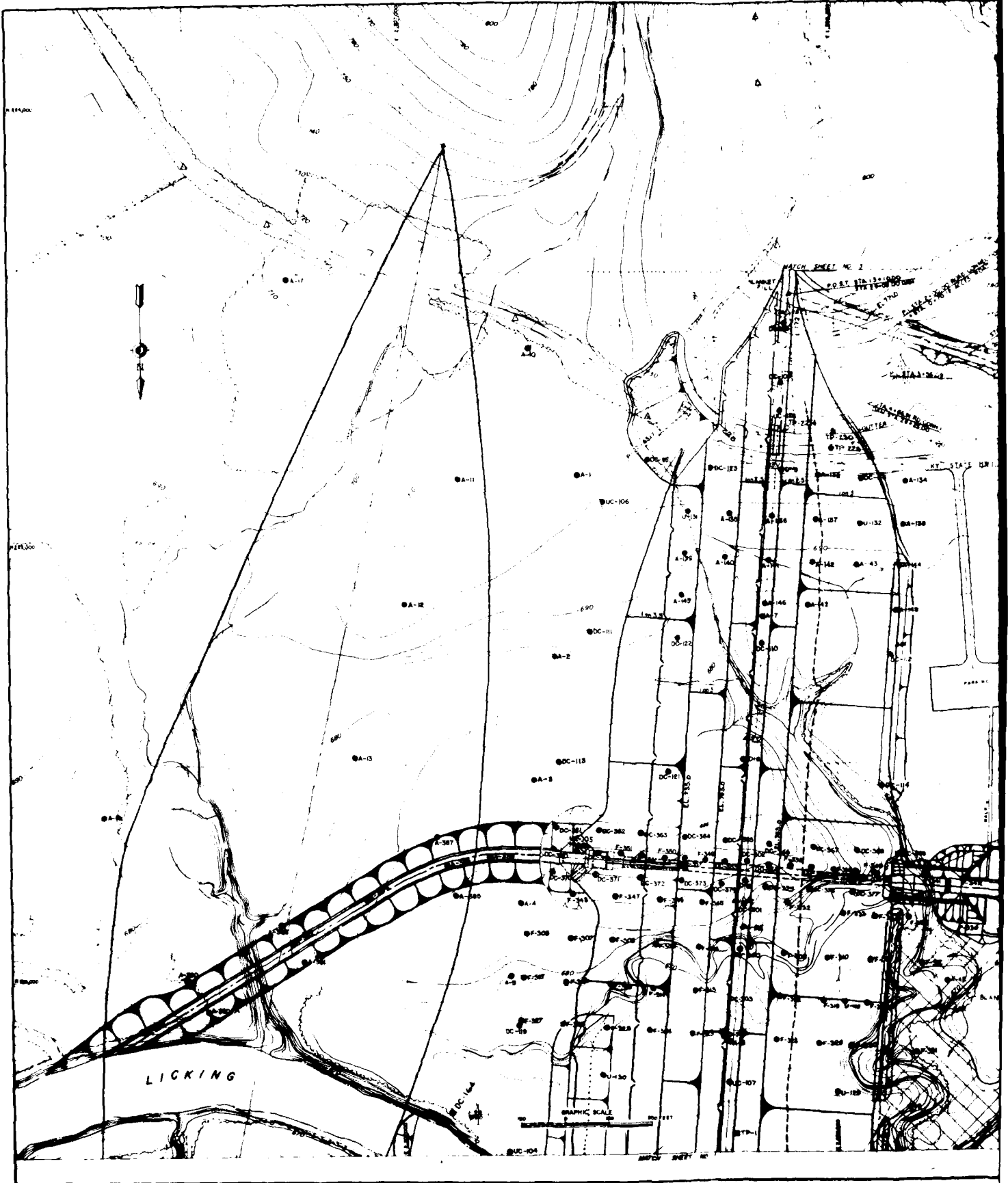


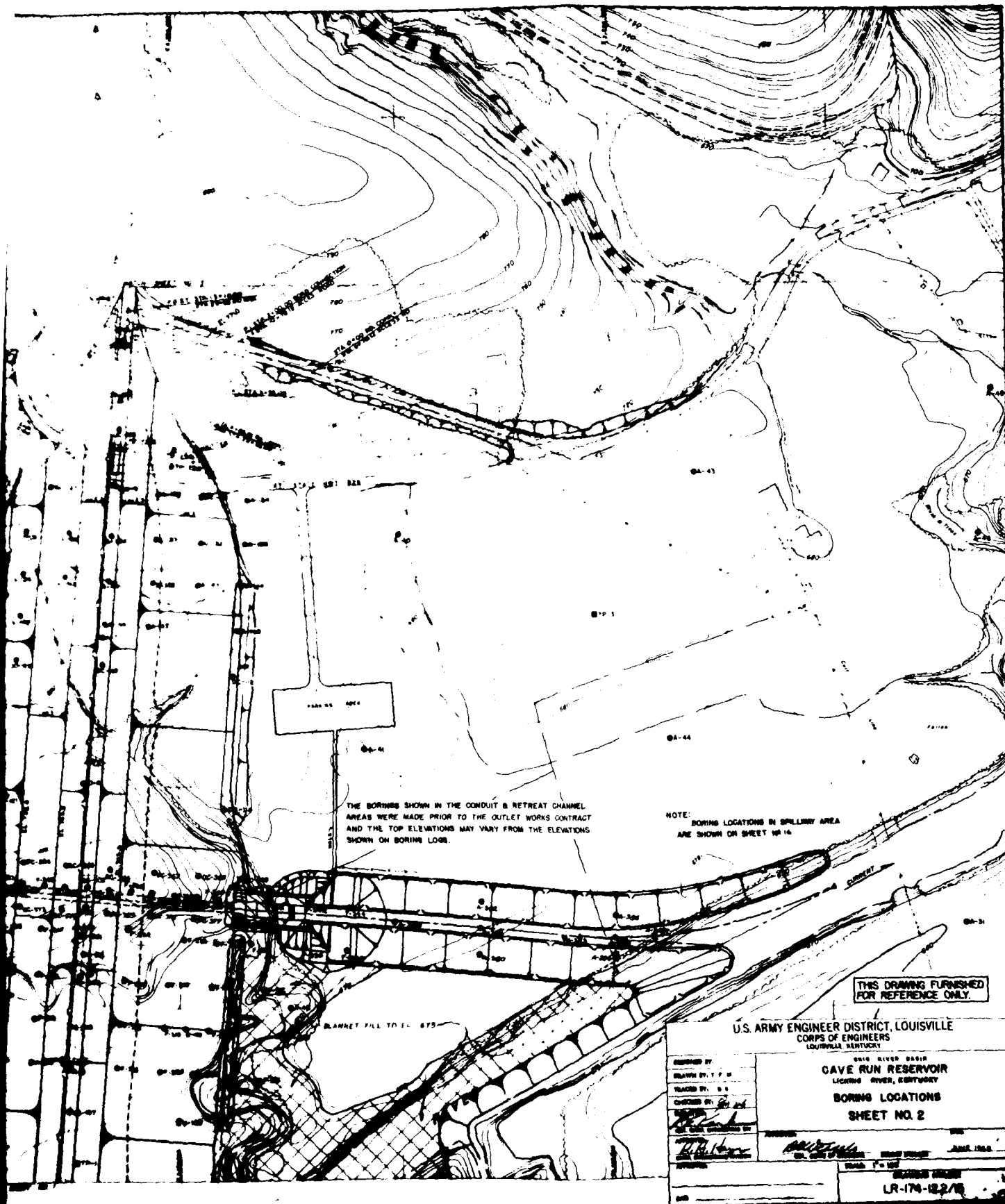
2

REVISION	DATE	DESCRIPTION	BY
U.S. ARMY ENGINEER DISTRICT, LOUISVILLE CORPS OF ENGINEERS LOUISVILLE, KENTUCKY			
DESIGNED BY:	OHIO RIVER BASIN		
DRAWN BY: T.P.B.	CAVE RUN RESERVOIR		
CHECKED BY: S.S.	LUCKING RIVER, KENTUCKY		
CHIEF BY: S.S.	BORING LOCATIONS		
APPROVED BY:	SHEET NO. 1		
DATE:	JUNE 1962		
SCALE:	1" = 100'		
DRAWING NUMBER		LR-174-122/M	

RECORD DRAWING - AS BUILT

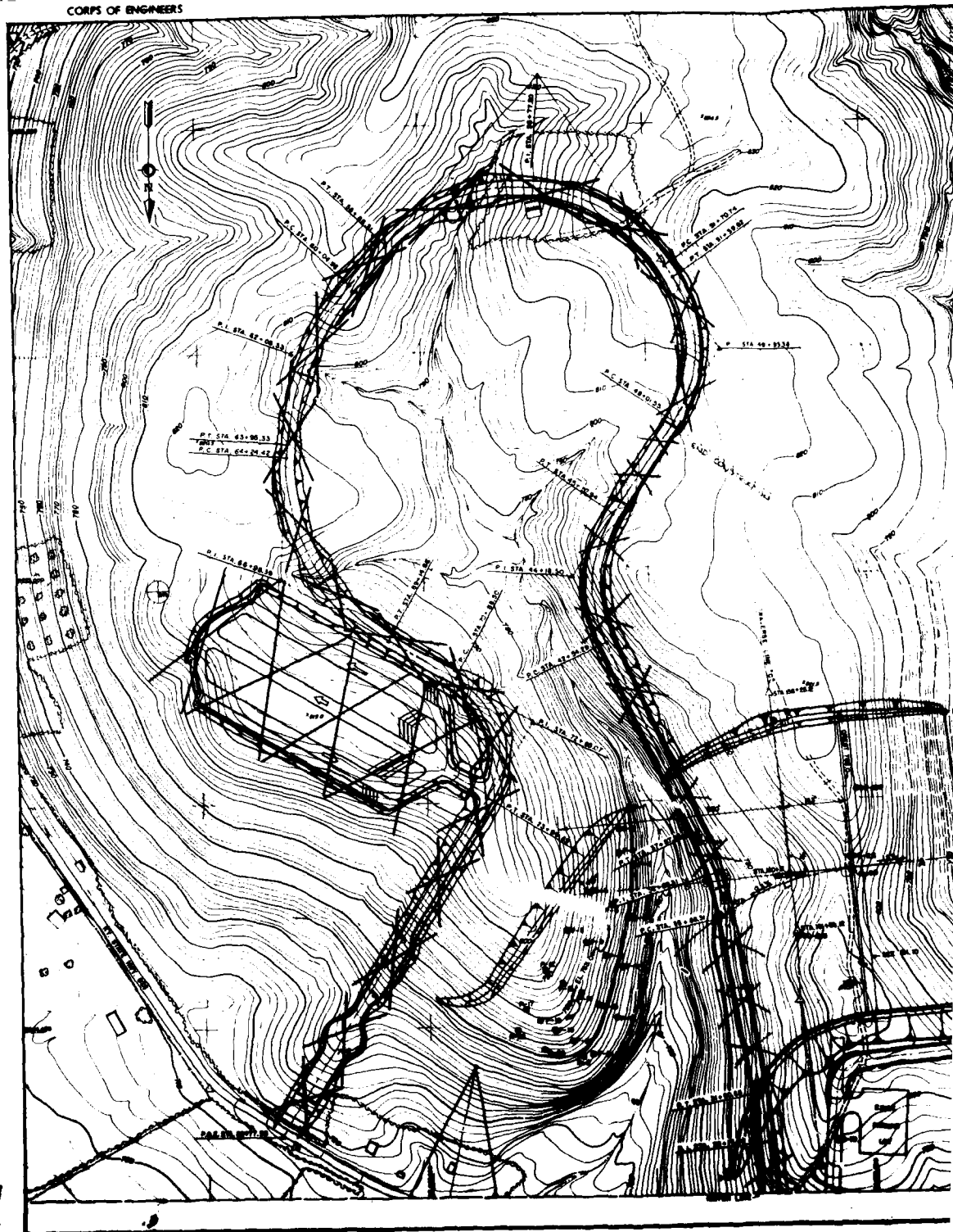
PLATE E





RECORD DRAWING: **PLATE 6**

The maximum settlement to date of the foundation has been 1.18 feet. The settlement gage plots are shown on Plates 77 through 80. All of the settlements are within the range of movement expected. All settlement has essentially stopped.

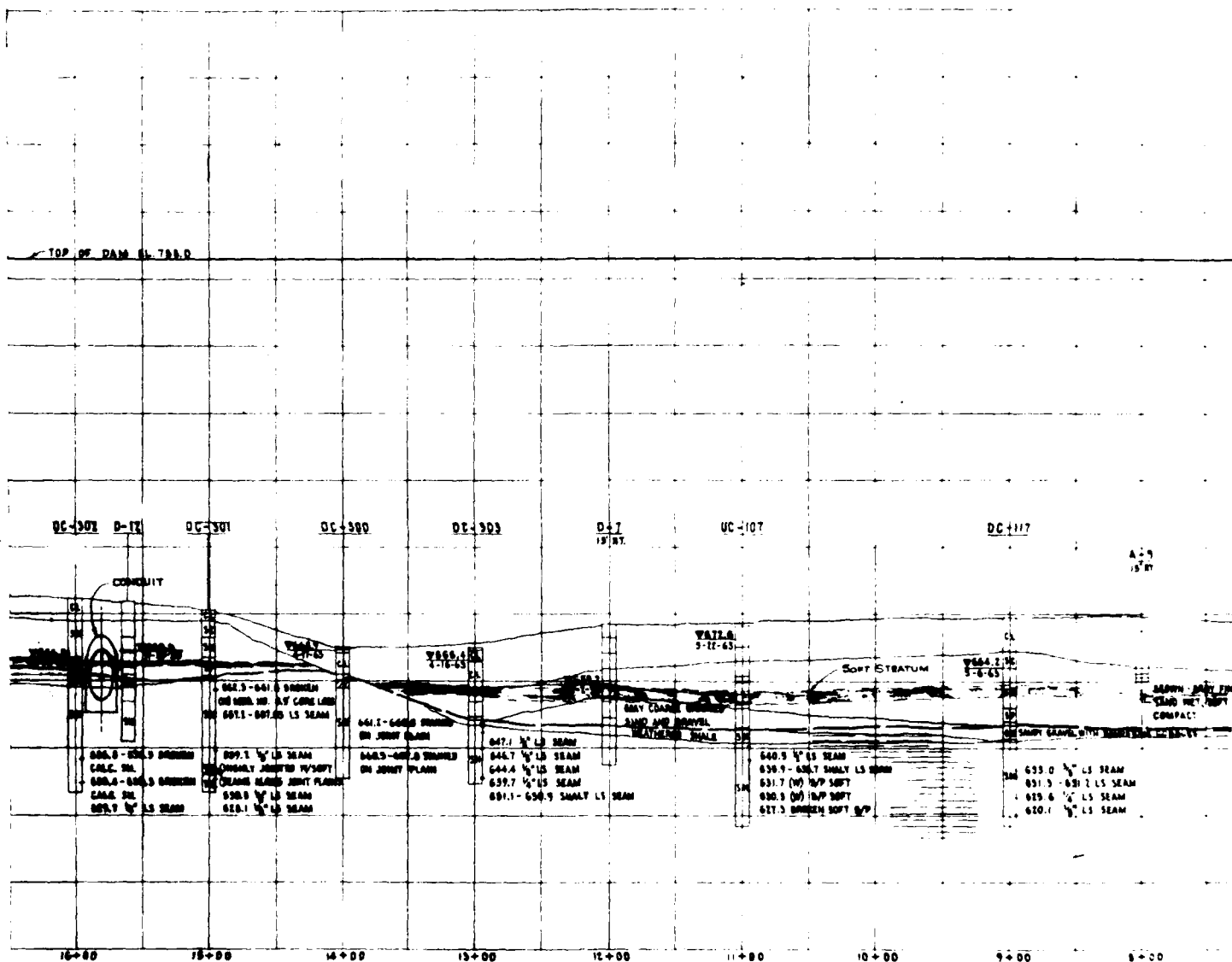


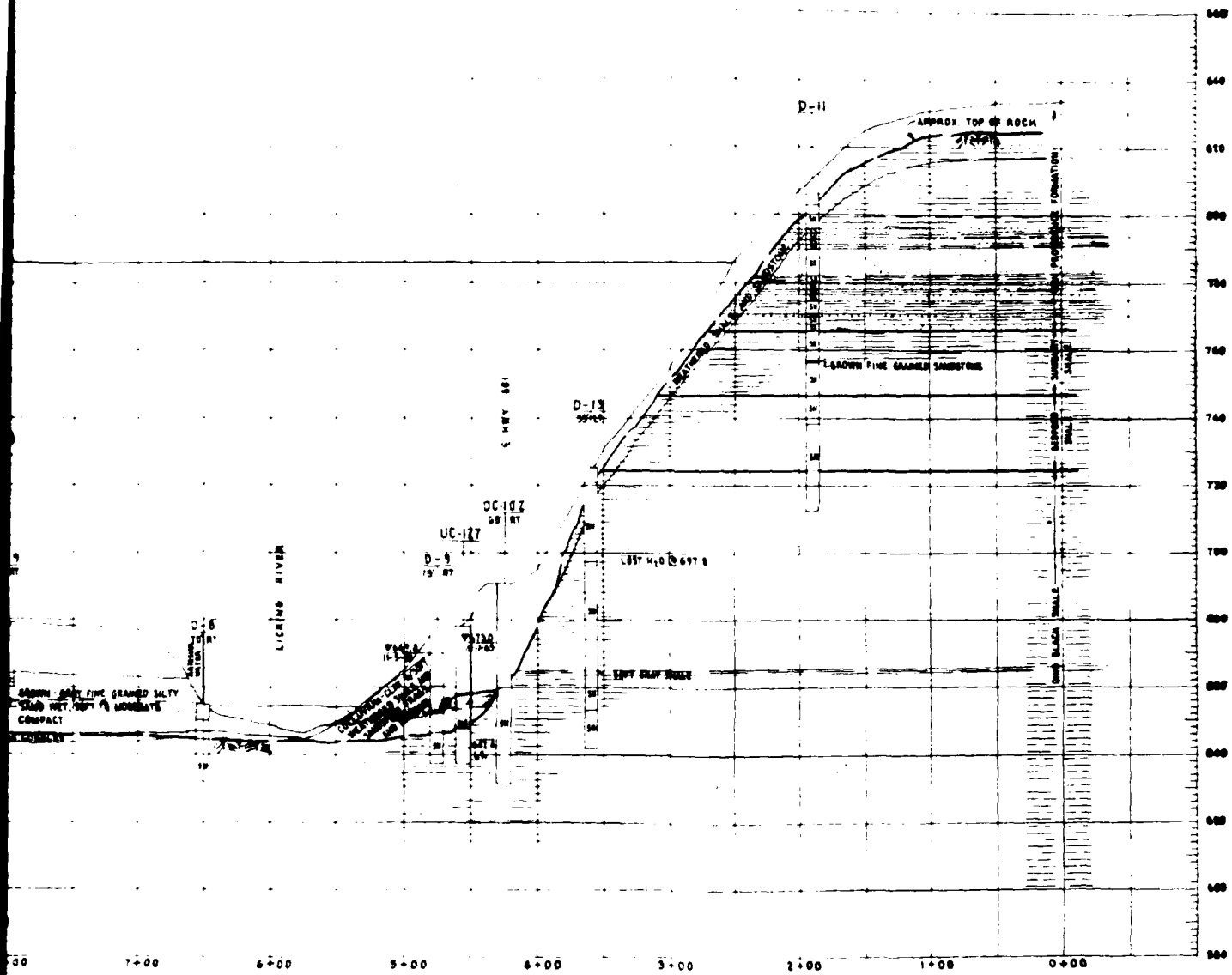
Topographic map of the Cave Run Reservoir area in Licking River, Kentucky. The map shows contour lines, a reservoir, and a dam. A title block in the bottom right corner contains project information.

SHEET NO. 1 U. S. ARMY ENGINEER DISTRICT, LOUISVILLE CORPS OF ENGINEERS LOUISVILLE DISTRICT	
DRAWN BY CHECKED BY DESIGNED BY APPROVED BY	DATE PROJECT CAVE RUN RESERVOIR LICKING RIVER, KENTUCKY BORING LOCATIONS SHEET NO. 1

APPROVAL	DATE	RECEPTION	BY
U. S. ARMY ENGINEER DISTRICT, LOUISVILLE CORPS OF ENGINEERS LOUISVILLE, KENTUCKY			
COMMENTS BLANKS PLACED S. S. CHECKED: <i>gym</i> REVISIONS <i>P. H. Hager</i> APPROVAL: <i>[Signature]</i> SPECIAL AGENT IN CHARGE OF PROJECTS	C&O RIVER BASIN CAVE RUN RESERVOIR LICKING RIVER, KENTUCKY BORING LOCATIONS SHEET NO. 3 DATE: <i>[Signature]</i> JUN 15 1946 100'		
<i>P. H. Hager</i> SPECIAL AGENT IN CHARGE OF PROJECTS	174-22716		

PLATE 7



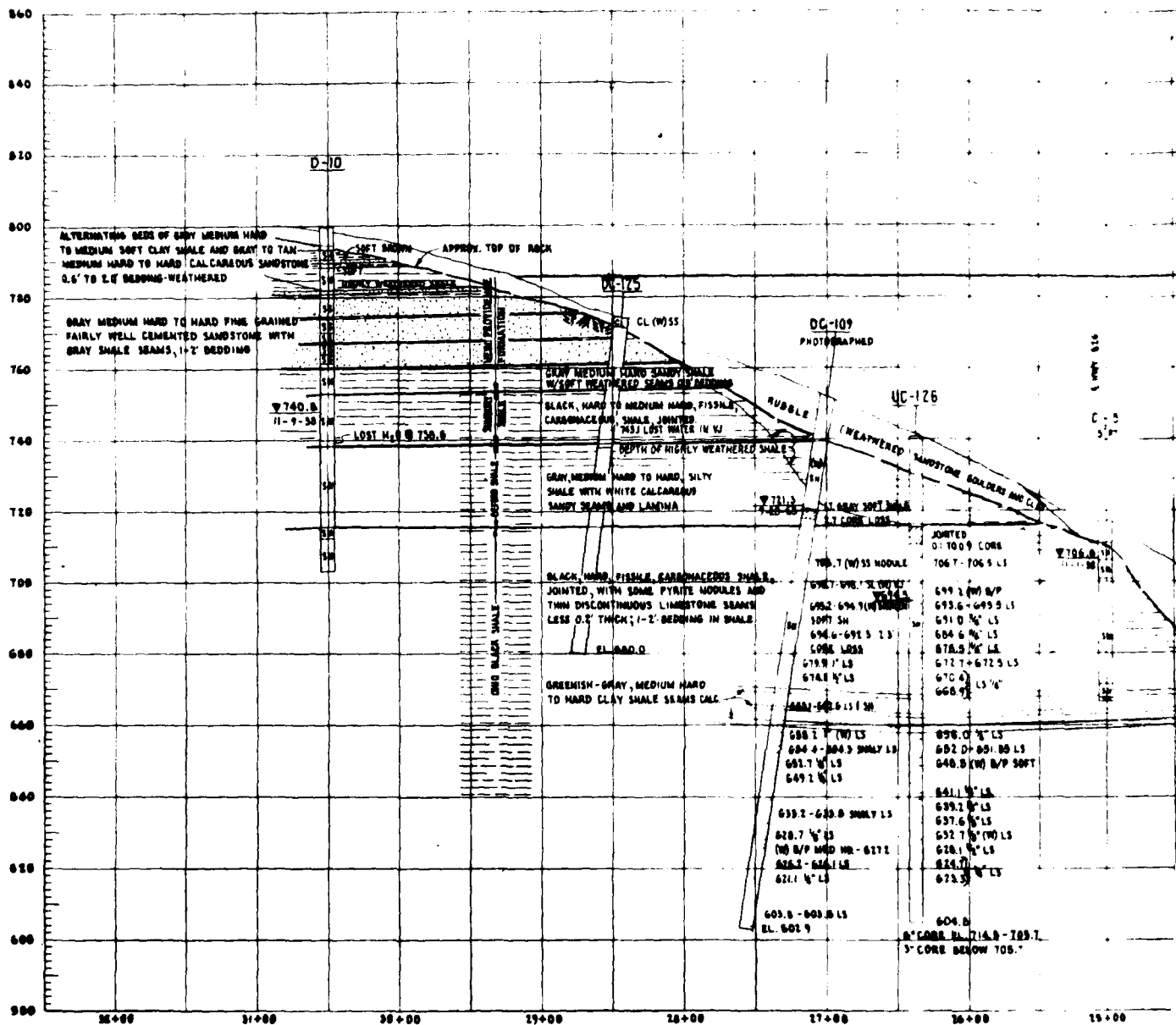


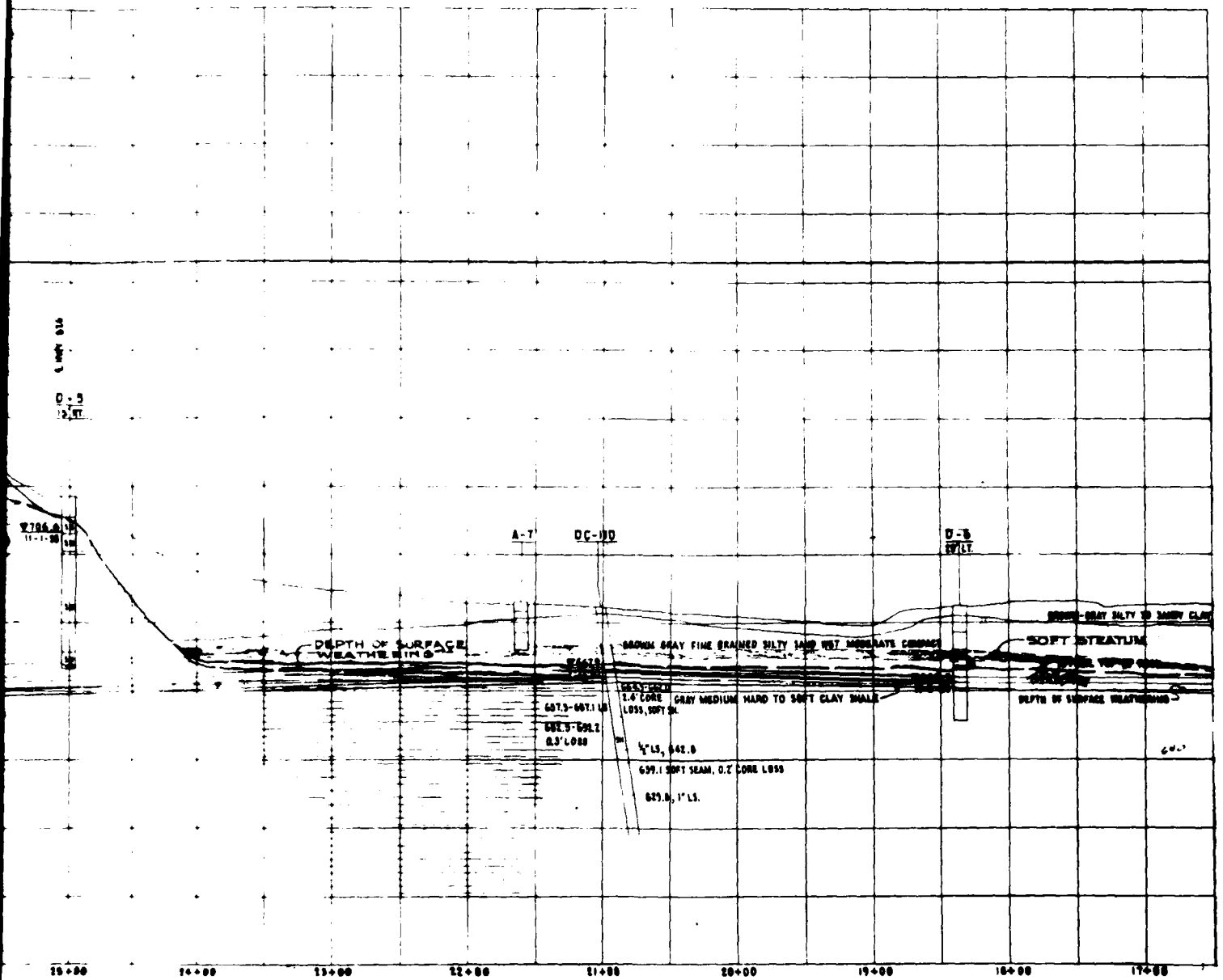
OHIO RIVER BASIN
CAVE RUN RESERVOIR
LICKING RIVER, KENTUCKY
GEOLOGIC PROFILE
DAM

DM NO. 3

PLATE 1

2



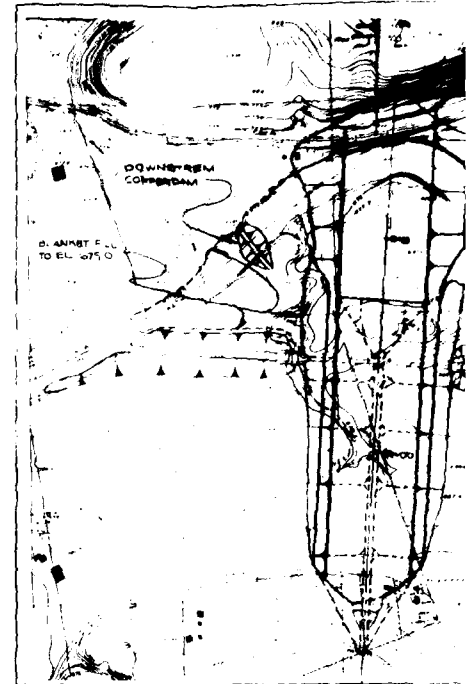


D.M. NO-3-PLATE 9

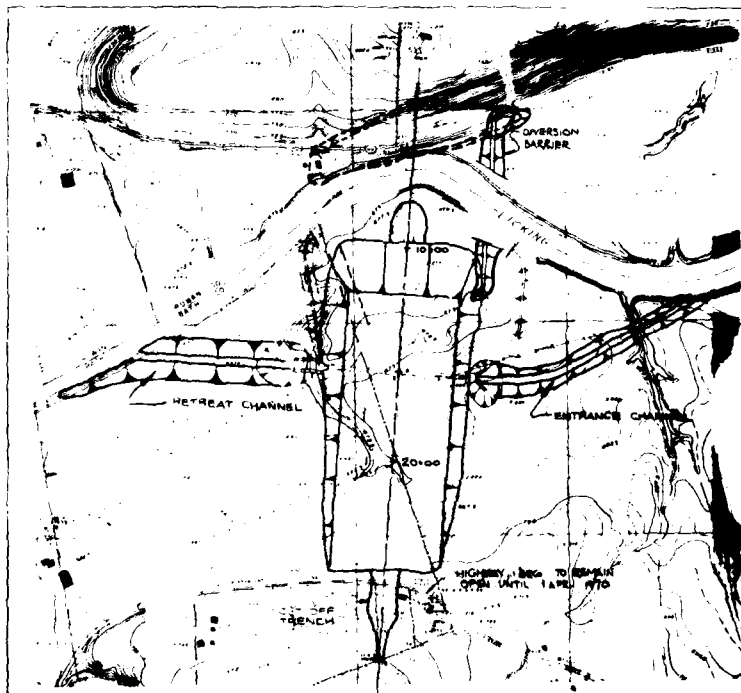
CORPS OF ENGINEERS



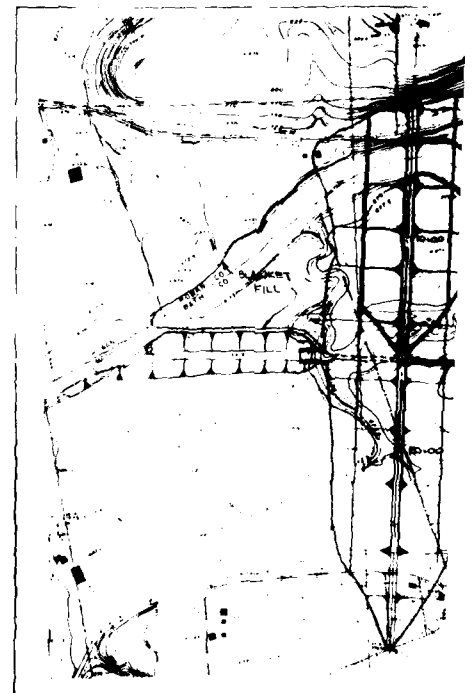
1ST CONSTRUCTION YEAR (1969)



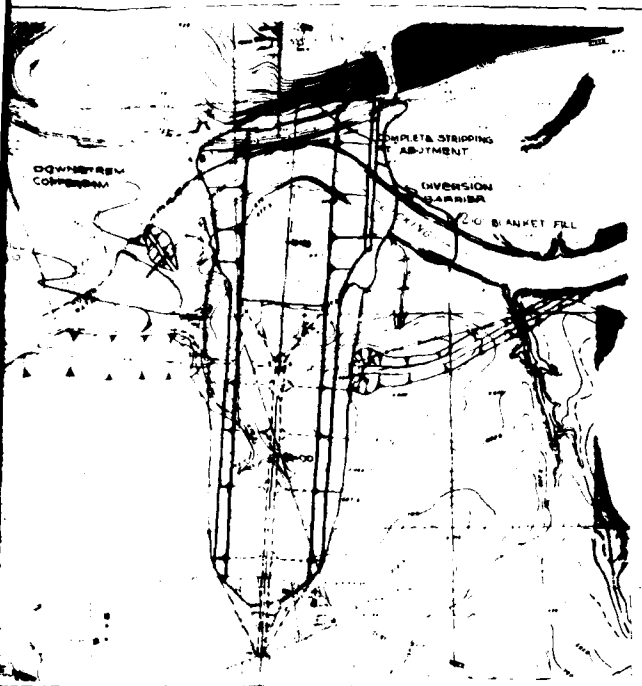
3RD CONSTRUCTION YEAR



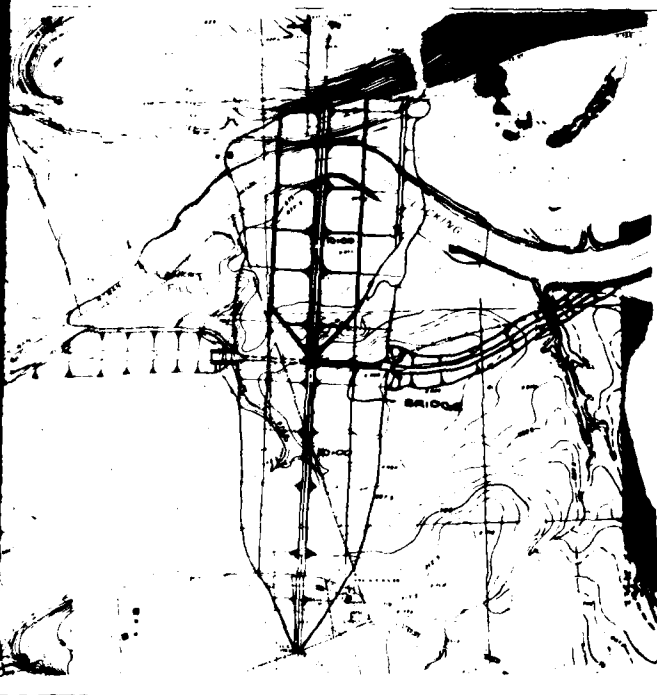
2ND CONSTRUCTION YEAR (1970)



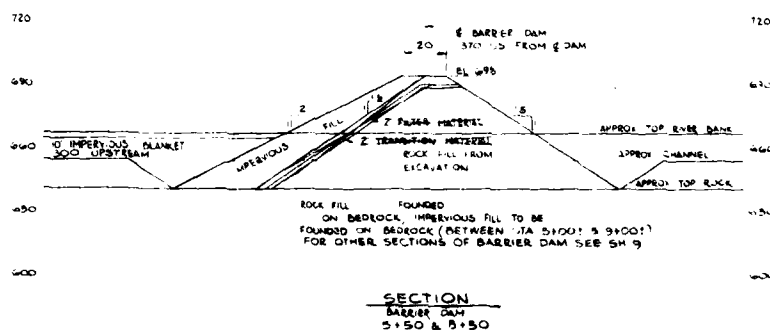
4TH CONSTRUCTION YEAR



1st CONSTRUCTION YEAR (1971)



2nd CONSTRUCTION YEAR (1972)



LEGEND

- WORK WHICH MAY PROCEED DURING YEAR INDICATED
- WORK REQUIRED TO BE COMPLETED PRIOR TO OR WITHIN THE YEAR INDICATED

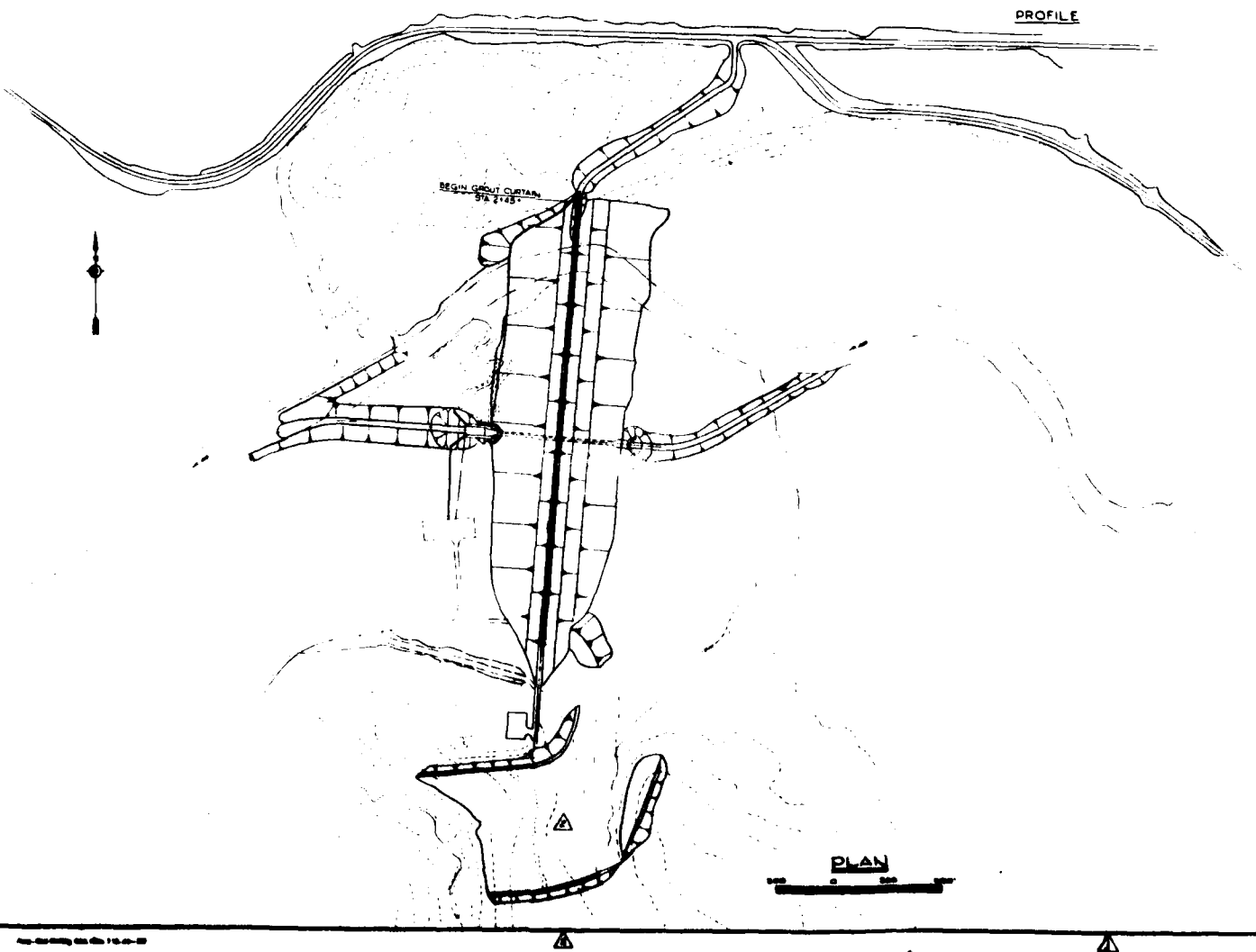
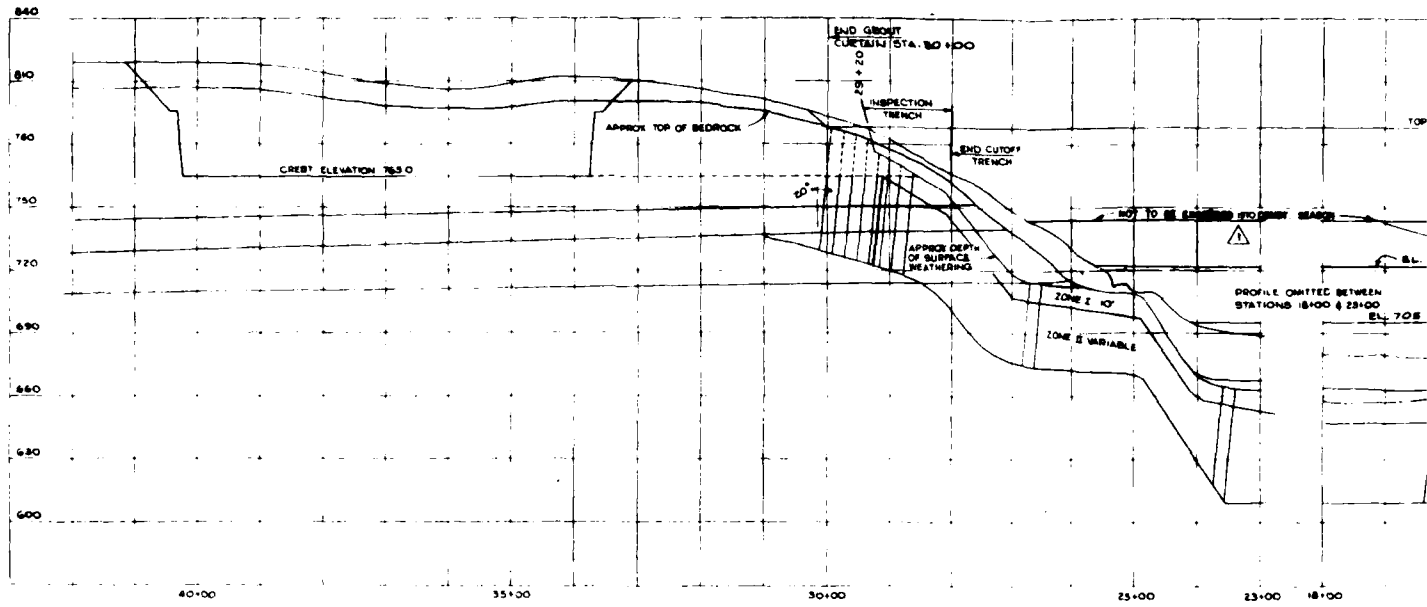
NOTE:
FOR MINIMUM REQUIRED AND MAXIMUM PERMITTED EMBANKMENT ELEVATIONS AT INTERIM PERIODS, SEE SHEETS 12.2.7 & 12.2.9

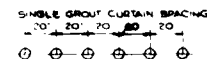
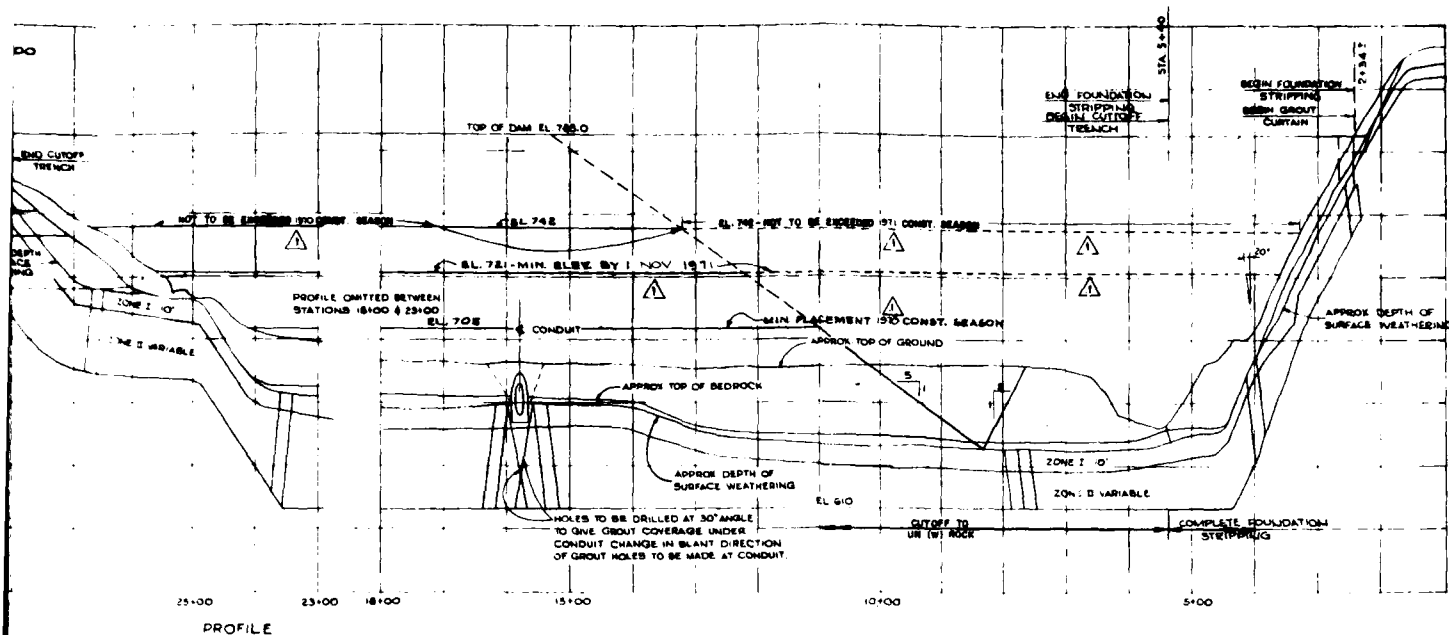
CONSTRUCTION PROCEDURES

NOTE: THE ABOVE PLAN SHOWS THE ELEVATION OF DAM EMBANKMENT & RELATED WORK BY CALENDAR YEARS IS BASED ON THE SPECIFIED CONSTRUCTION TIME THE WORK CAN PROGRESS AT A GREATER RATE PROVIDED THE DIVERSION & CARE OF STREAM REQUIREMENTS SET FORTH IN THE SPECIFICATIONS AND SHOWN ON THIS SHEET. THE EMBANKMENT PLANS ARE FULFILLED IN THEIR ENTIRETY ORDER, AS DETERMINED BY THE CONTRACTING OFFICIAL, AND ALL OTHER APPLICABLE REQUIREMENTS OF THE PLANS AND SPECIFICATIONS.

DESIGNED BY J.P.M.	TRACED BY J.J.S.	U. S. ARMY ENGINEER DISTRICT, LOUISVILLE CORPS OF ENGINEERS LOUISVILLE, KENTUCKY
DRAWING NUMBER LR-174-12.2/3A		CONSTRUCTION PROCEDURES
APPROVED BY J.J.S.		DATE 12.2.7
APPROVED BY J.J.S.		SCALE 1"=300'

CORPS OF ENGINEERS





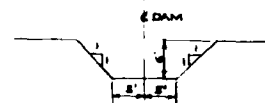
GROUTING PLAN

9CALE 1" x 4C

GROUT HOLES SPACED 20' C.C. INITIALLY.
ADDITIONAL HOLES MAY BE DRILLED
AND GROUTED BY THE SPLIT SPACING
METHOD AS DETERMINED IN THE
FIELD.

PALE CAMBER

NO SCALE



DETAIL OF INSPECTION TRENCH

MALE: 1910

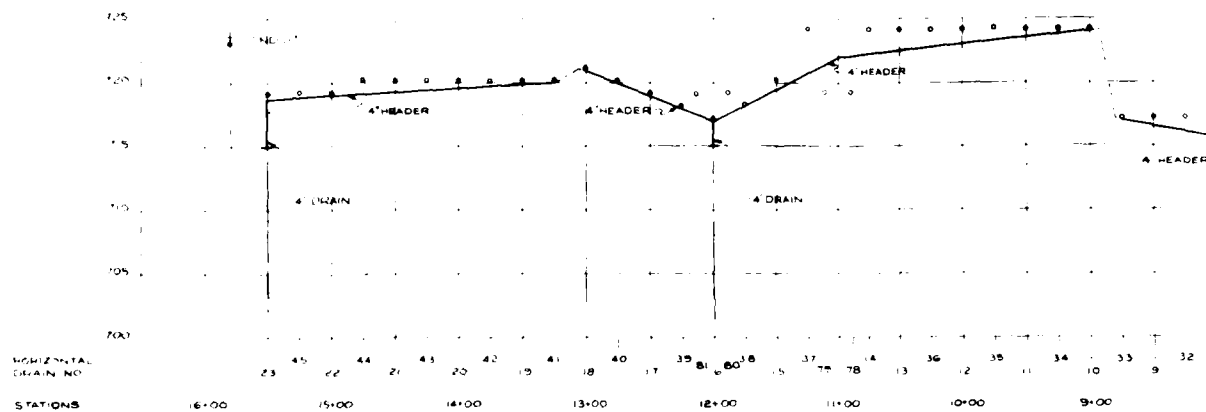
1. THE ROCK FOUNDATIONS AND ANCHORS SHALL BE CLASSED WITHIN THE CUTOFF TRUNK AND FOUNDATION STOPPING AREA. ALL UNDESIRABLES SHALL BE REMOVED OR TRIMMED BACK TO FORM A REASONABLE UNIFORM SLOPE ON THE EXISTING ADJACENCES. OVERHANGS WILL NOT BE PERMITTED AT ANY LOCATION AND SHALL BE REMOVED EITHER BY THE USE OF CONCRETE "FISHBONE TREATMENT" TO FILL THE EXISTING CAVITY OR BY THE REMOVAL OF THE EXISTING CONCRETE. ALL VERTICAL SPACING SHALL NOT BE GREATER THAN 2 FEET AND THE SPACING BETWEEN VERTICAL SPACING SHALL BE OF SIZE WITHIN AS TO PROVIDE A STEPPED SLOPE COMPARABLE TO THE UNIFORM SLOPE ON ADJACENT AREAS.
2. FILLING OF CRACKS OR FISSURES WITHIN THE CUTOFF TRUNK AND FOUNDATION STOPPING AREA SHALL BE WITH LEAP CONCRETE BUT LIMITED TO THE OPENINGS IN THE ROCK SURFACE, AND THEIR LAYERS OF LEAP CONCRETE SHALL NOT EXCEED THE SURFACE AREAS OF SOUND ROCK WHEN IN HEIGHT CHASE OFF SMALL RELICT ROCKS.

2. COMPLETE FOUNDATION STRIPPING TO UNWEATHERED ROCK TO BE ACCOMPLISHED BETWEEN ENDING OF DAM AND STATION 8+30 CUTOFF TO UNWEATHERED ROCK TO BE CONSTRUCTED BETWEEN STATION 5+50 AND 28+00. INSPECTION TUNNEL TO BE CONSTRUCTED BETWEEN STATION 28+00 AND END OF DAM.

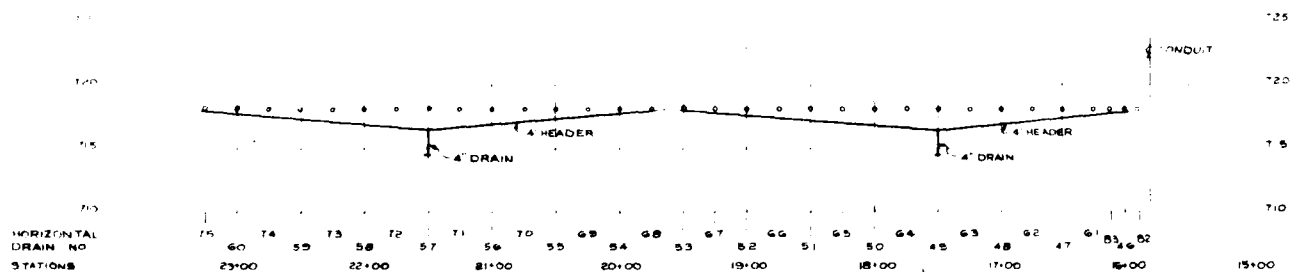
	1. EXPIRE REV'D PER AMDT NO. 3 DATED 18 JULY 1968 2. EXPIRE REV'D PER AMDT NO. 8		3. ☒
	4. ☐	5. ☐	6. ☐
7. ☐	8. ☐	9. ☐	10. ☐
11. ☐	12. ☐	13. ☐	14. ☐
15. ☐	16. ☐	17. ☐	18. ☐
19. ☐	20. ☐	21. ☐	22. ☐
23. ☐	24. ☐	25. ☐	26. ☐
27. ☐	28. ☐	29. ☐	30. ☐
31. ☐	32. ☐	33. ☐	34. ☐
35. ☐	36. ☐	37. ☐	38. ☐
39. ☐	40. ☐	41. ☐	42. ☐
43. ☐	44. ☐	45. ☐	46. ☐
47. ☐	48. ☐	49. ☐	50. ☐
51. ☐	52. ☐	53. ☐	54. ☐
55. ☐	56. ☐	57. ☐	58. ☐
59. ☐	60. ☐	61. ☐	62. ☐
63. ☐	64. ☐	65. ☐	66. ☐
67. ☐	68. ☐	69. ☐	70. ☐
71. ☐	72. ☐	73. ☐	74. ☐
75. ☐	76. ☐	77. ☐	78. ☐
79. ☐	80. ☐	81. ☐	82. ☐
83. ☐	84. ☐	85. ☐	86. ☐
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95. ☐	96. ☐	97. ☐	98. ☐
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107. ☐	108. ☐	109. ☐	110. ☐
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119. ☐	120. ☐	121. ☐	122. ☐
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127. ☐	128. ☐	129. ☐	130. ☐
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135. ☐	136. ☐	137. ☐	138. ☐
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147. ☐	148. ☐	149. ☐	150. ☐
151. ☐	152. ☐	153. ☐	154. ☐
155. ☐	156. ☐	157. ☐	158. ☐
159. ☐	160. ☐	161. ☐	162. ☐
163. ☐	164. ☐	165. ☐	166. ☐
167. ☐	168. ☐	169. ☐	170. ☐
171. ☐	172. ☐	173. ☐	174. ☐
175. ☐	176. ☐	177. ☐	178. ☐
179. ☐	180. ☐	181. ☐	182. ☐
183. ☐	184. ☐	185. ☐	186. ☐
187. ☐	188. ☐	189. ☐	190. ☐

RECORD DRAWING-"AS BUILT"
PLATE C

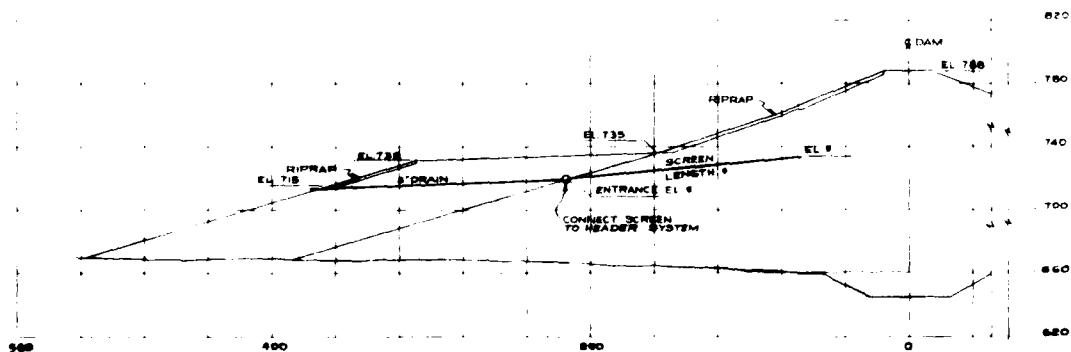
CORPS OF ENGINEERS



DRAINAGE SYSTEM
RIGHT OF CONDUIT

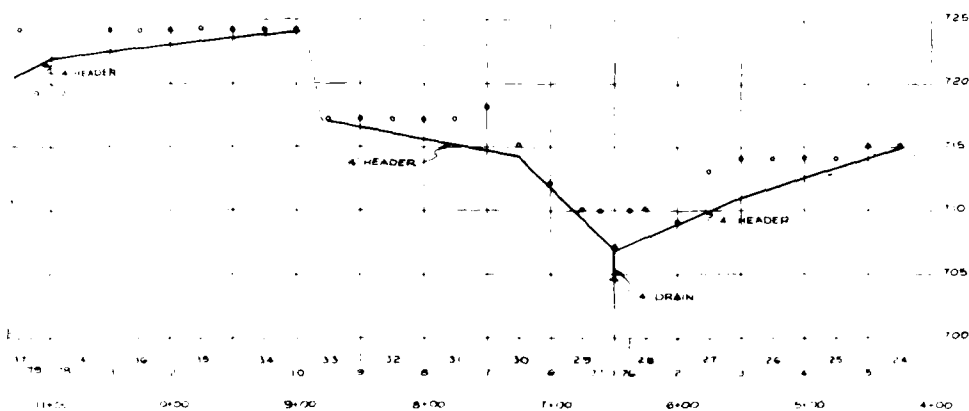


DRAINAGE SYSTEM
LEFT OF CONDUIT

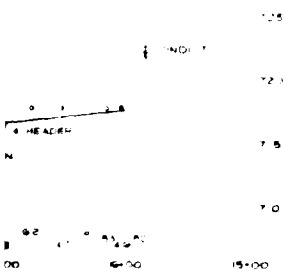


TYPICAL SECTION

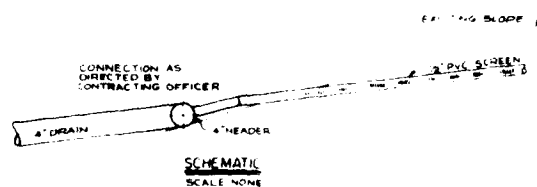
ENTRANCE ELEVATION
SCREEN LENGTH (FEET)
IS TO BE DETERMINED BY THE
CONTRACTING OFFICER



DRAINAGE SYSTEM
RIGHT OF CONDUIT



0 - REPRESENTS MINIMUM ENTRANCE
ELEV. OF HORIZONTAL DRAINS



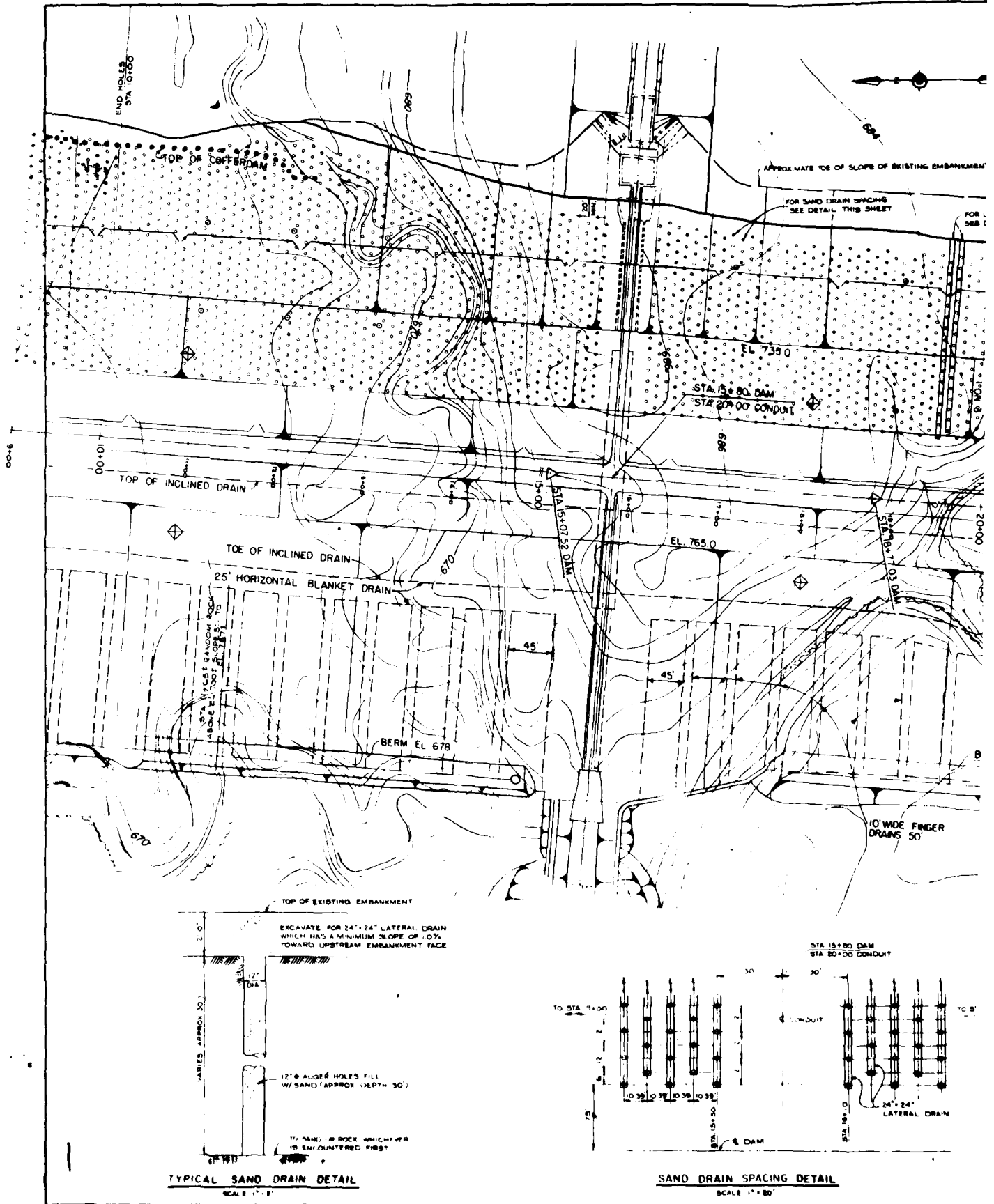
JUL 73		SHEET ADDED (CONT. MOD.)		EJM	
DIVISION	DATE	DESCRIPTION			BY
U. S. ARMY ENGINEER DISTRICT, LOUISVILLE					
CORPS OF ENGINEERS					
LOUISVILLE RESERVOIR					
DESIGNED EGM		OHIO RIVER BASIN			
DRAWN EGM		CAVE RUN RESERVOIR			
CHECKED W.F.B.		LICKING RIVER, KENTUCKY			
APPROVED		DRAINAGE SYSTEM FOR HORIZONTAL DRAINS			
SCALE		DRAWING NUMBER			
		LR 174-122/88			

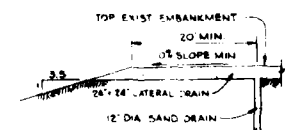
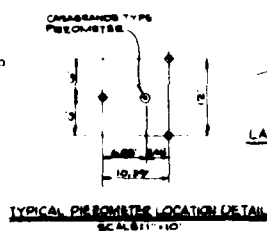
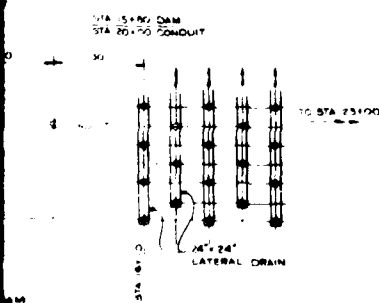
THIS DRAWING FURNISHED
FOR REFERENCE ONLY.

[illegible]

RECORD DRAWING NO.
PLATE 13

CORPS OF ENGINEERS



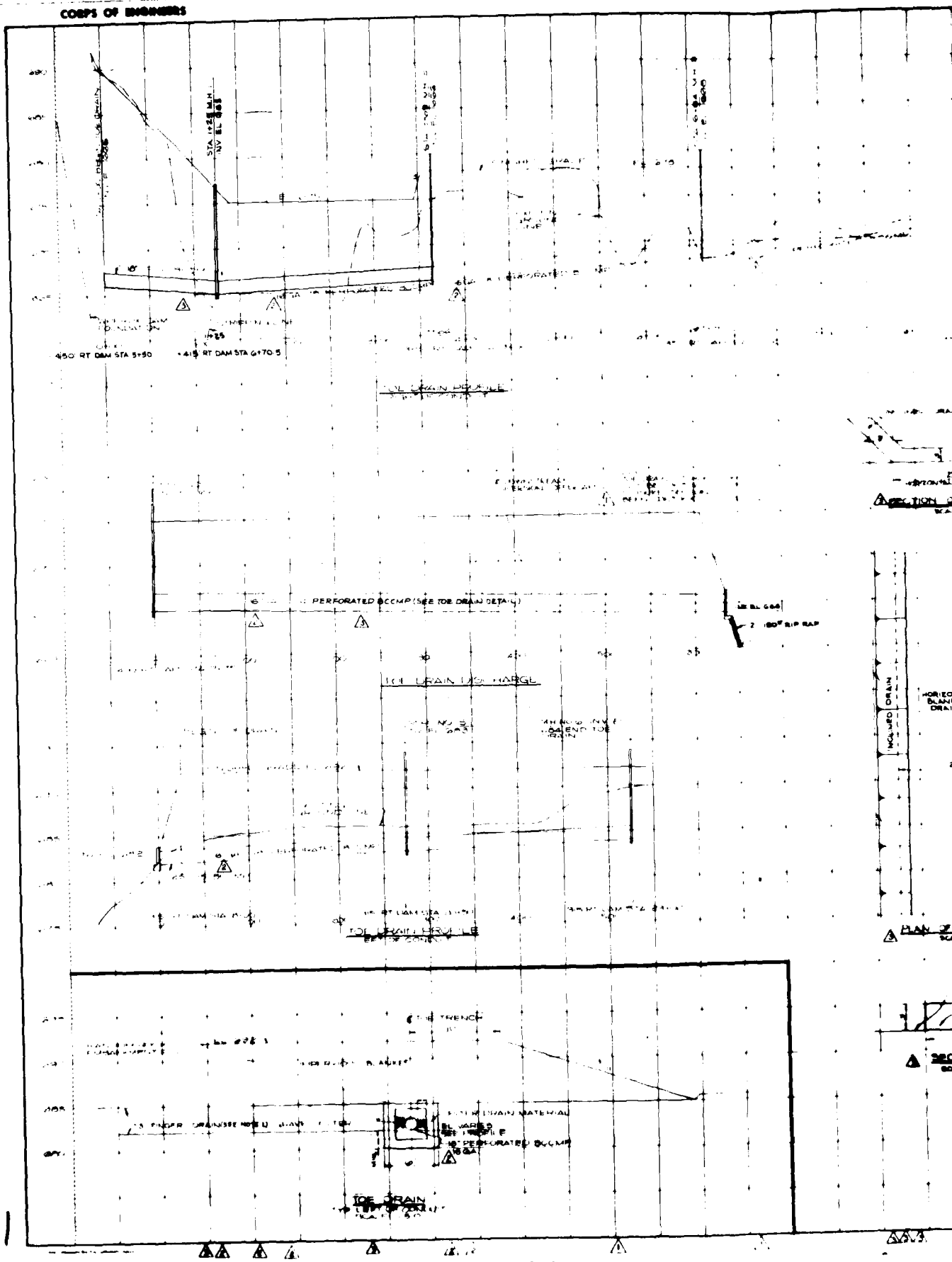


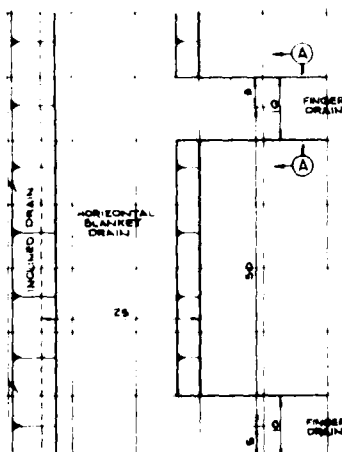
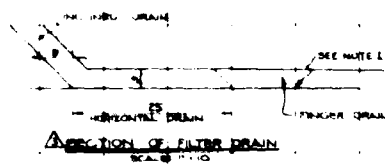
LATERAL DRAIN AT US SLOPE DETAIL
SCALE: 1:10'

DAM STATION : 0	RANGE 10	ELEVATION OF TIP ±'
11+00	150 U.S.	676
12+00	150 U.S.	672
13+00	250 U.S.	668
14+00	150 U.S.	664
15+00	100 U.S.	658
16+00	100 U.S.	654
17+00	100 U.S.	650
18+00	100 U.S.	646
20+00	100 U.S.	641
11+00	250 U.S.	676
13+00	150 U.S.	668
14+00	150 U.S.	664

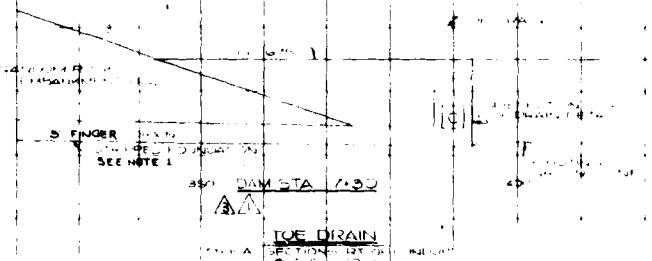
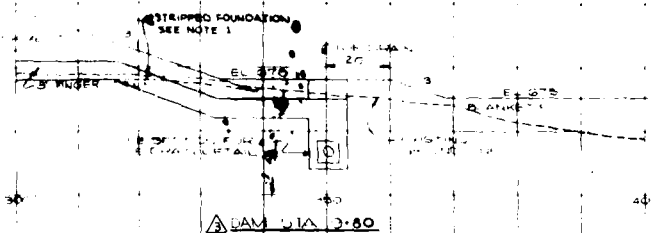
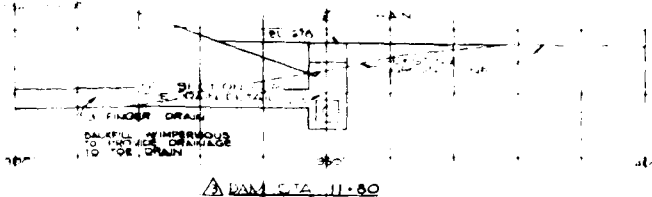
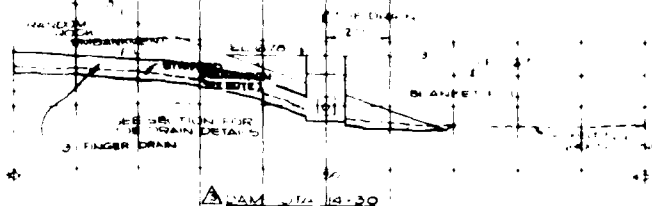
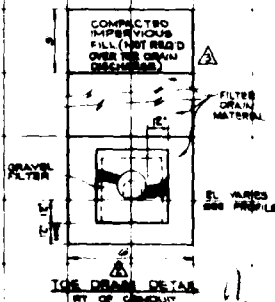
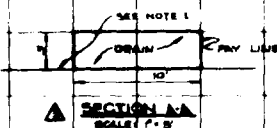
		SHEET ADDED (CONT. MOQ)		JFB	
DIVISION		DATE		DESCRIPTION BY	
U. S. ARMY ENGINEER DISTRICT, LOUISVILLE CORPS OF ENGINEERS LOUISVILLE DISTRICT					
DESIGN NO.		OHIO RIVER BASIN CAVE RUN LAKE LICKING RIVER, KENTUCKY			
DRAWN C.T.B. CHECKED ↑ TRACED		PLAN OF EMBANKMENT SAND DRAINS			
TPO DATED					
APPROVAL SIGN.					
FOR FIELD USE ONLY		FOR DISTRICT USE ONLY		FOR DISTRICT USE ONLY	
APPROVED		DATE		DRAWING NUMBER LR 174 - 12.2/8A	

CORPS OF ENGINEERS





SECTION A-A SCALE 1/10



NOTE 1: AFTER STRIPPING PLACE MINIMUM AMOUNT OF FILL REQUIRED TO GRADE AREA TO DRAIN TO DOWNSTREAM FOR EXCAVATE 10+3 TRENCHES IN GRADED AREA FOR FINGER DRAINS AND FILL TRENCHES WITH COMPACTED HORIZONTAL DRAIN MATERIAL.

STORY 10 FOR DRAIN REVD. DETAILS ADDED (CONT. MOD.)
 15 SEPT 48 REVD. PER AMOTS 2 & 3 DATED 14 & 15 JULY 1948
 16 JUL 48 REVD. PER AMOTS 2 & 3 DATED 14 & 15 JULY 1948

U. S. ARMY ENGINEER DISTRICT, LOUISVILLE
 CORPS OF ENGINEERS
 LOUISVILLE DISTRICT

DESIGNED BY EJM
 DRAWN BY T. H. HARRIS
 CHECKED BY H. H. HARRIS
 SCALE 1/10

CAVE RUN RESERVOIR
 LICKING RIVER, KENTUCKY
 SEEPAGE CONTROL MEASURES
 PROFILES & SECTIONS

JUNE 1948
 DRAWING NUMBER
 LR-174-12 2/B

RECORD DRAWING, AS BUILT

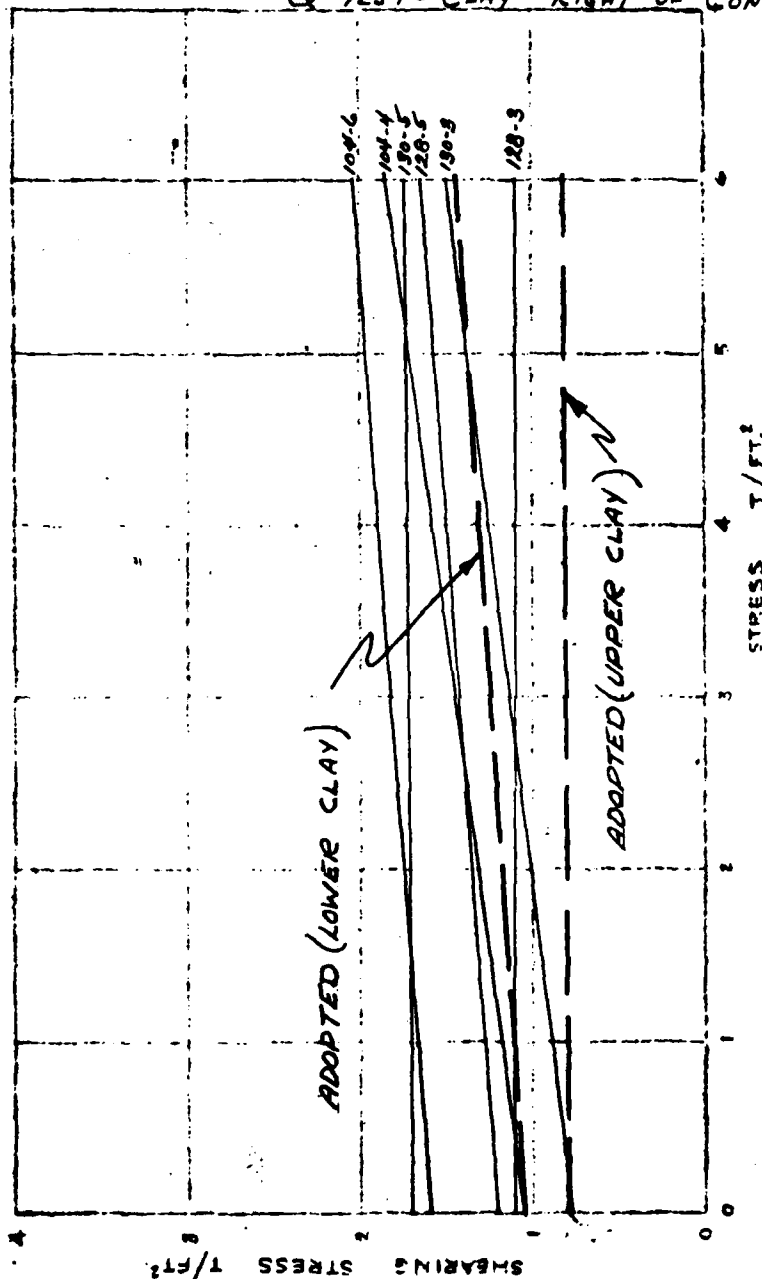
PLATE 15

Qm

DATE 7/2/64
DATE

SUBJECT CAVE RUN RESERVOIR, KY
FOUNDATION SHEAR TEST SUMMARY
Q TEST - CLAY - RIGHT OF CONDUIT

SHEET NO. 1 OF 1
JOB NO.



ADOPTED VALUES

Upper Clay

Tan ϕ : 0.00

C : 0.80 T/FT²

Lower Clay

Tan ϕ : 0.05

C : 1.05 T/FT²

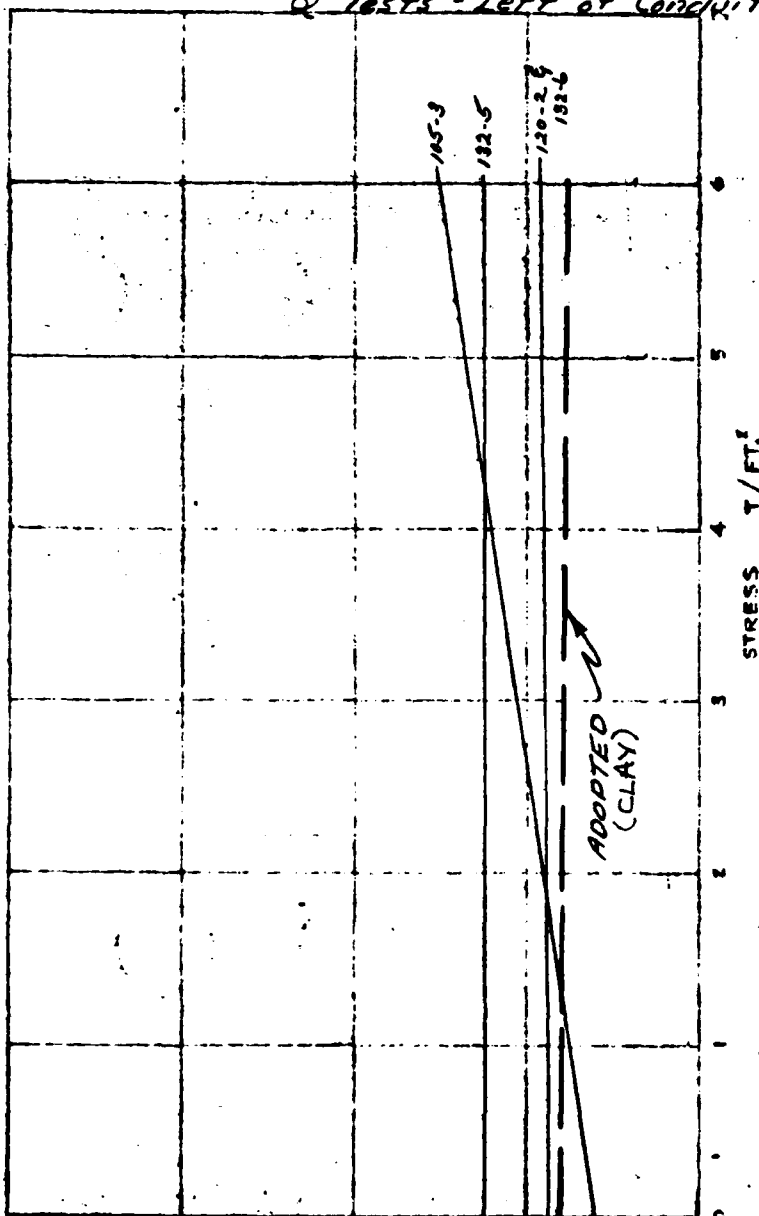
HOLE NO.	SAMPLE NO.	CLASS.	LL	PL	TAN ϕ	T/FT²	Classification & Depth
U-128	3	CL	44.8	26.7	0.000	1.10	Silty Clay (5.0-7.5) Upper Clay
U-130	3	CL-MH	46.1	28.4	0.109	0.78	Silty Clay (6.0-7.5) Clay
UK-104	4	CL			0.132	1.05	Lean Clay (8.7-10.5)
	6	CL	22.4	14.5	0.062	1.60	Sandy Silty Clay (13.7-15.4) Lower Clay
U-128	5	CL	43.1	25.6	0.026	1.20	Silty Clay (10.0-12.5)
U-130	5	CL	38.2	25.6	0.000	1.71	Silty Clay (10.0-12.5)

Y *Em*
HKT 11

DATE 5/23/64

SUBJECT CAVE RUN RESERVOIR, Ky.
FOUNDATION SHEAR TEST SUMMARY
Q Tests - Left of Conduit - Clay

SHEET NO. OF
JOB NO.



ADOPTED VALUE

Tan ϕ : 0.00

C: 0.80 T/FT²

* Material to be stripped

HOLE NO.	SAMPLE NO.	CLASS.	LL	PL	TAN ϕ	C T/FT²	Classification & Depth
UC-105	3	CL	33.5	17.2	0.140	0.60	Sandy Clay (6.2-8.0)
UC-106	2	CL	24.2	14.0	0.068	0.00	Sandy Clay (3.7-5.5)
UC-120	2	CL	43.0	23.5	0.000	0.88	Lean Clay (4.2-5.0)
U-132	5	CL	32.6	20.6	0.000	1.25	Sandy Clay (9.1-11.6)
	6	CL	32.5	19.3	0.000	0.88	Sandy Clay (11.6-14.1)

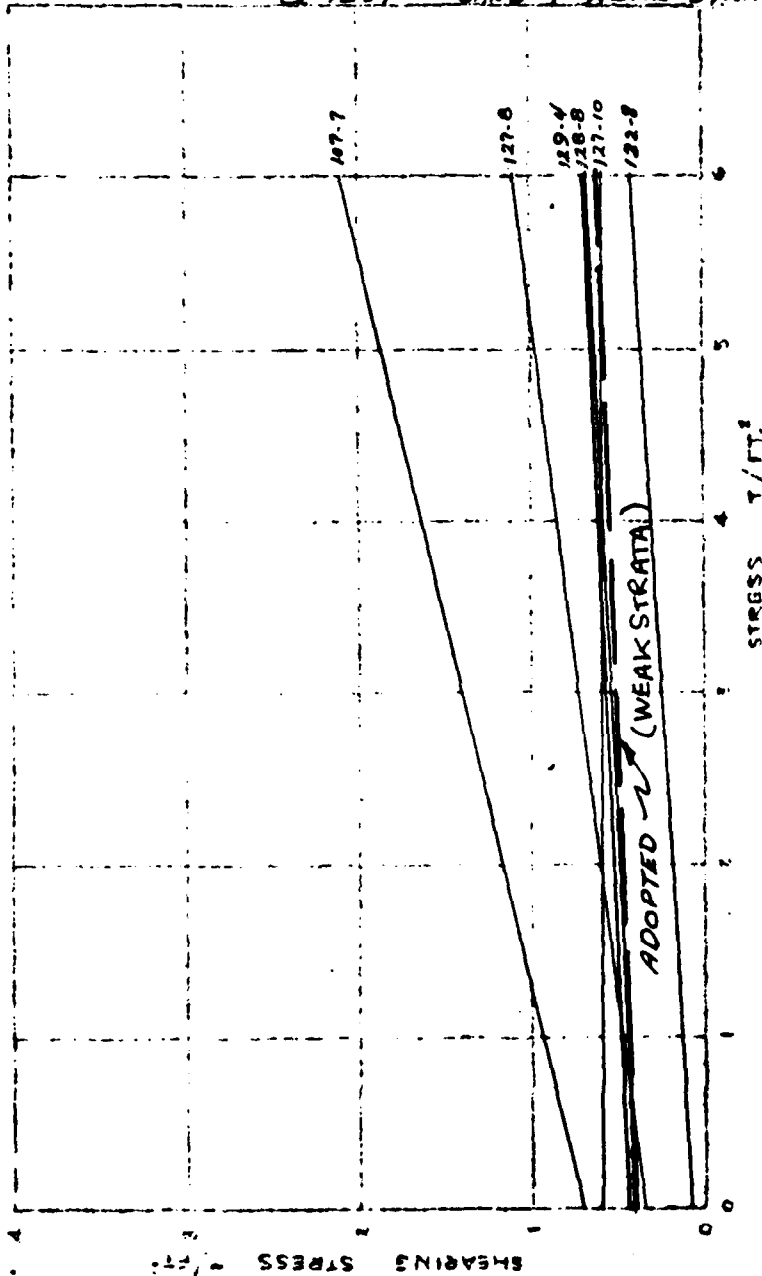
*

Qm

DATE 7/2/64

CAVE RUN RESERVOIR, Ky.
FOUNDATION SHEAR TEST SUMMARY
Q TEST - SAND & WEAK STRATA

SHEET NO.
JOB NO.



ADOPTED

WEAK STRATA

TAN $\phi = 0.04$

C = 0.40 T/A²

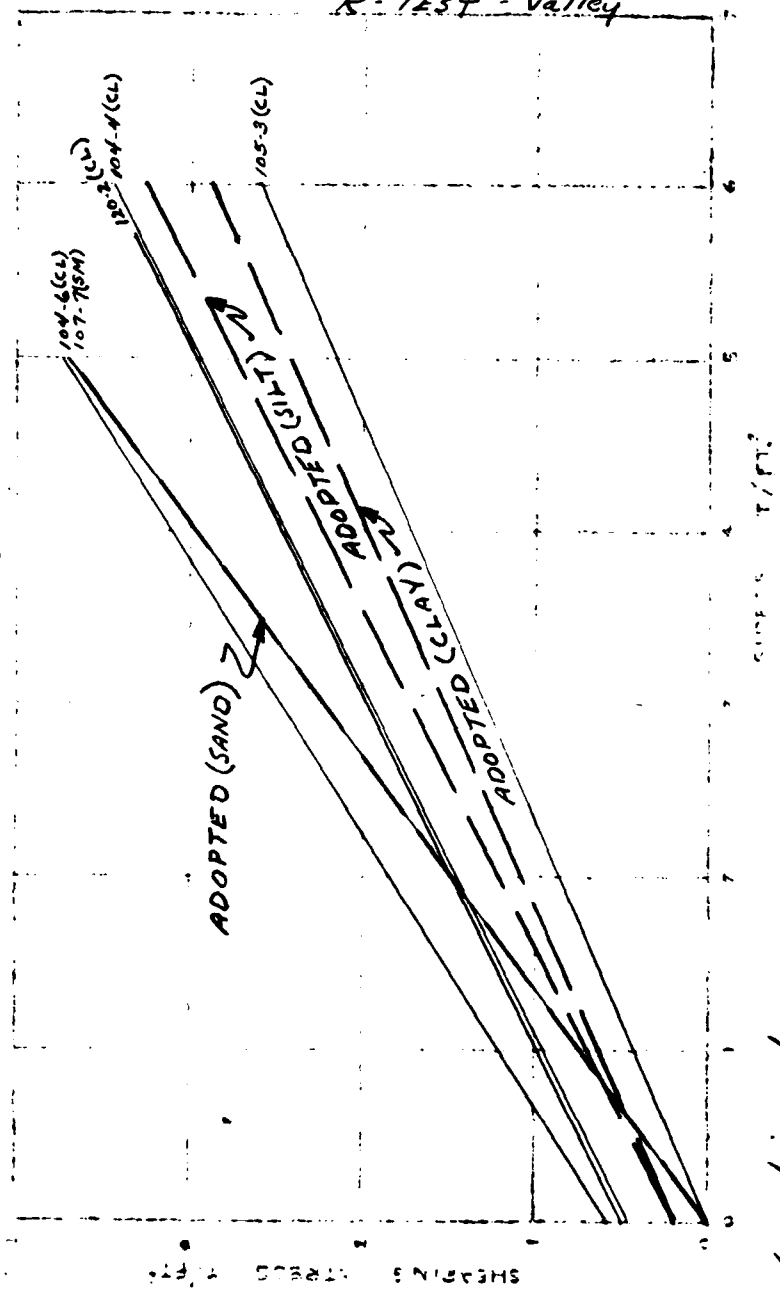
HOLE NO.	SAMPLE NO.	CLASS.	LL	PL	TAN ϕ	T/C	CLASSIFICATION & DEPTH
UC-107	7	SM	N-P		0.240	0.70	Silty f. Sand (15.7-17.5)
UC-127	8	ML	N-P		0.123	0.35	Sandy Silt (19.1-20.0)
	10	SM	N-P		0.000	0.60	Silty Sand (23.2-25.0)
U-128	8	SM	N-P		0.055	0.39	Silty Sand (17.5-20.0)
U-129	4	ML	N-P		0.021	0.45	Sandy Silt (7.5-10.0)
U-132	8	CL	28.8	18.0	0.050	0.075	Sandy Clay (21.9-24.4)

8/m

6/25/64

CAVE RUN RESERVOIR, KY FOUNDATION SHEAR TEST SUMMARY R-TEST - Valley

1 2



ADOPTED

SAND

Tan ϕ : 0.75
C: 0.00 T/ft²

SILT

Tan ϕ : 0.50
C: 0.20 T/ft²

CLAY

Tan ϕ : 0.42
C: 0.20 T/ft²

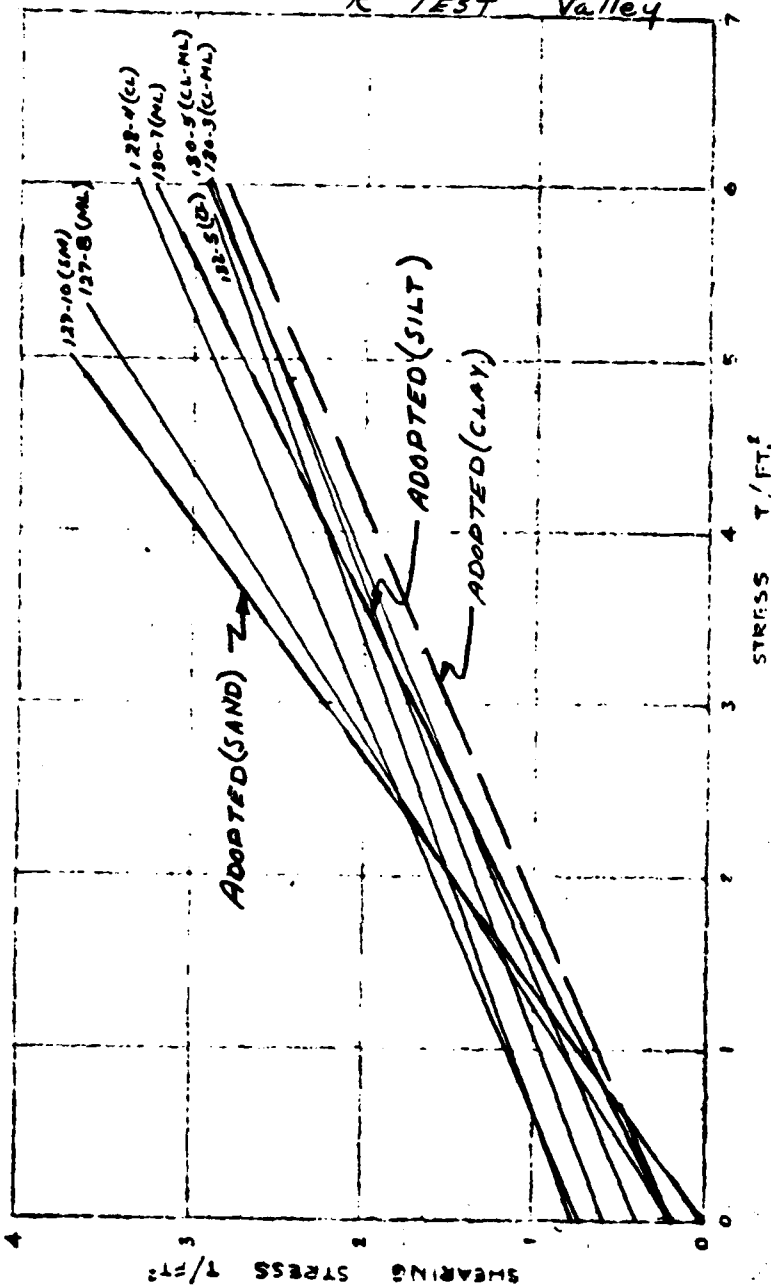
* Material to be stripped

HOLE NO.	SAMPLE NO.	CLASS.	LL	PL	TAT	SATURATION	Tip of Sample	Bottom of Sample	
UC-104	4	CL			0.493	0.46	99.9	99.4	100.0
	6	CL	22.4	14.5	0.617	0.58	99.9	97.3	98.3
UC-105	3	CL	33.5	17.2	0.420	0.00	95.3	100.0	100.0
UC-106	2	CL	24.2	14.0	0.533	0.00	86.9	84.4	86.5
	2	CL	24.2	14.0	0.443	0.10	100.0	86.0	84.0
UC-107	7	SM			0.750	0.00	88.1	93.4	93.9
UC-120	2	CL			0.482	0.50	95.6	94.3	95.0

DATE 6/25/64
DATE

SUBJECT: CAVE RUN RESERVOIR, KY
FOUNDATION SHEAR TEST SUMMARY
R TEST Valley

SHEET NO. 2 OF 2



ADOPTED

See Sheet 1

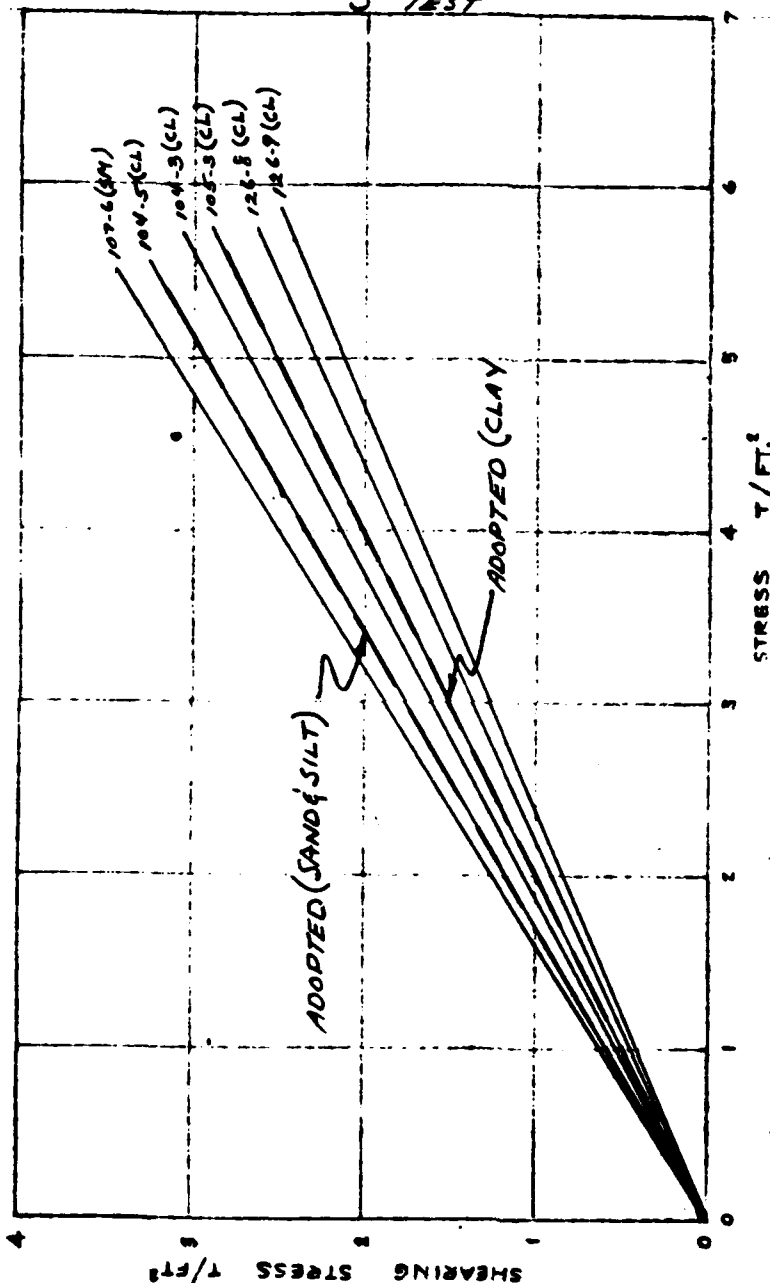
HOLE NO.	SAMPLE NO.	CLASS.	LL	PL	TAN ϕ	C, %	SATURATION
UK-127	8	ML	N-P		0.633	0.20	88.2 82.1 81.6
	10	SM	N-P		0.750	0.00	90.4 91.4 86.0
U-128	4	CL	44.8	26.7	0.333	0.82	100.8 100.8 101.2
U-130	3	CL-ML	46.1	28.4	0.381	0.59	103.3 104.5 105.4
	5	CL-ML	38.2	25.6	0.420	0.40	93.6 95.4 98.6
	7	ML	N-P		0.500	0.20	92.1 99.4 96.3
U-132	5	CL	32.6	20.6	0.359	0.77	97.9 99.4 100.6

Qm

DATE 6/25/64

SUBJECT CAVE RUN RESERVOIR, KY
FOUNDATION SHEAR TEST SUMMARY
5 TEST

SHEET NO. 1 OF 2
JOB NO.



ADOPTED

Clay

Tan $\phi = 0.50$

C = 0.00 T/FT²

Sand & Silt

Tan $\phi = 0.60$

C = 0.00 T/FT²

* Material to be stripped

HOLE NO.	SAMPLE NO.	CLASS.	LL	PL	TAN ϕ	C T/FT²	SATURATION
UC-104	3	CL	42.5	23.6	0.537	0.00	
	5	CL	26.8	16.6	0.592	0.00	
UC-105	3	CL	33.5	17.2	0.497	0.00	
UC-106	1	CL	25.4	15.0	0.641	0.00	
UC-107	6	SM	N-P		0.614	0.00	
UC-126	8	CL			0.462	0.00	
	9	CL	38.3	18.5	0.404	0.00	

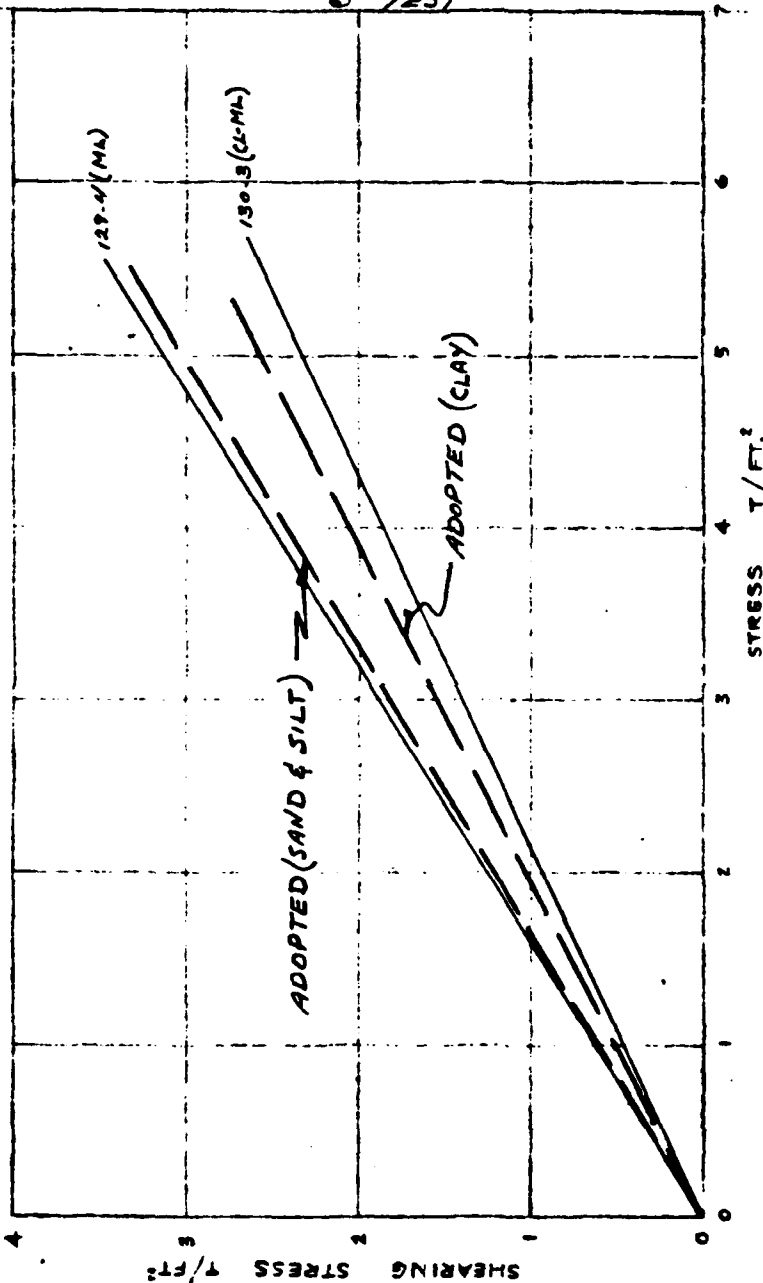
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PLATE 2:

gpm

DATE 6/25/64

SUBJECT CAVE RUN RESERVOIR, KY
FOUNDATION SHEAR TEST SUMMARY
S TEST

SHEET NO 2 OF 2
JOB NO.



ADOPTED

See Sheet 1

* Materials to be removed

MOLE NO.	SAMPLE NO.	CLASS.	LL	PL	TAN ϕ	C T/FT²	SATURATION
U-127	6	CL			0.516	0.00	
	9	CL			0.633	0.00	
U-129	4	ML			0.620	0.00	
U-130	3	CL-ML			0.466	0.00	

* *

PLATE 22

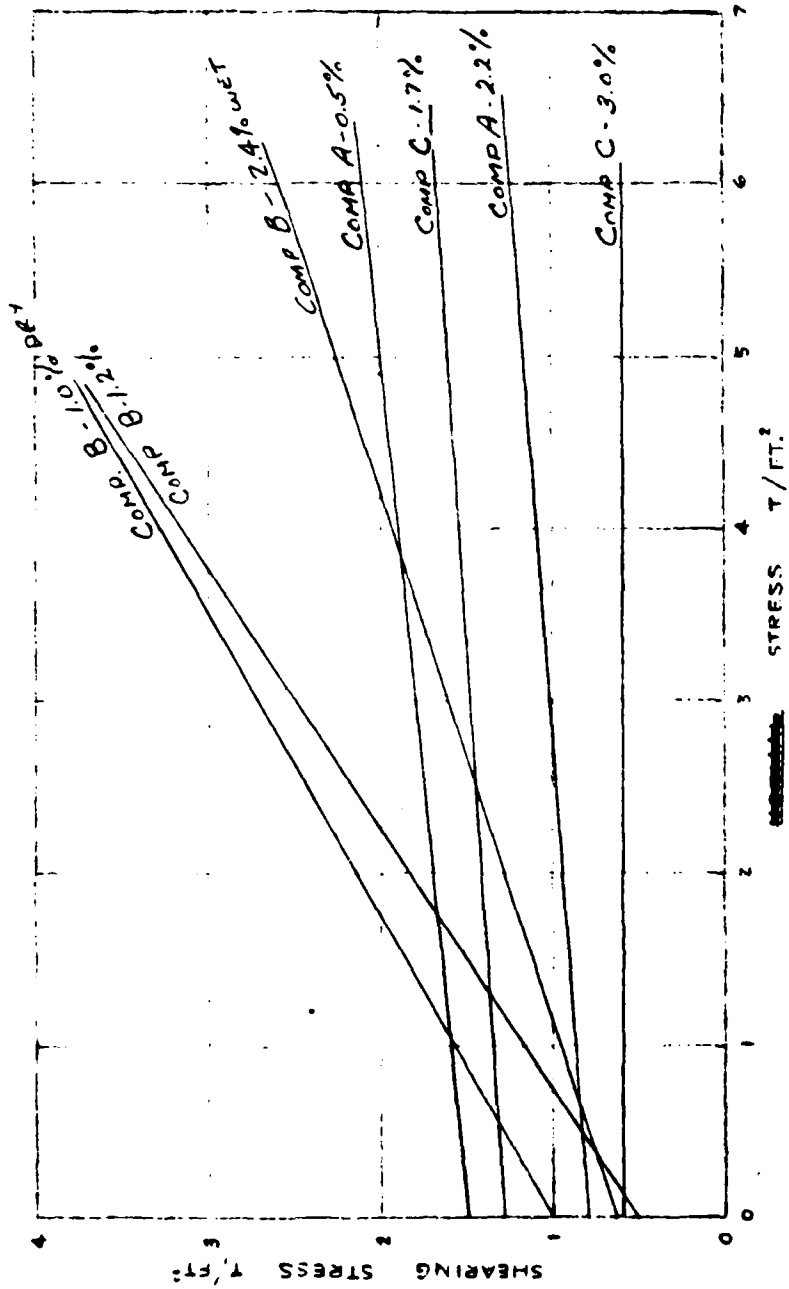
BY
DATE

Am

DATE 10/12/63

SUBJECT CAVE RUN RESERVOIR
SOIL TEST DATA

SHEET NO.
101



ADOPTED
Tan $\phi = 0.00$
"C" = 1.10

CAVE RUN RESERVOIR

HOLE NO.	SAMPLE NO.	CLASS.	LL %	PL %	TAN ϕ	C T/FT.	SATURATION
Comp "A"		CL	30.5	17.7	0.093	1.50	0.5% wet of optimum
Comp "B"		SM	N.P.		0.093	0.80	2.2% WET
					0.460	1.00	1.0% DRY OF OPTIMUM
					0.500	0.67	1.2% WET
					0.335	0.60	2.4% WET
Comp "C"		CL	28.0	16.5	0.061	1.28	1.7% WET
					0.000	0.59	3.0% WET

UNCONSOLIDATED-UNDRAINED (U)

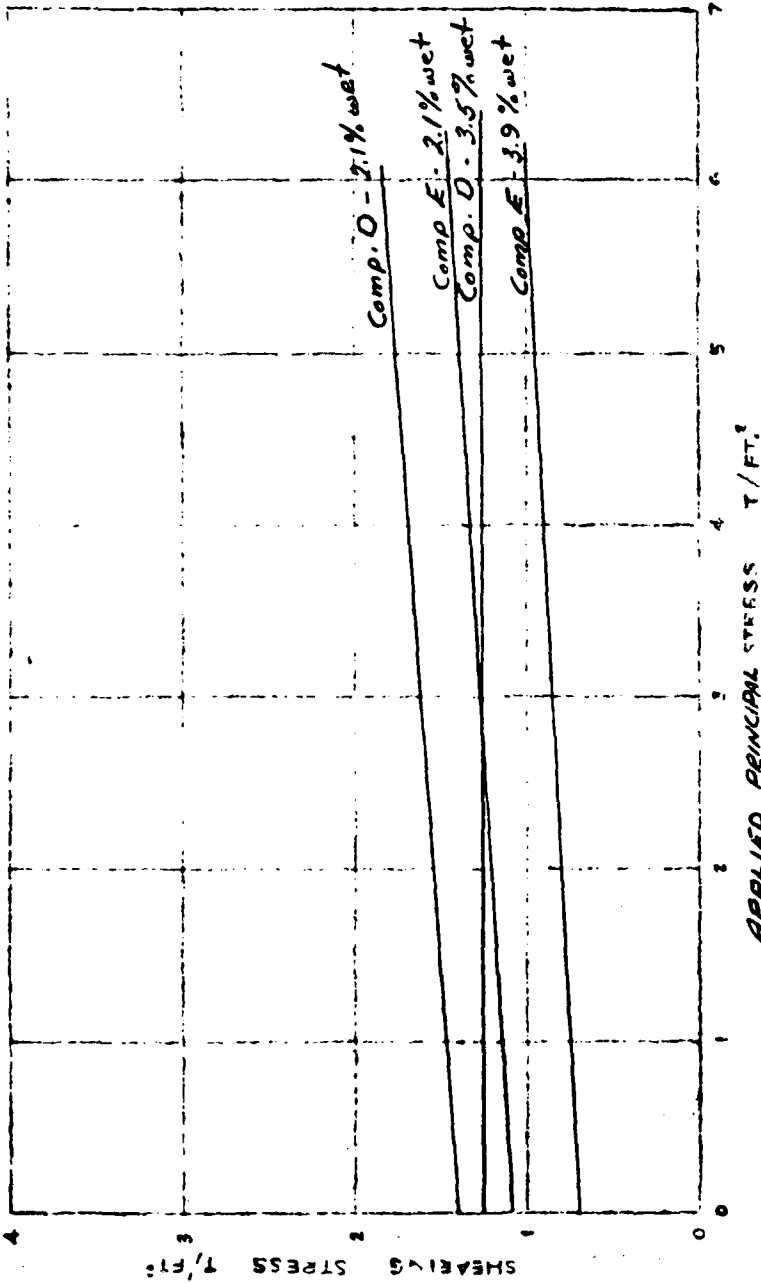
EMBANKMENT MATERIALS

ELM

DATE 3/7/64
DATE

SUBJECT Cave Run Reservoir
Q Test Summary - Borrow

SHEET NO. 2 OF 2
JOB NO.



HOLE NO.	SAMPLE NO.	CLASS.	LL	FL	TAIN	C	T/FT
Comp "D"		CL	41.7	21.0	0.066	1.40	2.1 % Wet of Optimum
					0.000	1.25	3.5 % Wet
Comp "E"		SC	25.4	17.5	0.038	1.10	2.1 % Wet
					0.040	0.70	3.9 % Wet

Q TEST SUMMARY

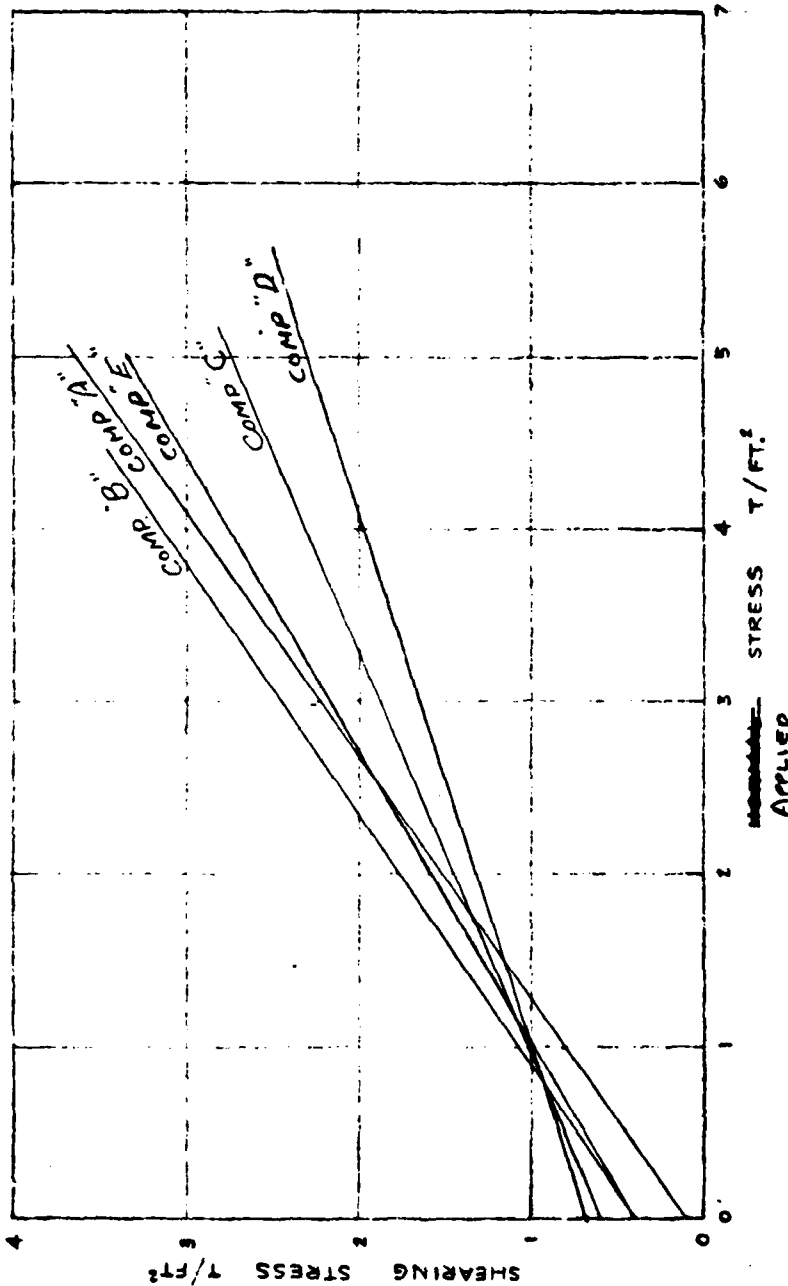
EMBANKMENT MATERIALS

8m

DATE 10/21/63

SUBJECT CAVE RUN RESERVOIR
SOIL TEST DATA

SHEET NO.
JOB NO.



ADOPTED

$\tan \phi = 0.51$
 $C = 0.40 \text{ T/FT}^2$

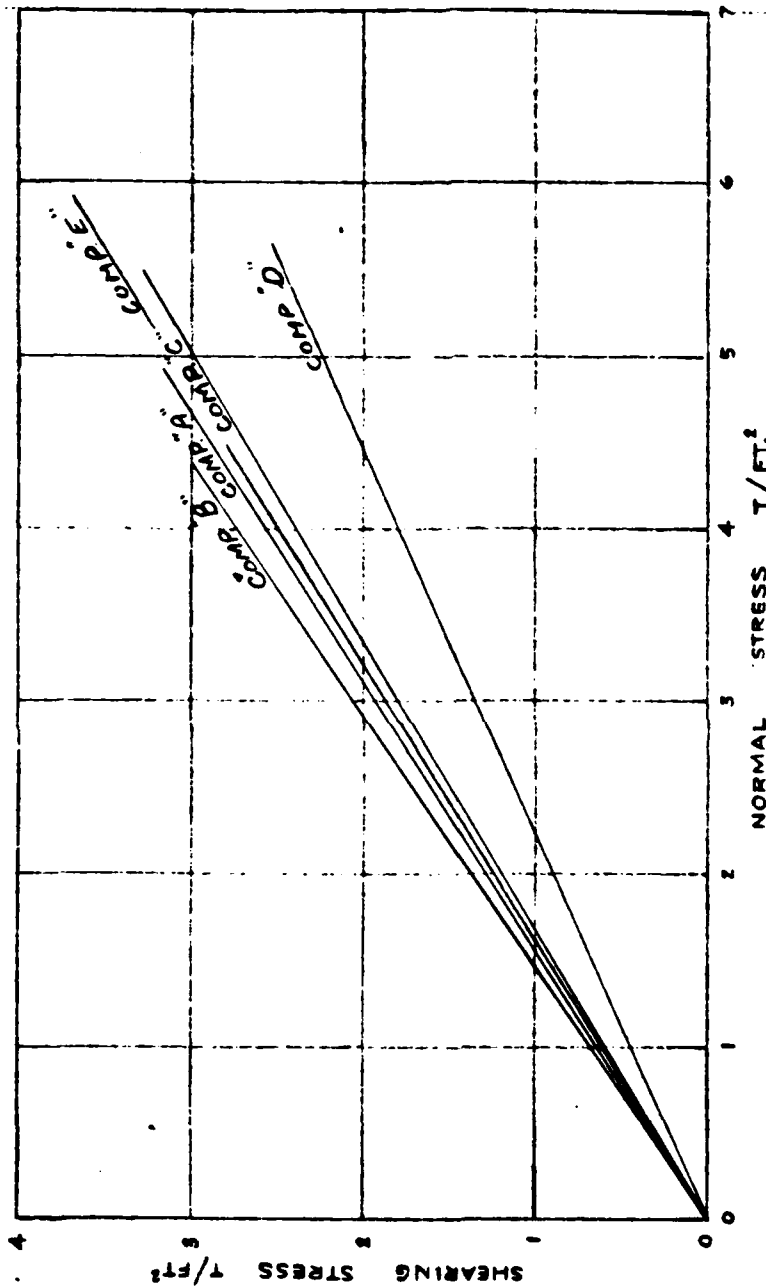
CAVE RUN RESERVOIR

HOLE NO.	SAMPLE NO.	CLASS.	LL %	PL %	TAN ϕ	C T/FT ²	SATURATION
Comp "A"		CL	30.8	17.7	0.700	0.10	100
Comp "B"		SM	N/D		0.674	0.40	88.3
Comp "C"		CL	28.0	16.5	0.510	0.60	100
Comp "D"		CL	41.7	21.0	0.329	0.67	100
Comp "E"		SC	25.4	17.5	0.623	0.40	99.4
							Do not Average
							87.5
							97.3
							97.4

PLATE 25

BY SM DATE 12/21/63 SUBJECT CAVE RUN RESERVOIR
 CHK'D BY DATE 12/21/63 SHEAR TEST DATA

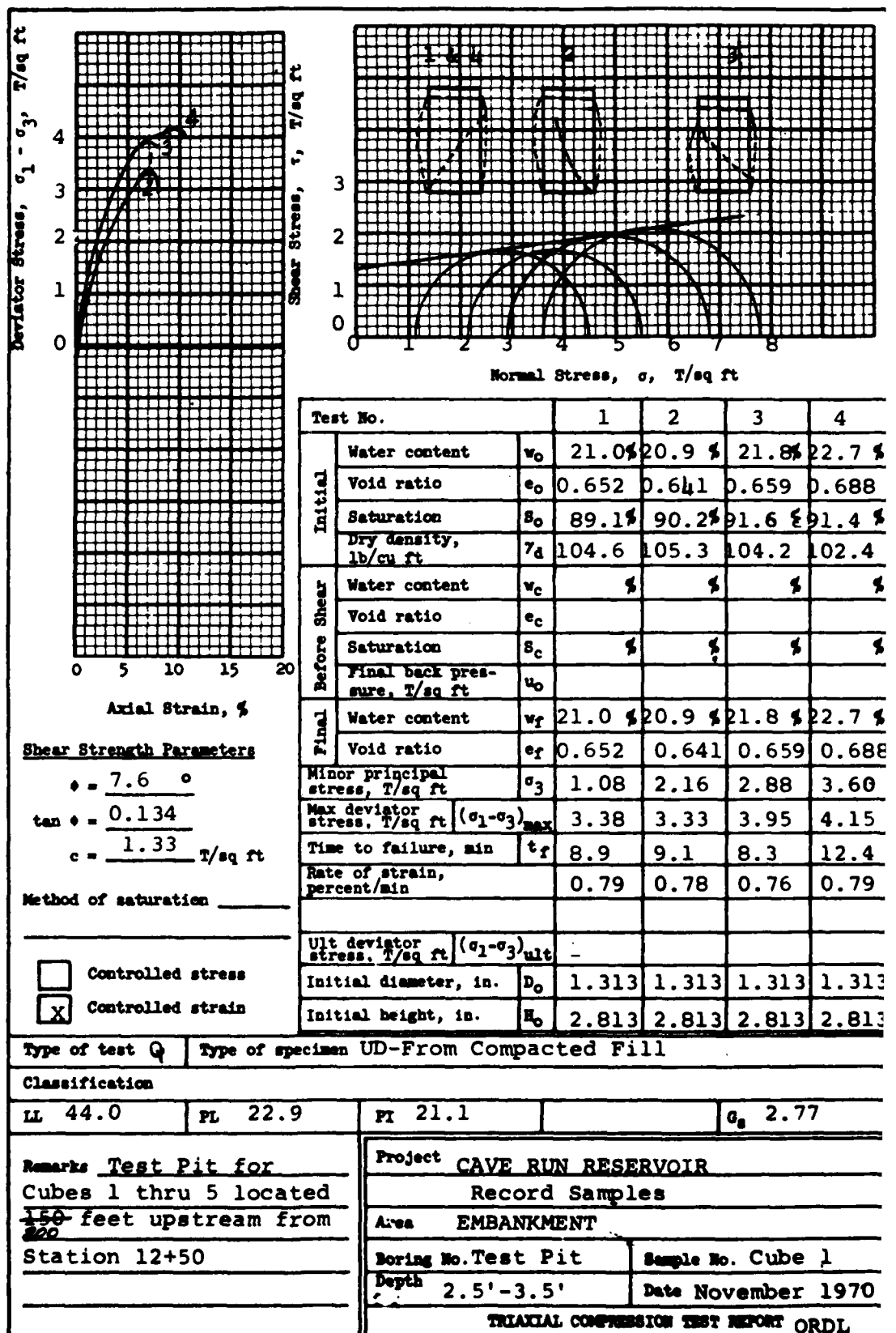
SHEET NO. _____ OF _____
 JOB NO. _____

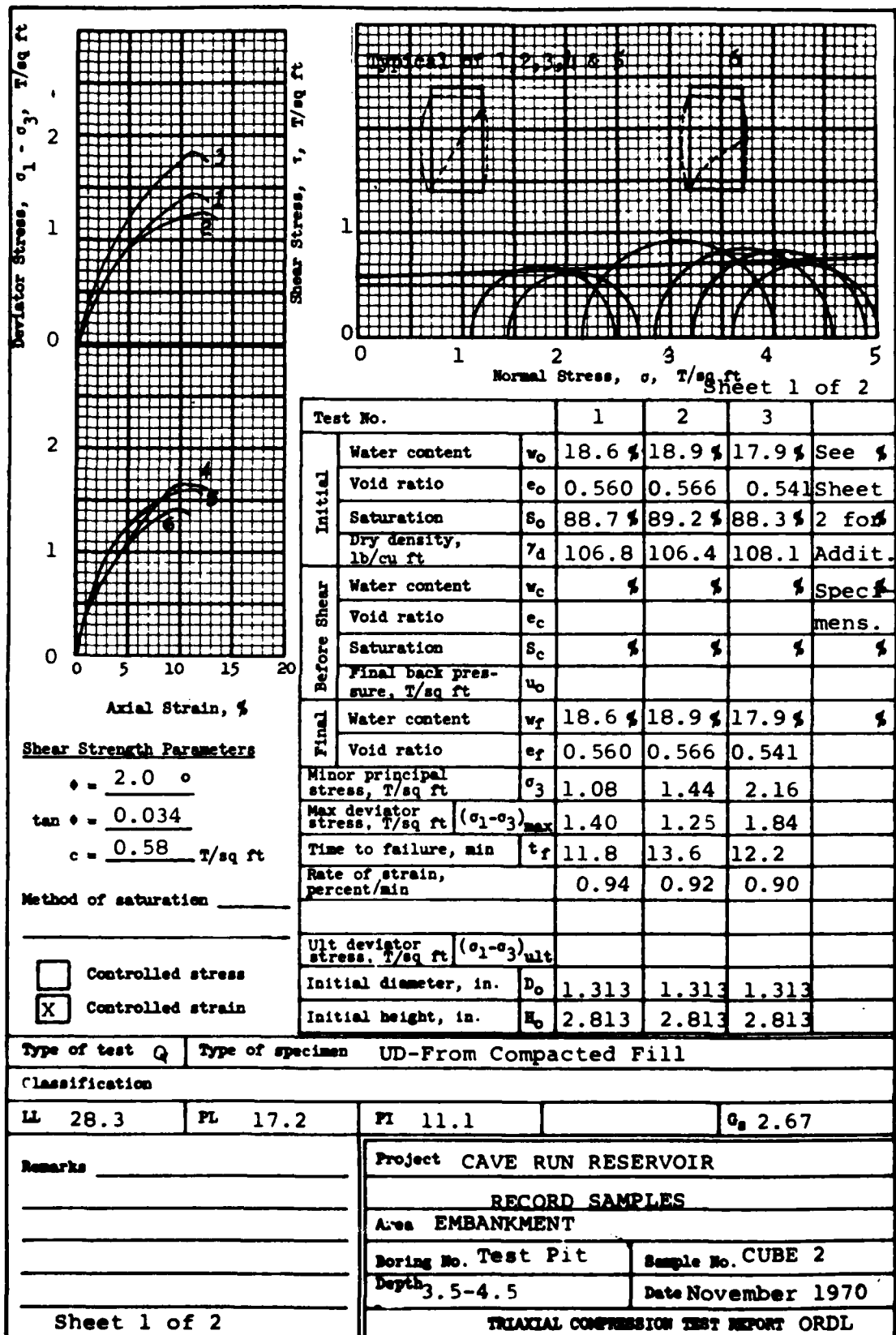


ADOPTED
 $\tan \phi = 0.57$
 $c = 0.00$

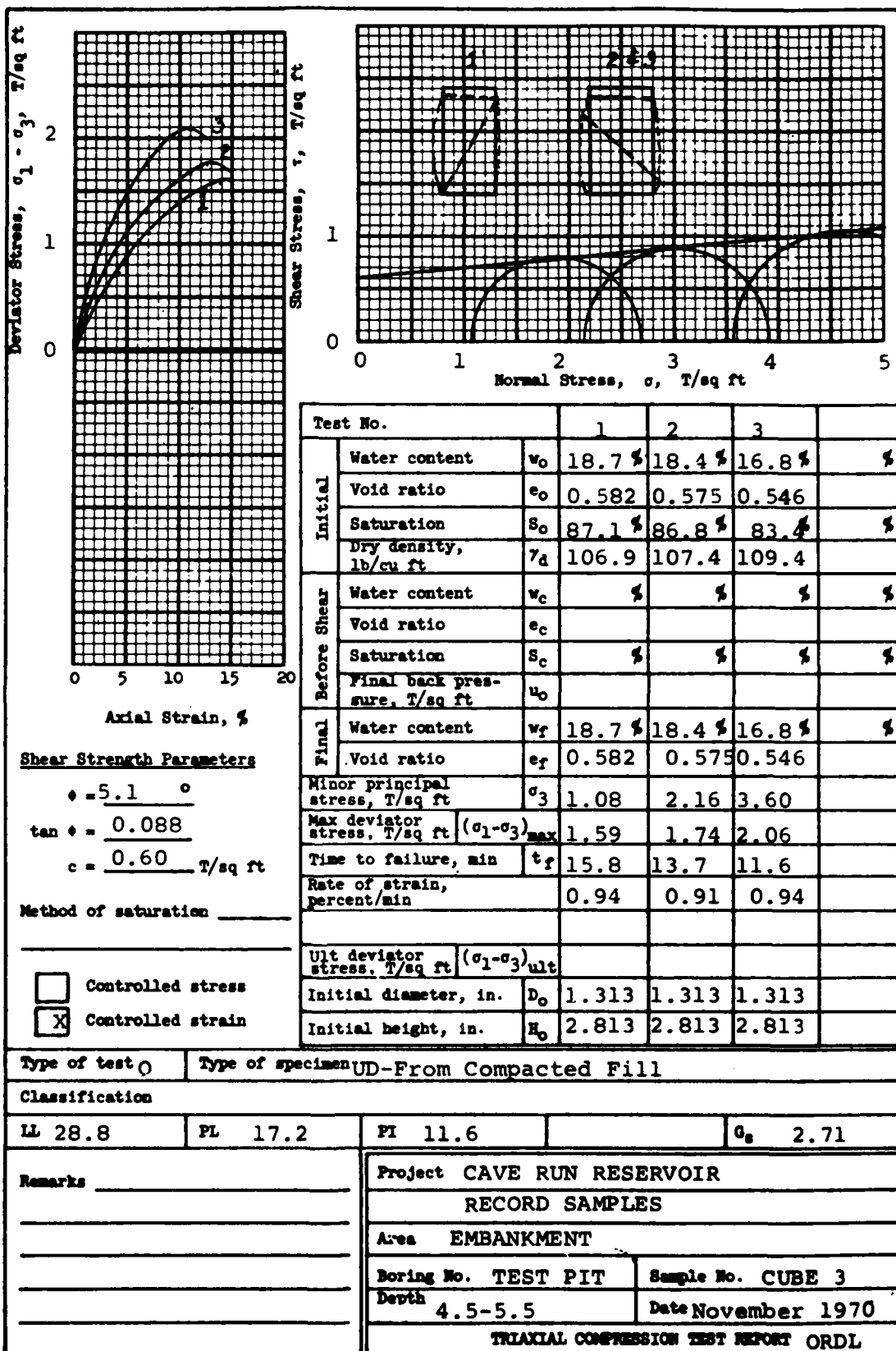
EMBANKMENT
 MATERIAL

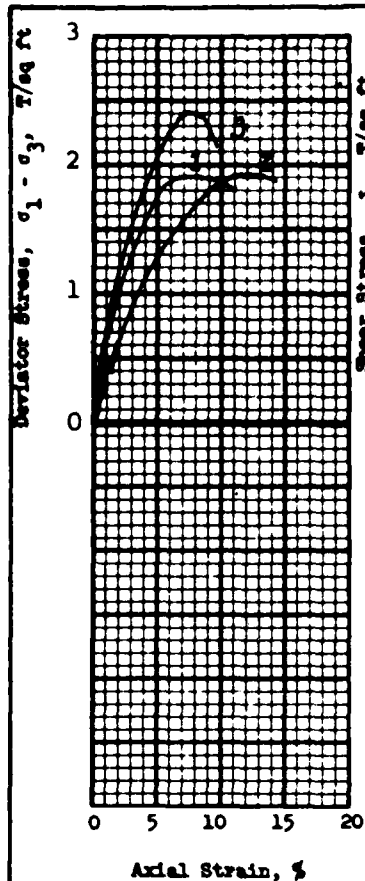
HOLE NO.	SAMPLE 'NO.	CLASS.	LL %	PL %	TAN ϕ	C T/FT²	SATURATION
COMP. "A"	413-1	CL	30.8	17.7	0.632	0.00	
COMP. "B"	413-2	SM	N.P.		0.662	0.00	Do not Average
	212-1						
COMP. "C"	422-1	CL	28.0	16.5	0.598	0.00	
	422-2						
COMP. "D"	488	CL	41.7	21.0	0.432	0.00	





Deviator Stress, $\sigma_1 - \sigma_3$, T/sq ft		Shear Stress, τ , T/sq ft		Normal Stress, σ , T/sq ft		
Axial Strain, % 05101520		Shear Strength Parameters $\phi =$ _____ ° $\tan \phi =$ _____ $c =$ _____ T/sq ft Method of saturation _____ ☐ Controlled stress ☒ Controlled strain		Normal Stress, σ, T/sq ft 05101520		Sheet 2 of 2
Test No.		4		5		
Initial	Water content	w_o	18.1 %	17.5%	17.9%	
	Void ratio	e_o	0.572	0.538	0.536	
	Saturation	s_o	84.5 %	86.8%	89.2%	
	Dry density, lb/cu ft	γ_d	106.0	108.3	108.5	
Before Shear	Water content	w_c	%	%	%	
	Void ratio	e_c				
	Saturation	s_c	%	%	%	
	Final back pressure, T/sq ft	u_o				
Final	Water content	w_f	18.1 %	17.5%	17.9%	
	Void ratio	e_f	0.572	0.538	0.536	
Minor principal stress, T/sq ft		σ_3	2.88	3.24	3.60	
Max deviator stress, T/sq ft ($\sigma_1 - \sigma_3$) _{max}			1.69	1.63	1.41	
Time to failure, min		t_f	12.2	11.8	10.7	
Rate of strain, percent/min			0.90	0.93	0.90	
Ult deviator stress, T/sq ft ($\sigma_1 - \sigma_3$) _{ult}						
Initial diameter, in.		D_o	1.313	1.313	1.313	
Initial height, in.		H_o	2.813	2.813	2.813	
Type of test Q		Type of specimen UD-From Compacted Fill				
Classification						
LL 28.3		PL 17.2		PI 11.1		
				U _s 2.67		
Remarks		Project CAVE RUN RESERVOIR				
		RECORD SAMPLES				
		Area EMBANKMENT				
		Boring No. TEST PIT		Sample No. CUBE 2		
		Depth 3.5-4.5		Date November 1970		
Sheet 2 of 2		TRIAXIAL COMPRESSION TEST REPORT ORDL				





Shear Strength Parameters

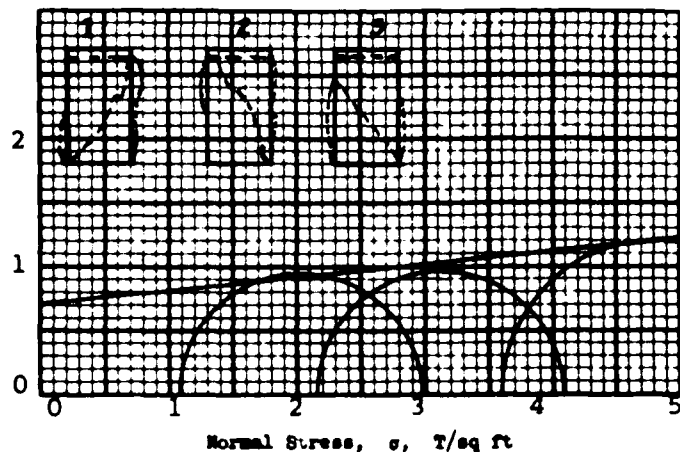
$$\phi = 5.6^\circ$$

$$\tan \phi = 0.098$$

$$c = 0.71 \text{ T/sq ft}$$

Method of saturation _____

- ☐ Controlled stress
☒ Controlled strain



Test No.		1	2	3	
Initial	Water content	w_o 17.6 %	19.6 %	17.5 %	%
	Void ratio	e_o 0.543	0.569	0.533	
	Saturation	S_o 87.5 %	93.0 %	88.6 %	%
	Dry density, lb/cu ft	γ_d 109.2	107.4	109.9	
Before Shear	Water content	w_c	%	%	%
	Void ratio	e_c			
	Saturation	S_c	%	%	%
	Final back pressure, T/sq ft	u_o			
Final	Water content	w_f 17.6 %	19.6 %	17.5 %	%
	Void ratio	e_f 0.543	0.569	0.533	
Minor principal stress, T/sq ft		σ_3 1.08	2.16	3.60	
Max deviator stress, T/sq ft ($\sigma_1 - \sigma_3$) _{max}		1.91	1.93	2.40	
Time to failure, min		t_f 7.2	13.3	7.4	
Rate of strain, percent/min		0.93	0.93	0.89	
Ult deviator stress, T/sq ft ($\sigma_1 - \sigma_3$) _{ult}					
Initial diameter, in.		D_o 1.313	1.313	1.313	
Initial height, in.		H_o 2.813	2.813	2.813	

Type of test Q Type of specimen UD-from Compacted Fill

Classification

LL 30.5

PL 18.2

PI 12.3

q_u 2.70

Remarks _____

Project CAVE RUN RESERVOIR

RECORD SAMPLES

Area EMBANKMENT

Boring No. TEST PIT

Sample No. CUBE 4

Depth 5.5-6.5

Date NOVEMBER 1970

TRIAXIAL COMPRESSION TEST REPORT ORDL

Deviator Stress, $\sigma_1 - \sigma_3$, T/sq ft

Axial Strain, %

Normal Stress, σ , T/sq ft

Shear Stress, τ , T/sq ft

Shear Strength Parameters

$\phi = 0^\circ$

$\tan \phi = 0$

$c = 0.84$ T/sq ft

Method of saturation _____

☐ Controlled stress

☒ Controlled strain

Test No.		1	2	3	4
Initial	Water content	w_o 19.2%	18.2%	18.8%	16.9%
	Void ratio	e_o 0.601	0.574	0.607	0.554
	Saturation	S_o 87.2%	86.5%	84.5%	83.2%
	Dry density, lb/cu ft	γ_d 106.4	108.2	106.0	109.6
Before Shear	Water content	w_c %	%	%	%
	Void ratio	e_c			
	Saturation	S_c %	%	%	%
	Final back pressure, T/sq ft	u_o			
Final	Water content	w_f 19.2%	18.2%	18.8%	16.9%
	Void ratio	e_f 0.601	0.574	0.607	0.554
Minor principal stress, T/sq ft		σ_3 1.08	2.16	2.88	3.60
Max deviator stress, T/sq ft ($\sigma_1 - \sigma_3$) _{max}		1.67	1.75	1.67	3.90
Time to failure, min		t_f 10.0	10.3	11.9	16.3
Rate of strain, percent/min		0.96	0.94	0.93	0.90
Ult deviator stress, T/sq ft ($\sigma_1 - \sigma_3$) _{ult}					
Initial diameter, in.		D_o 1.313	1.313	1.313	1.313
Initial height, in.		H_o 2.813	2.813	2.813	2.813

Type of test **Q** Type of specimen **UD-From Compacted Fill**

Classification

LL 35.1	PL 18.1	PI 7.0	a_u 2.73
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Remarks _____

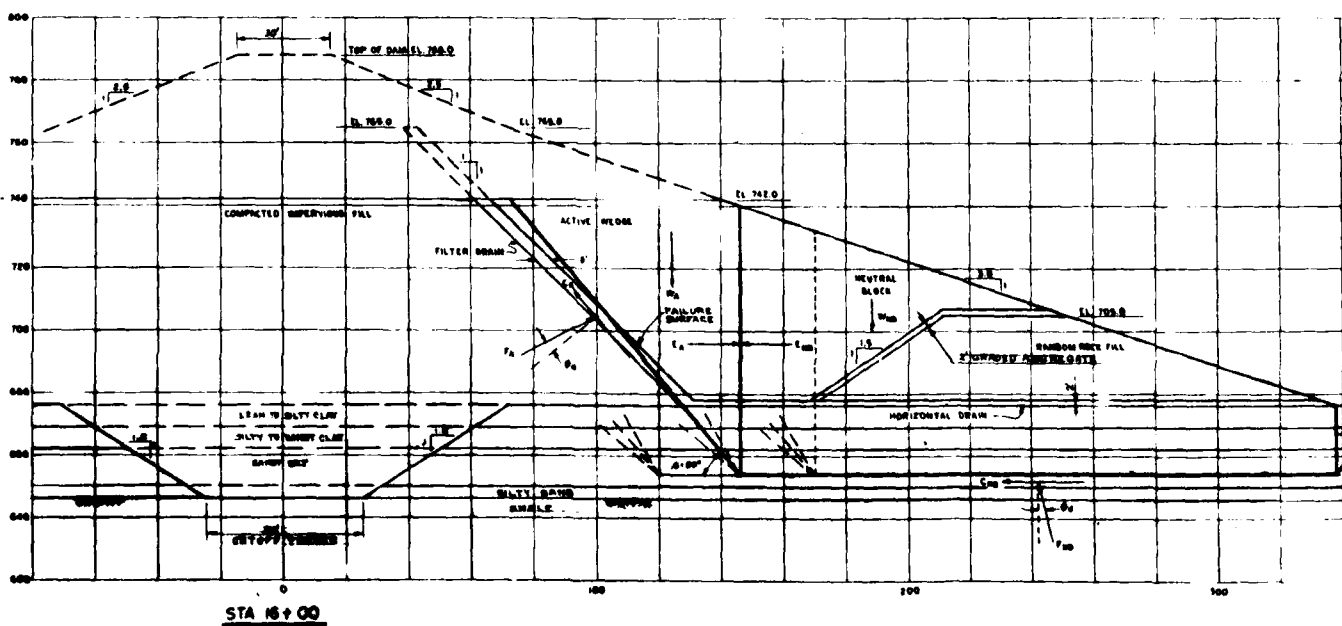
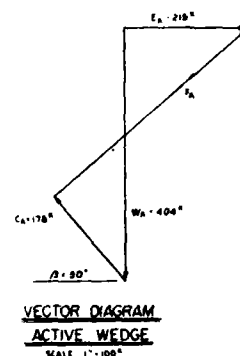
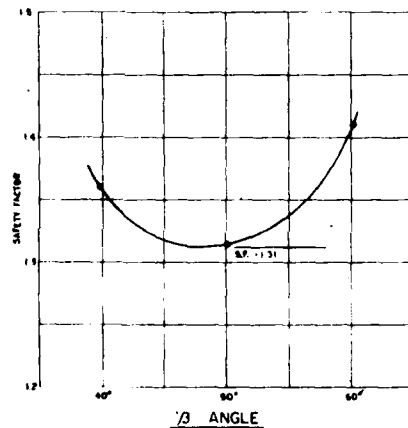
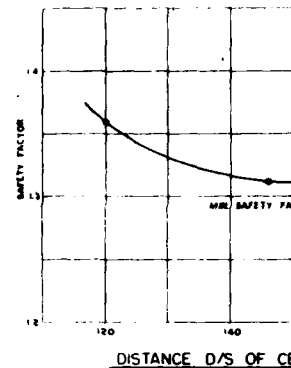
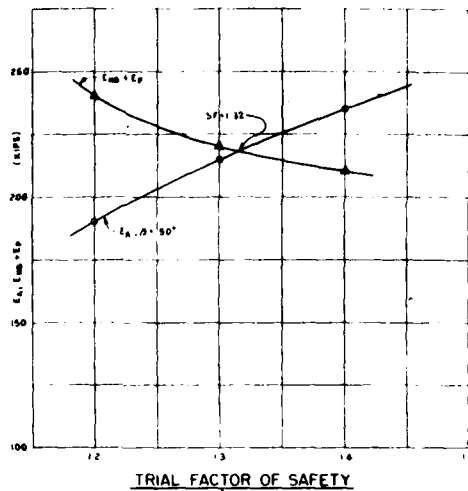
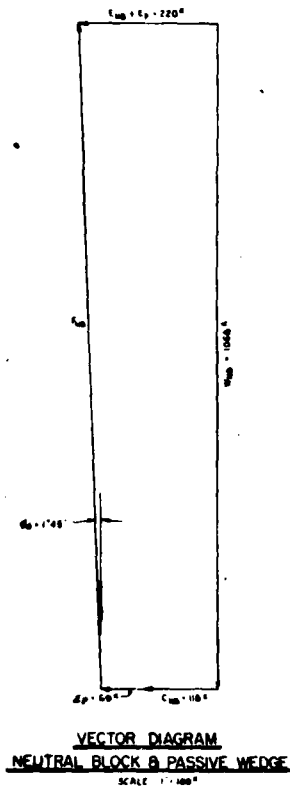
Project **CAVE RUN RESERVOIR**

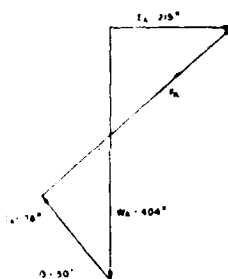
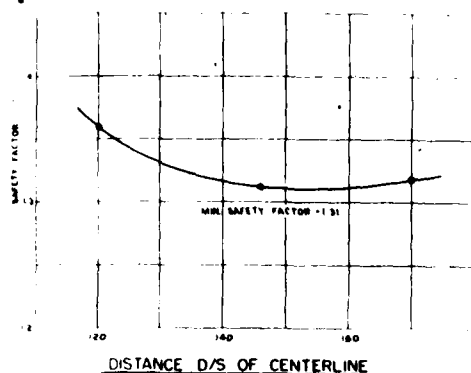
RECORD SAMPLES

Area **EMBANKMENT**

Boring No. TEST PIT	Sample No. CUBE 5
Depth 6.5-7.5	Date November 1970

TRIAXIAL COMPRESSION TEST REPORT ORDL





VECTOR DIAGRAM
ACTIVE WEDGE
SCALE 1"=100'

MATERIALS	ADOPTED DESIGN VALUES				
	F ₀ /F ₁		STRENGTH		
	MOIST	DRY	φ	TAN φ	γ
EMBANKMENT	127.0	90.0	0°	0.000	1.10
FOUNDATION TOP CLAY		50.0	0°	0.000	0.90
FOUNDATION LOWER CLAY		40.0	3°00'	0.050	1.00
FOUNDATION SALT		50.0	3°10'	0.050	0.90

NOTES

1. "0" SHEAR STRENGTHS USED
2. UNWEIGHTED WEIGHTS USED BELOW BOUNDING SURFACE
3. $F_0 = \frac{TAN \phi}{100}$, $F_1 = \frac{C}{100}$
4. COMPUTATIONS PRESENTED FOR PLANE 100' S.E. FROM C, A = 60° AND TAN φ = 1.5

PASSIVE WEDGE

$$E_p = 2HC_p \cos^2 \phi + \frac{1}{2} H^2 H_p$$

$$\text{WEIGHTED } \phi = 1.400^\circ \quad \phi_p = \frac{1.70}{1.75} = 1.30^\circ$$

$$\text{WEIGHTED COHESION } C = 0.5 \text{ ST} \quad C_p = \frac{1.5}{1.75} = 1.104$$

$$H_p = \tan^2 (40^\circ + \frac{\phi_p}{2})$$

$$= \tan^2 (40^\circ + 0.65^\circ)$$

$$= \tan^2 (40^\circ 40')$$

$$= (1.026)^2$$

$$= 1.053$$

$$E_p = 2(22)(1.104)(1.026) + \frac{0.90}{2} (22)^2 (1.053) = 49'$$

ACTIVE WEDGE

ASSUME TAN φ = 0

$$W_A = \left[\left(\frac{50 + 100}{2} \right) (20) + \left(\frac{20 + 100}{2} \right) (40) \right] (1270) + \left(\frac{10 + 20}{2} \right) (40) (0.050) + \left(\frac{20 + 100}{2} \right) (0.050)$$

$$W_A = 404'$$

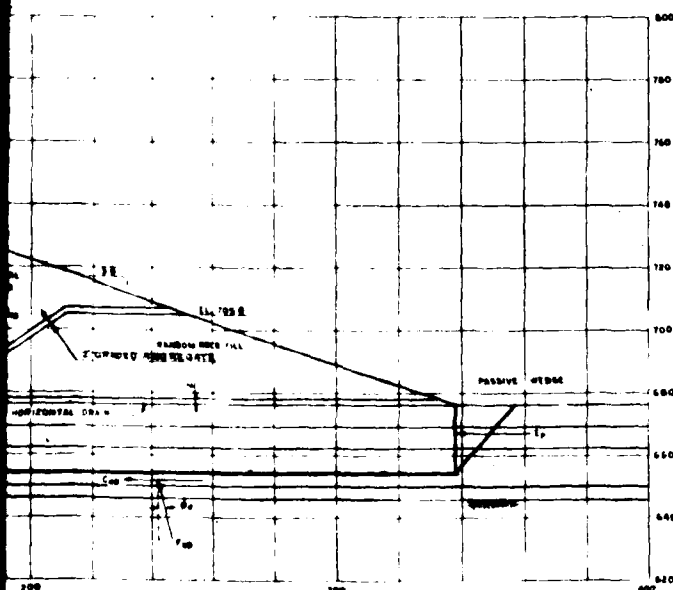
$$C_A = 0.5 \left(\frac{20}{1.75} \right) + 0 \left(\frac{10}{1.75} \right) + 0 \left(\frac{20}{1.75} \right) + 10 \left(\frac{0.5}{1.75} \right) = 170'$$

NEUTRAL BLOCK

$$\tan \phi_0 = \frac{\tan \phi}{1.75} = \frac{0.0}{1.75} = 0.000 \quad \phi_0 = 1^\circ 40'$$

$$W_{NB} = \left(\frac{50 + 100}{2} \right) (1270) + (100)(40)(0.050) + (100)(40)(0.050) = 1066'$$

$$C_{NB} = (100) \left(\frac{0.5}{1.75} \right) = 106'$$



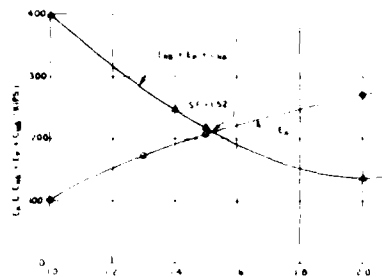
DESIGNED BY		CHECKED BY		APPROVED BY	
DRAWN BY		PLACED BY		SCALE	
DATE		DATE		DATE	
U. S. ARMY ENGINEER DISTRICT, LOUISVILLE					
COPY OF DRAWING					
ORIGINAL DEPOSITED					
CHAS. RIVER BASIN					
CAVE RUN RESERVOIR					
LOCKING RIVER, KENTUCKY					
STABILITY ANALYSIS					
END OF CONSTRUCTION					
DESIGNED BY		CHECKED BY		APPROVED BY	
DRAWN BY		PLACED BY		SCALE	
DATE		DATE		DATE	
U. S. ARMY ENGINEER DISTRICT, LOUISVILLE					
COPY OF DRAWING					
ORIGINAL DEPOSITED					
CHAS. RIVER BASIN					
CAVE RUN RESERVOIR					
LOCKING RIVER, KENTUCKY					
STABILITY ANALYSIS					
END OF CONSTRUCTION					

DM 3

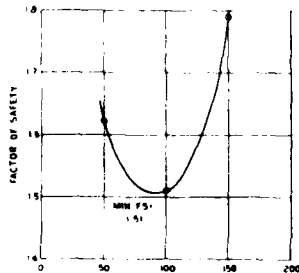
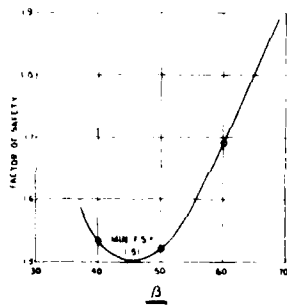
PLATE 30

PLATE 30

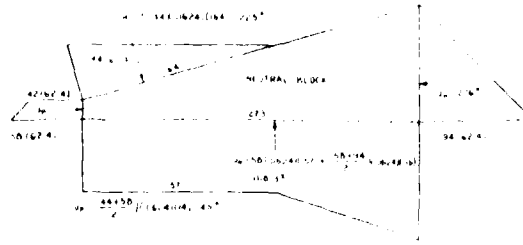
CORPS OF ENGINEERS



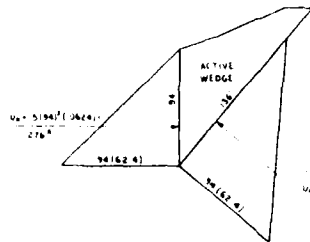
TRIAL FACTOR OF SAFETY



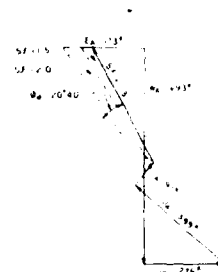
DISTANCE U.S. OF CENTERLINE



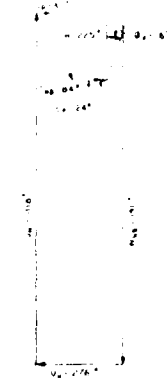
TYPICAL HYDROSTATIC PRESSURE
NEUTRAL BLOCK
SCALE 1" = 50'



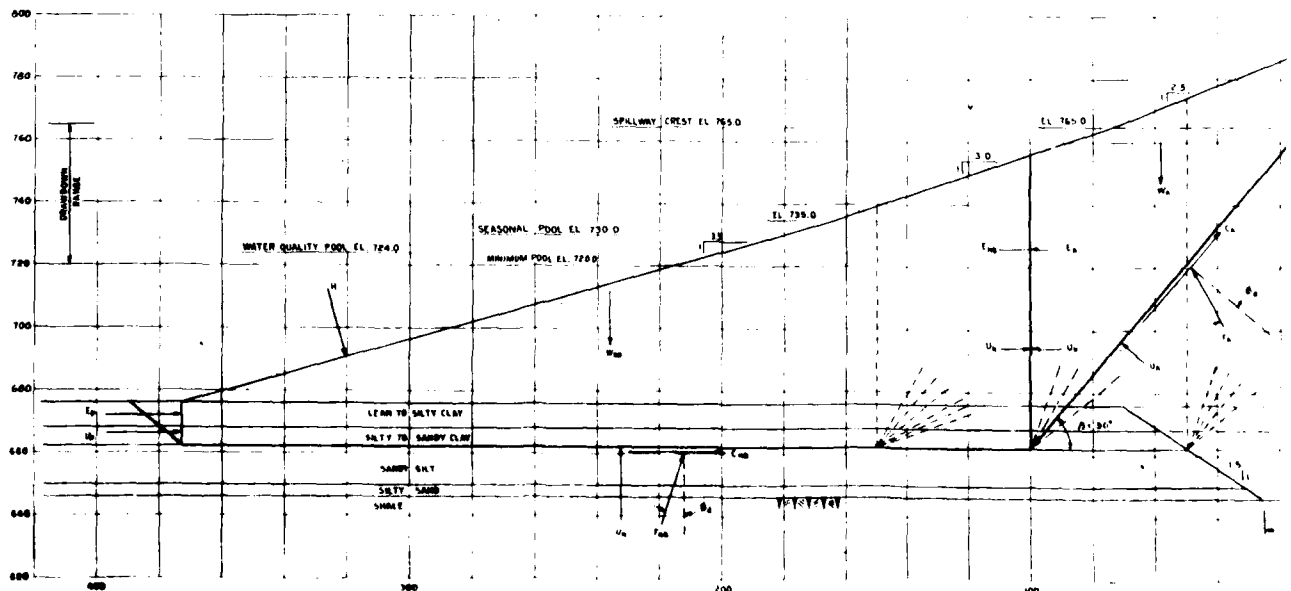
TYPICAL HYDROSTATIC PRESSURE
ACTIVE WEDGE
SCALE 1" = 50'



VECTOR DIAGRAM
ACTIVE WEDGE
SCALE 1" = 200'



VECTOR DIAGRAM
NEUTRAL BLOCK
SCALE 1" = 100'



ACTIVE WEDGE

NEUTRAL BLOCK

PASSIVE WEDGE

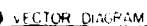
$$x_p = 2 \sin \alpha \sqrt{100} + \frac{f \cdot 10^3}{c} = 40$$

$$100 \cdot \tan^2 45^\circ + \frac{0.2}{2}$$

$$\tan^2 54.0$$

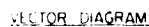
$$1 \cdot 38.5$$

$$x_p = 2 \sin \alpha (100.5 + 36) + 5 = 0.651(4)^2 + 36.5$$

$$1.9 + 12.1 = 24.0$$


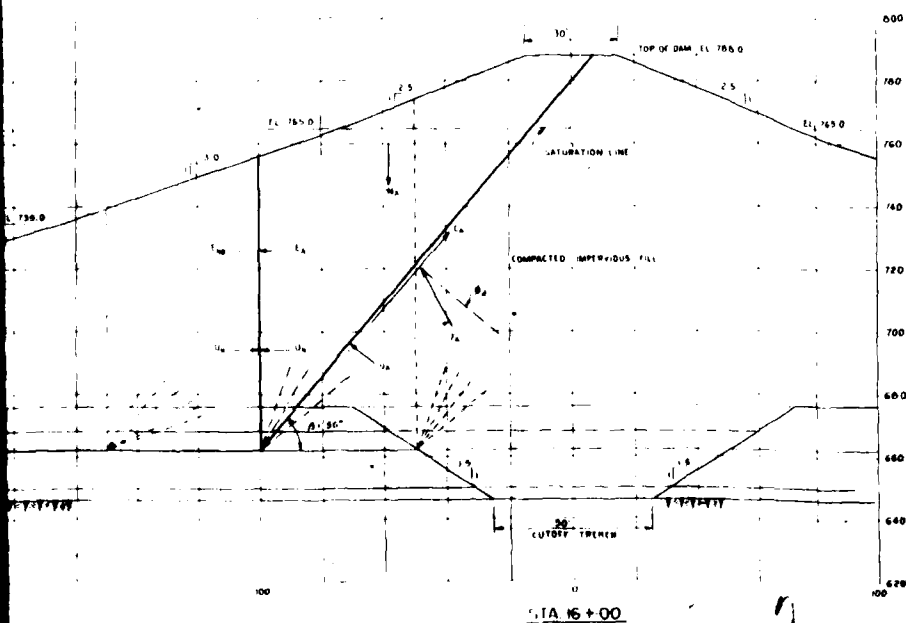
ACTIVE WIFE

PLANE 000 U.S. JET
CALL



NEUTRAL BLOCK

W. 44E 00 115 OF 6 13 30"
SCALE . :00"



REF ID: A66547		CLASSIFICATION		OF
SPECIFIC DATE U. S. ARMY ENGINEER DISTRICT, LOUISVILLE CORPS OF ENGINEERS LOUISVILLE, KENTUCKY		CHRO INTR BASH CAVE RUN RESERVOIR LOUISVILLE, KENTUCKY STABILITY ANALYSIS RAPID DRAINDOWN		
DESIGNED DWT DRAWN CHECKED DLT SUBMITTED APPROVED APPROVED APPROVED	TRACED S.O.R. 9-1 R.H.	DATE AUG. 1964 COL. JOHN A. BROWN SENIOR ENGINEER DRAWING NUMBER		

CORPS OF ENGINEERS

MATERIAL	Wt	ADOPTED DESIGN VALUES				
		SAT	SUB	ϕ	TAN β	C
EMBANKMENT	1.8	90.4	48.0	27°	0.51	0.40
FOUNDATION CLAY	1.6	116	48.0	19°	0.48	0.30
FOUNDATION SILT	1.6	116	48.0	24.5°	0.50	0.10

NOTES

- SHEAR STRENGTH 1980
- SUBMERSED WEIGHTS USED BELOW POOL ELEVATION
- COMPUTATIONS PRESENTED FOR PLANE 140' W/S FROM
- CL. DIA. 8'-10" 140' S.F. 1.0 & POOL EL. 710.0

ACTIVE WEDGE

$$W_A = (1.8)(90.4)(1.0) + (1.6)(116)(1.0) + (1.6)(48.0)(1.0) + (1.6)(48.0)(1.0) = 188.8$$

$$W_A = 188.8$$

WEIGHTED VALUES

$$W_{WB} = (1.8)(90.4)(1.0) = 162.7$$

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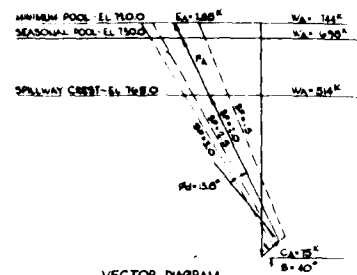
$$W_{WB} = 162.7$$

$$W_{WB} = 162.7$$

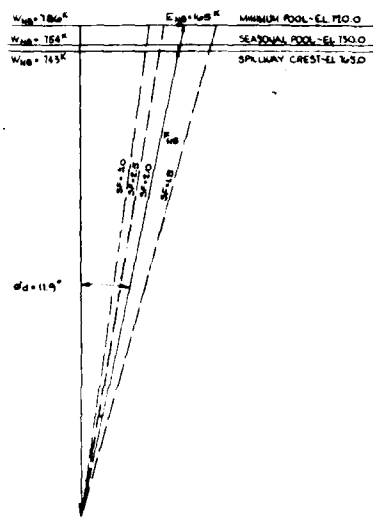
$$W_{WB} = 162.7$$

$$W_{WB} = 162.7$$

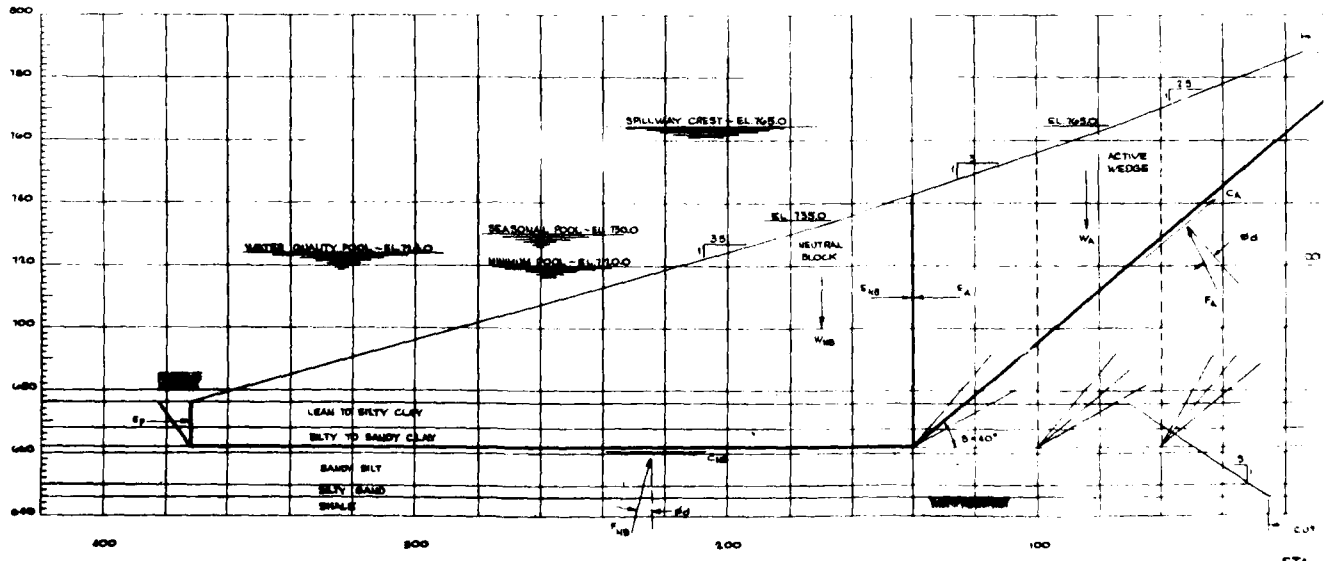
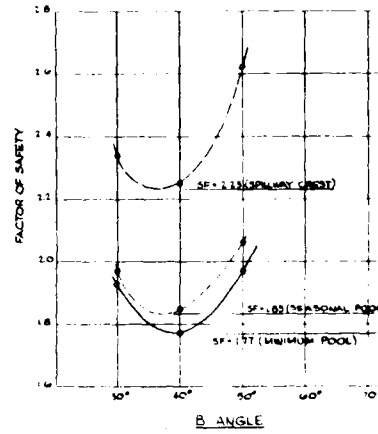
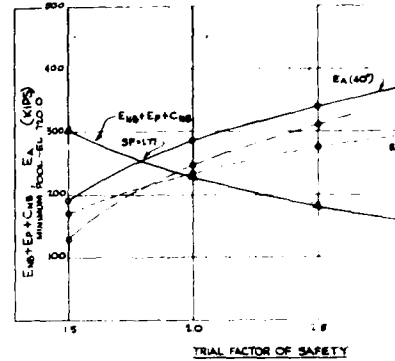
$$W_{WB} = 162.7$$

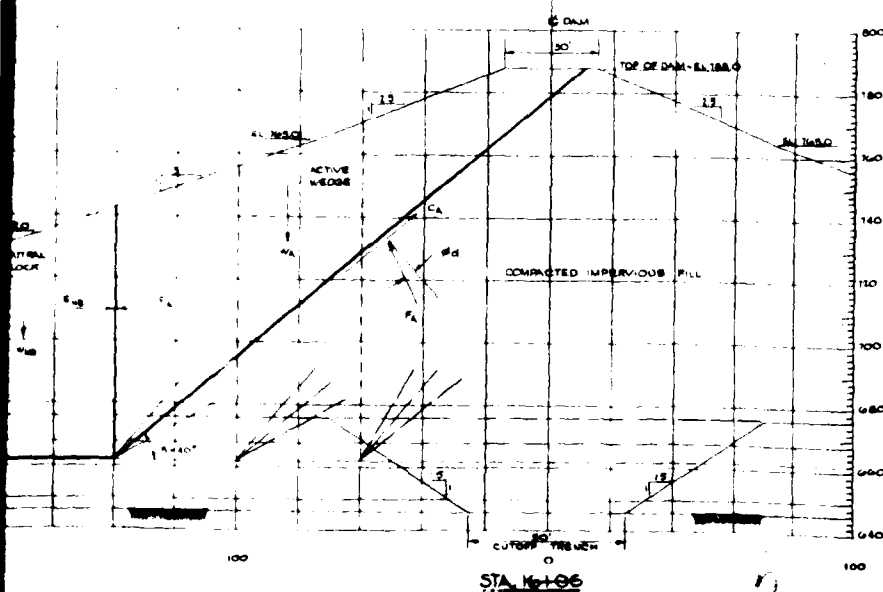
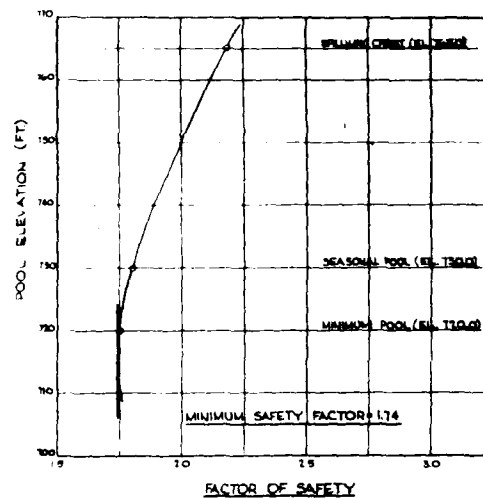
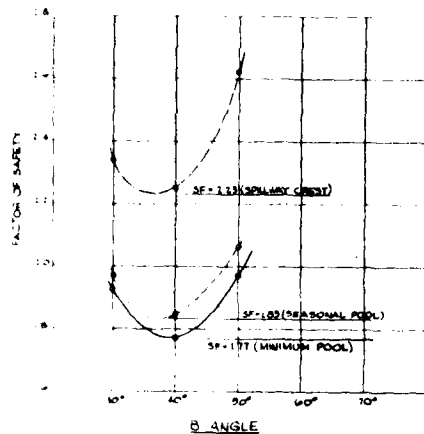
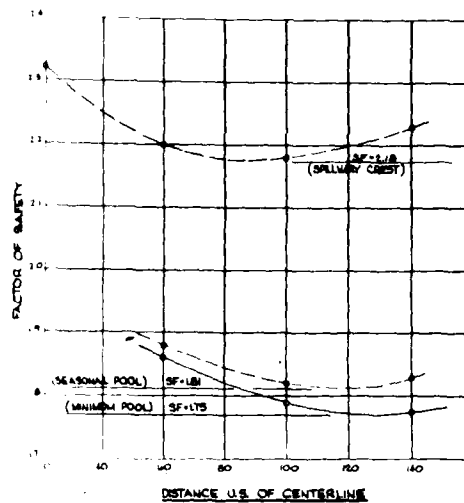
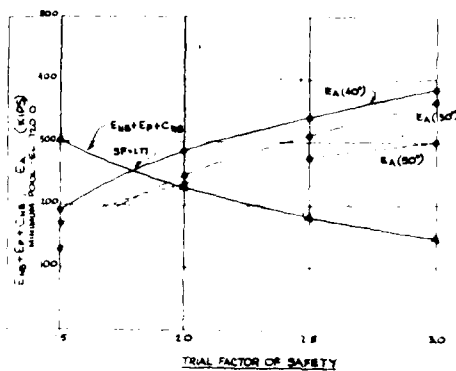


VECTOR DIAGRAM
ACTIVE WEDGE
SCALE: 1"=100'



VECTOR DIAGRAM
NEUTRAL BLOCK
SCALE: 1"=100'





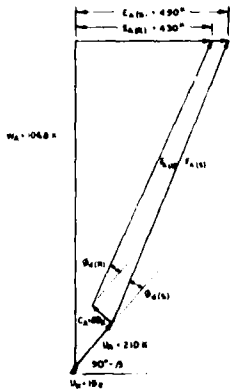
REVISION	DATE	DESCRIPTION	BY
U. S. ARMY ENGINEER DISTRICT, LOUISVILLE CORPS OF ENGINEERS LOUISVILLE DISTRICT			
CHOD RIVER BASIN CAVE RUN RESERVOIR LUCKING RIVER, KENTUCKY STABILITY ANALYSIS PARTIAL POOL			
DESIGNED D.L.T.	PLACED A.J.B.	CHECKED R.L.T.	APPROVED R.H. HARRIS
APPROVED R.H. HARRIS		APPROVED R.H. HARRIS	
DATE AUG. 1954		SCALE 1" = 10'	
DRAWING NUMBER			

DM-3

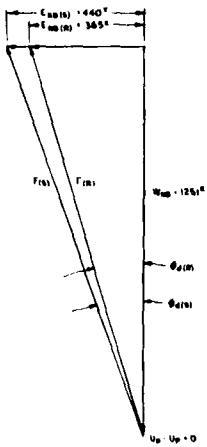
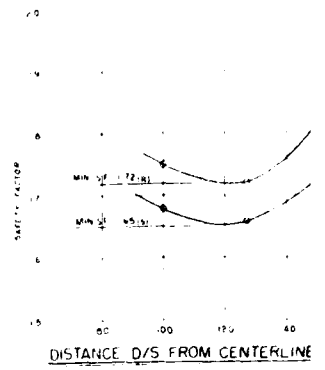
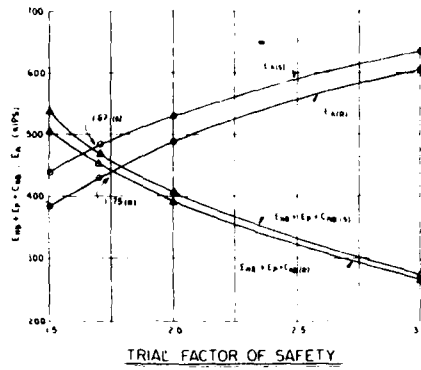
PLATE-11

PLATE 35

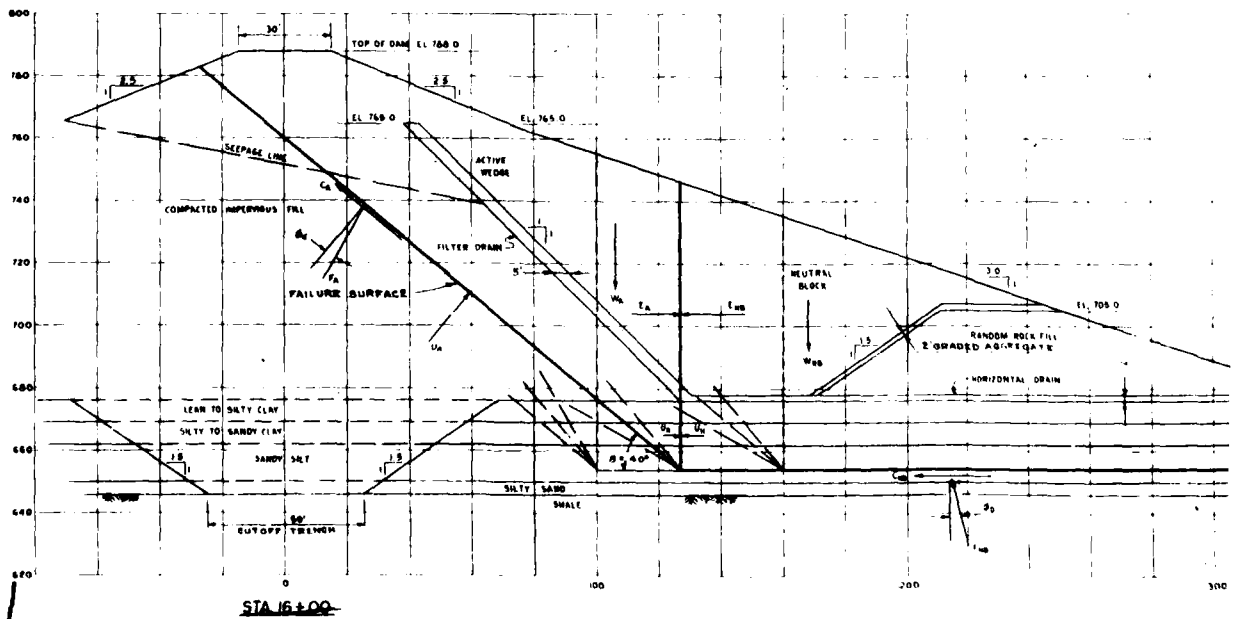
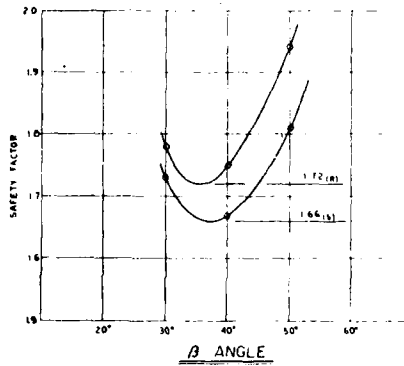
CORPS OF ENGINEERS

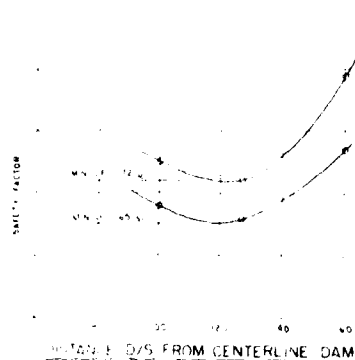


VECTOR DIAGRAM
ACTIVE WEDGE
SCALE 1"=200'



VECTOR DIAGRAM
NEUTRAL BLOCK
SCALE 1" = 200'





MATERIAL	ADOPTED DESIGN VALUES									
	WT	W ₁	W ₂	W ₃	W ₄	W ₅	W ₆	W ₇	W ₈	W ₉
EMBANKMENT	127.0	30.4	48.0	27	0.51	0.40	32.2	0.870	0.00	0.00
FOUNDATION	124.4	17.4	65.0	27	0.42	0.80	26.6	0.900	0.00	0.00
FOUNDATION	122.4	40.8	24.5	0.90	0.20	31	0.60	0.00	0.00	0.00

NOTES

1. SEE SHEAR STRENGTHS USED
2. SUBMERGED WEIGHTS USED BELOW GROUND SURFACE OF NEUTRAL BLOCK
3. $F_3 = \frac{C}{1 + \tan \phi}$
4. $F_5 = 40' - 127' D/S$ FROM CENTERLINE DAM TYPICAL
5. FAILURE SURFACES
6. COMPUTATIONS PRESENTED FOR TOTAL ST. 1.7
7. TAILWATER @ GROUND SURFACE

PASSIVE WEDGE

$$L_3 = 2 H_3 \tan \phi + \frac{C}{1 + \tan \phi}$$

ASSUME ALL CLAY

$$\tan \phi = 0.42 \quad \phi = 23.1^\circ$$

$$\tan \phi = 0.90 \quad \phi = 42.0^\circ$$

$$C = 0.40 \quad \frac{C}{1 + \tan \phi} = 0.25$$

$$H_3 = \tan^2(45^\circ + \frac{\phi}{2})$$

$$H_3(1) = \tan^2(45^\circ + 11.5^\circ) = \tan^2(56.5^\circ) = 2.83$$

$$H_3(2) = \tan^2(45^\circ + 21^\circ) = \tan^2(66^\circ) = 3.81$$

$$E_3(1) = 2(22)(2.83) + \frac{36.5}{2} = 122.2 + 18.25 = 140.45$$

$$E_3(2) = 2(22)(3.81) + \frac{36.5}{2} = 168.84 + 18.25 = 187.09$$

ACTIVE WEDGE

$$W_4 = 1058.8$$

$$\text{WEIGHTED } \tan \phi(1) = \frac{456}{1.7} = 268.24 \quad \phi(1) = 16.2^\circ$$

$$C_4 = \frac{80}{1.7} = 47.06 \quad \frac{C_4}{1 + \tan \phi} = 40.8$$

$$\text{WEIGHTED } \tan \phi(2) = \frac{560}{1.7} = 329.41 \quad \phi(2) = 18.2^\circ$$

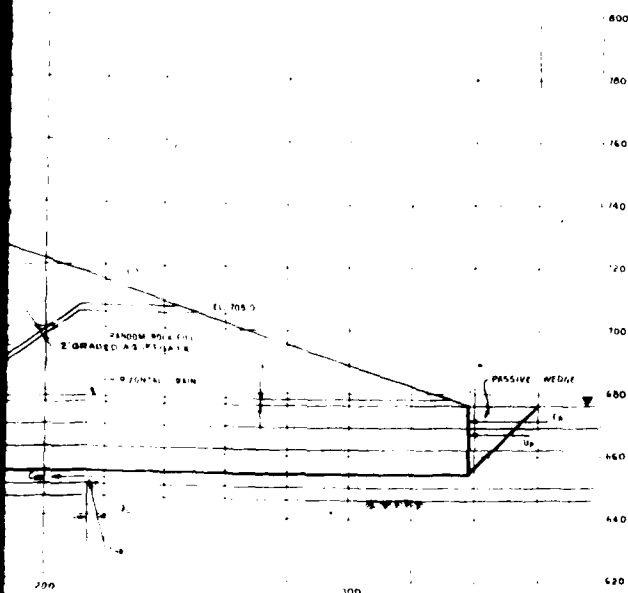
NEUTRAL BLOCK

$$\tan \phi(1) = \frac{500}{1.7} = 294.12 \quad \phi(1) = 16.4^\circ$$

$$\tan \phi(2) = \frac{600}{1.7} = 352.94 \quad \phi(2) = 19.4^\circ$$

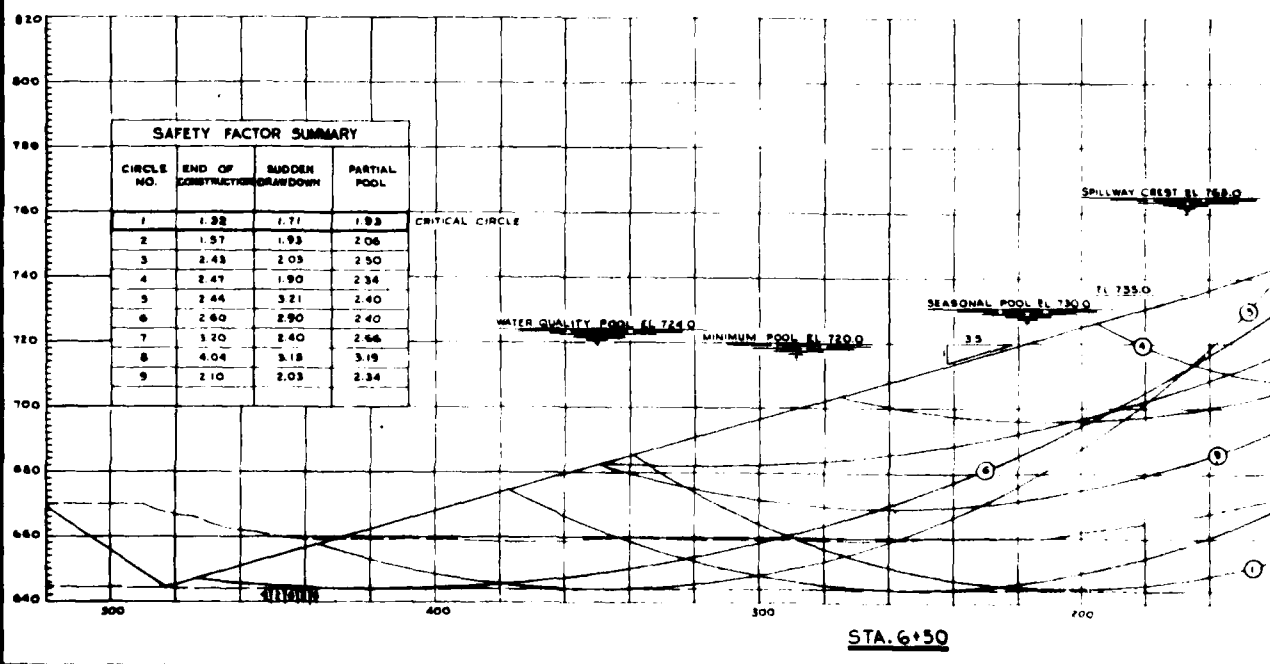
$$W_{NS} = \frac{1}{2} \left(\frac{40}{1.7} \right) (1270 + (14)(21)(0.65) + (10)(21)(0.60)) = 1261.5$$

$$C_{NS}(1) = 2(1) \left(\frac{40}{1.7} \right) = 58.8$$

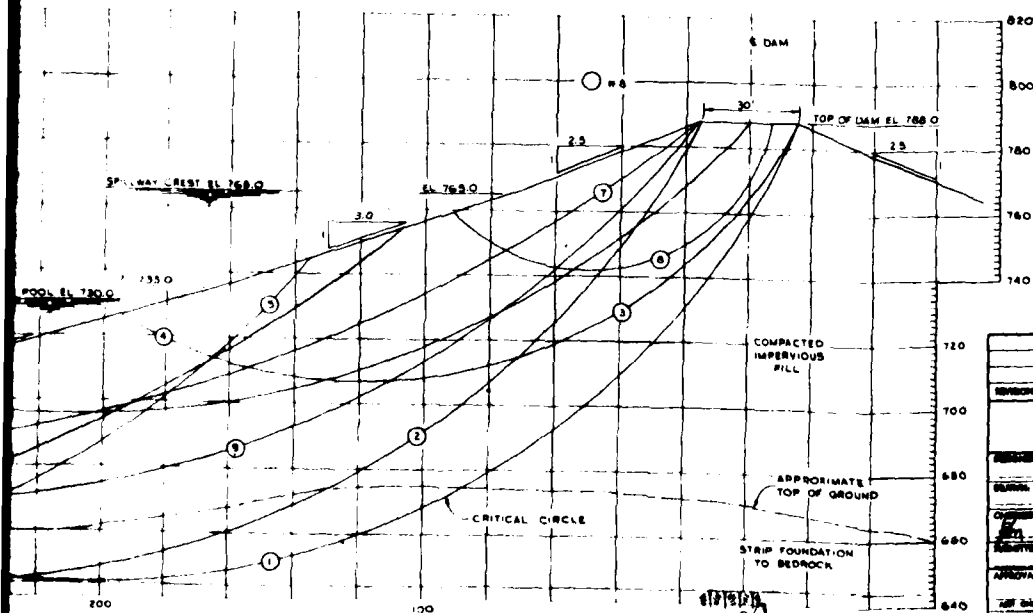


REVISION	DATE	DESCRIPTION
U. S. ARMY ENGINEER DISTRICT, LOUISVILLE CORPS OF ENGINEERS LOUISVILLE DIVISION		
DESIGNED D.L.F.	BRANN B.R.	CHEROKEE RIVER BASIN CAVE RUN RESERVOIR LICKING RIVER, KENTUCKY
CHECKED D.L.F.	BRANN B.R.	STABILITY ANALYSIS STEADY SEEPAGE
APPROVED R.H. Hays	APPROVED R.H. Hays	SCALE DRAWING NUMBER

CORPS OF ENGINEERS

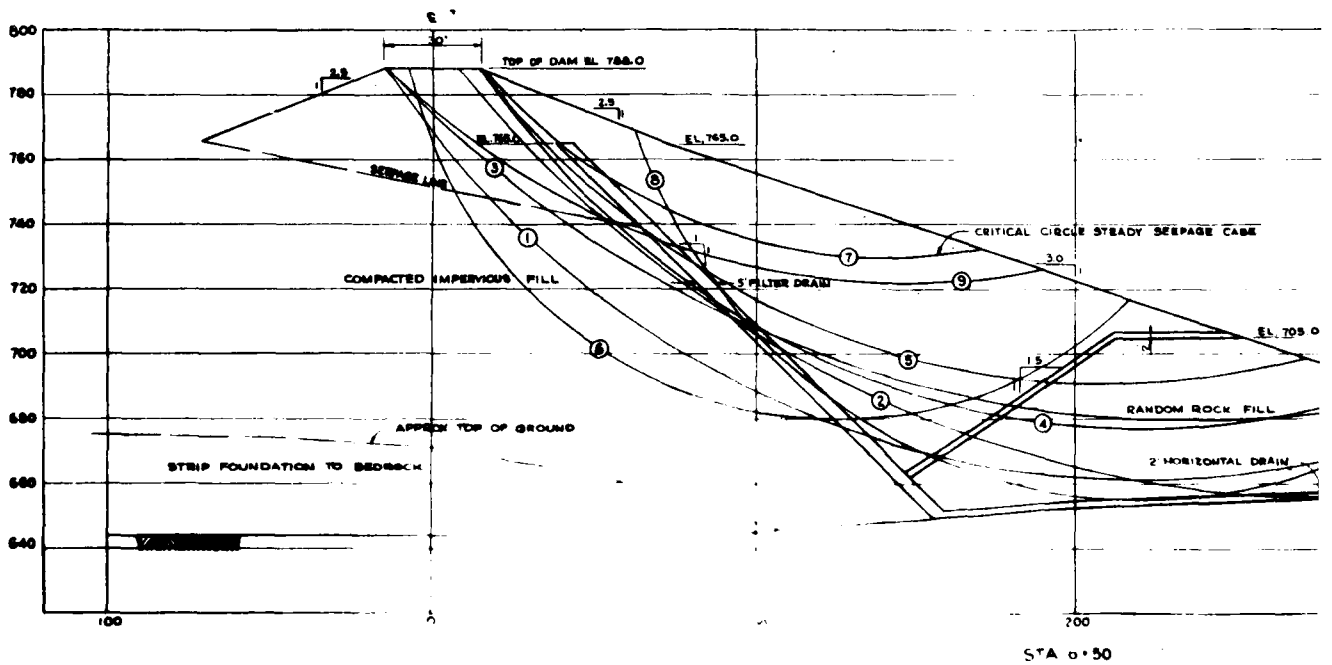


○ 3



REVISION DATE		DESCRIPTION	
U. S. ARMY ENGINEER DISTRICT, LOUISVILLE CORPS OF ENGINEERS LOUISVILLE, KENTUCKY			
PROJECT DESIGN DRAWING NO.		C&D RIVER BASIN CAVE RUN RESERVOIR LICKING RIVER, KENTUCKY STABILITY ANALYSIS UPSTREAM SUMMARY STA 8+80	
APPROVAL AUTHORITY		DATE	
T&E APPROVED		DATE	
T&E APPROVED		DATE	

PLATE 87 PLAN



CORPS OF ENGINEERS

ADOPTED DESIGN VALUES

MATERIAL	Wt % / ST		A STRENGTH		B STRENGTH		C STRENGTH	
	MOIST	SAT	W	TAN ϕ	W	TAN ϕ	W	TAN ϕ
EMBANKMENT	127.0	130.0	0.0	0.00	1.10	27°	0.91	0.40
FOUNDATION CLAY (UPPER)	124.0	127.0	0.0	0.00	0.80	23°	0.42	0.20
FOUNDATION CLAY (LOWER)	124.4	127.4	0.0	0.00	1.05	23°	0.42	0.20
FOUNDATION SILT			0.0	2.3°	0.04	0.40	0.50	0.20
FOUNDATION SAND			0.0	35.0°	0.70	0.00	30.0°	0.75

NOTES:

1. "Q" SHEAR STRENGTHS USED FOR EMBANKMENT AND FOUNDATION CLAYS.
2. "R" SHEAR STRENGTH USED FOR FOUNDATION SILT.
3. SURMERGED WEIGHTS USED BELOW GROUND SURFACE.
4. $FS = \frac{C}{TAN \phi}$; $FS = \frac{C}{C_u}$
5. COMPUTATIONS PRESENTED FOR PLANE 140' D.E. FROM C. $\beta = 30^\circ$ AND TRIAL $57 = 1.0$

ACTIVE WEDGE

ASSUME $TAN \phi = 0$

$W_A = 1200 \text{ K}$

$$C_A = 16 \left(\frac{0.4}{1.4} \right) + 12 \left(\frac{0.1}{1.4} \right) + 16 \left(\frac{1.0}{1.4} \right) + 187 \left(\frac{0.4}{1.4} \right) = 335 \text{ K}$$

NEUTRAL BLOCK

$$W_{NB} = (8)(200)(.080) + (8)(0)(200)(.080) + \left(\frac{80 \times 800}{2} \right) (1270) = 1181 \text{ K}$$

$$TAN \phi_A = \frac{TAN \phi}{FS} = \frac{0.00}{1.4} = 357 \quad \phi_A = 10.6^\circ$$

$$C_{NB} = 200 \left(\frac{0.00}{1.4} \right) = 27 \text{ K}$$

PASSIVE WEDGE

$$E_P = 2HC_u \sqrt{NB} + \frac{P}{2} H^2 N_H$$

$$WEIGHTED \phi = 0.63^\circ \quad \phi_A = \frac{0.63^\circ}{1.4} = 7.01^\circ$$

$$WEIGHTED COHESION = 136 \text{ K/50 FT. } C_A = \frac{136}{1.4} = 0.97$$

$$N_H = TAN^2 \left(45^\circ + \frac{\phi_A}{2} \right)$$

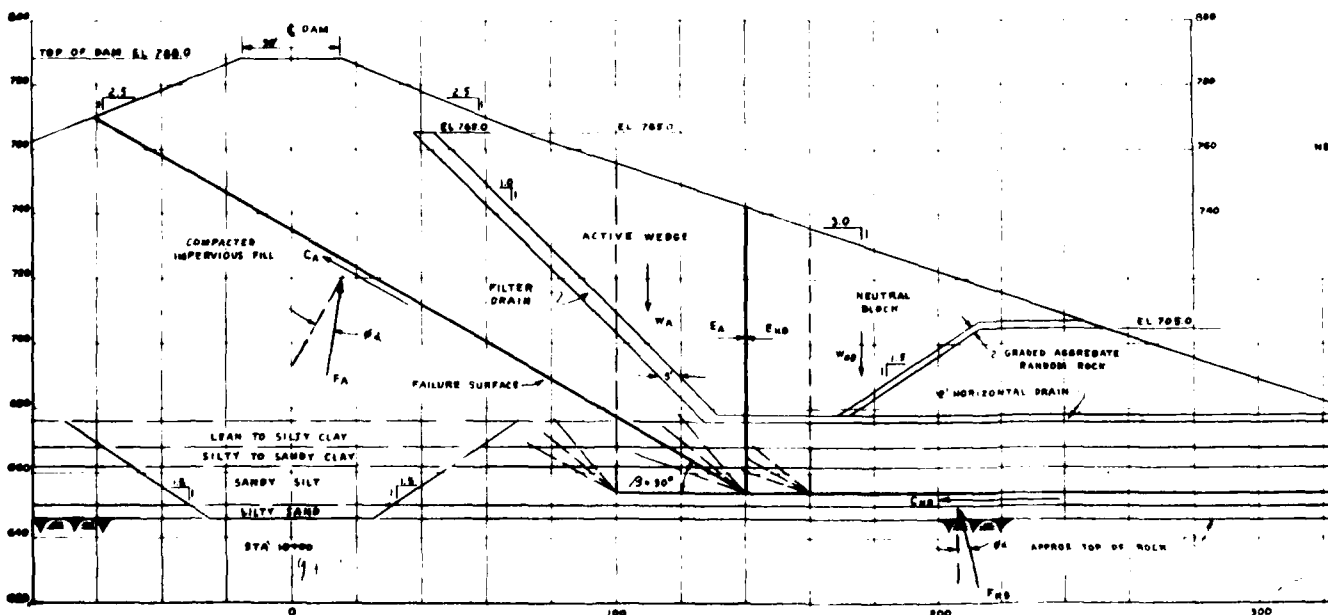
$$N_H = TAN^2 (45^\circ + 3.5^\circ)$$

$$N_H = TAN^2 (48.5^\circ)$$

$$N_H = (1.13)^2$$

$$N_H = 1.28$$

$$E_P = 2(22)(.97)(1.13) + \frac{.087}{2} (22)^2 (1.28) = 68 \text{ K}$$



EDGE

$$107 \left(\frac{EA}{1.4} \right) = 335'$$

LOCK

$$98 \left(\frac{60 \times 200}{2} \right) (1.270) = 1181'$$

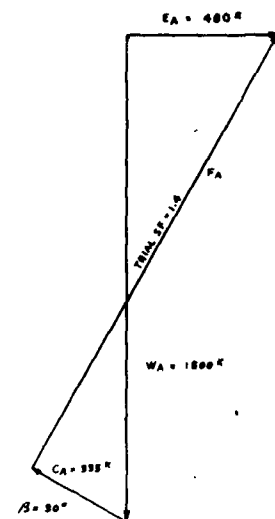
$$\beta_0 = 10.6'$$

DSE

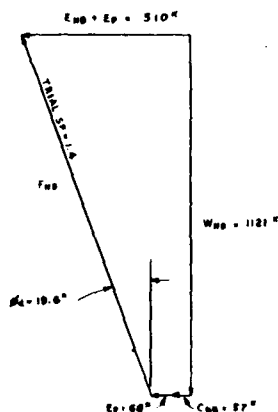
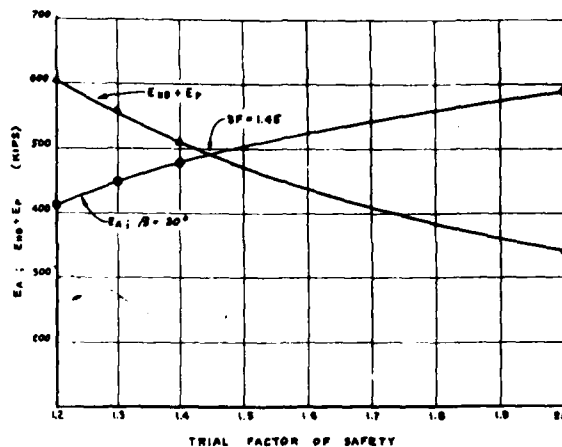
7.00'

$$C_4 = \frac{1.30}{1.4} = 0.97$$

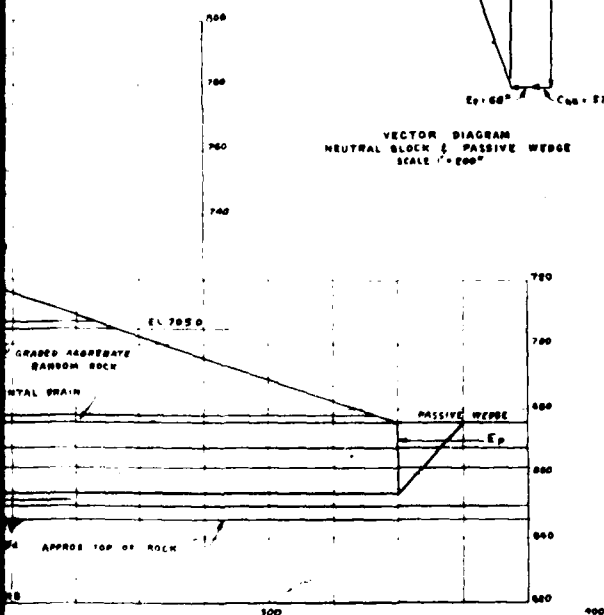
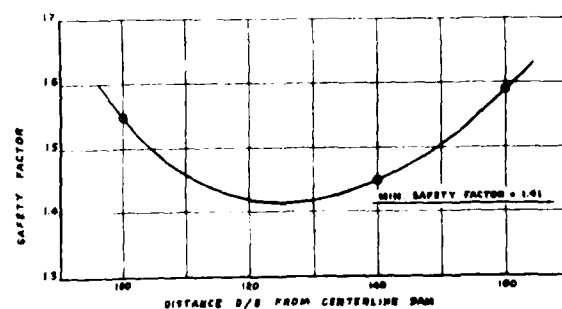
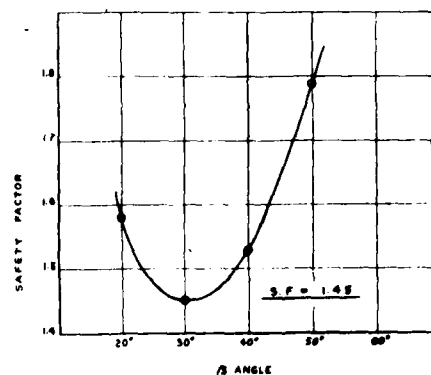
$$(1.20) = 0.06'$$



VECTOR DIAGRAM
ACTIVE WEDGE
SCALE: 1" = 200'



VECTOR DIAGRAM
NEUTRAL BLOCK & PASSIVE WEDGE
SCALE: 1" = 200'



REVISION	DATE	DESCRIPTION	BY
U.S. ARMY ENGINEER DISTRICT, LOUISVILLE CORPS OF ENGINEERS LOUISVILLE DISTRICT			
DRAWN: TRACED: J.E.W.		CHIEF ENGINEER CAVE RUN RESERVOIR LOUISVILLE DISTRICT, KENTUCKY	
CHECKED: J.E.W.		END OF CONSTRUCTION PREVIOUS FOUNDATION CONSOLIDATED STA. 14+00	
APPROVAL: J.E.W.		APPROVED: J.E.W.	
DATE: 10/10/50		SCALE: 1" = 20' H & V	
APPROVED: J.E.W.		DRAWN: J.E.W.	

CORPS OF ENGINEERS

ADOPTED DESIGN VALUES

MATERIAL	WT. # / FT ³			C ^u STRENGTH			C ^o STRENGTH		
	DRY	SAT	SFB	ϕ	TAN ϕ	$\frac{C}{\gamma H}$	ϕ	TAN ϕ	$\frac{C}{\gamma H}$
EMBANKMENT	127.0	130.4	66.0	0°	0.00	1.10	27°	0.51	0.40
FOUNDATION CLAY (UPPER)	124.4	127.4	65.0	0°	0.00	0.80	23°	0.42	0.20
FOUNDATION CLAY (LOWER)	124.4	127.4	65.0	3.0°	0.05	1.08	23°	0.42	0.20
FOUNDATION SBT			60.0	2.3°	0.04	0.40	26.8°	0.50	0.20
FOUNDATION SAND			60.0	35.0°	0.70	0.00	36.0°	0.70	0.00

- NOTES:
1. ϕ SHEAR STRENGTHS USED
 2. SUBMERGED WEIGHTS USED BELOW GROUND SURFACE
 3. R.S. = $\frac{\text{TAN } \phi}{\text{TAN } \phi_d}$; F.S. = $\frac{C}{C_d}$
 4. COMPUTATIONS PRESENTED FOR PLANE 100' DOWNSTREAM FROM ϕ ; $\phi = 40^\circ$ AND TRIAL S.R. = 1.3

ACTIVE WEDGE

$$\text{TAN } \phi = 0$$

$$W_A = \frac{(80)(10)(0.85)}{2} + \left[\left(\frac{80+83}{2} \right) (10) + \left(\frac{83+85}{2} \right) (1.5) + \left(\frac{85+86}{2} \right) (30) + \left(\frac{86+89}{2} \right) (1270) \right] (1270)$$

$$W_A = 810 \text{ K}$$

$$C_A = 13 \left(\frac{1.0}{1.3} \right) + 162 \left(\frac{0.8}{1.3} \right) = 280 \text{ K}$$

NEUTRAL BLOCK

$$\text{TAN } \phi = 0$$

$$W_{NB} = \left(\frac{80+83}{2} \right) (1270) + (8)(130)(0.85)$$

$$W_{NB} = 1561 \text{ K}$$

$$C_{NB} = 230 \left(\frac{1.0}{1.3} \right) = 293 \text{ K}$$

PASSIVE WEDGE

$$E_P = 2 + C_4 \sqrt{H} + \frac{E}{2} H^2 + H \phi$$

$$C_4 = \frac{1.00}{1.3} = 1.25 \text{ } \frac{\text{K}}{\text{ft}^{1/2}}$$

$$\text{TAN } \phi = 0$$

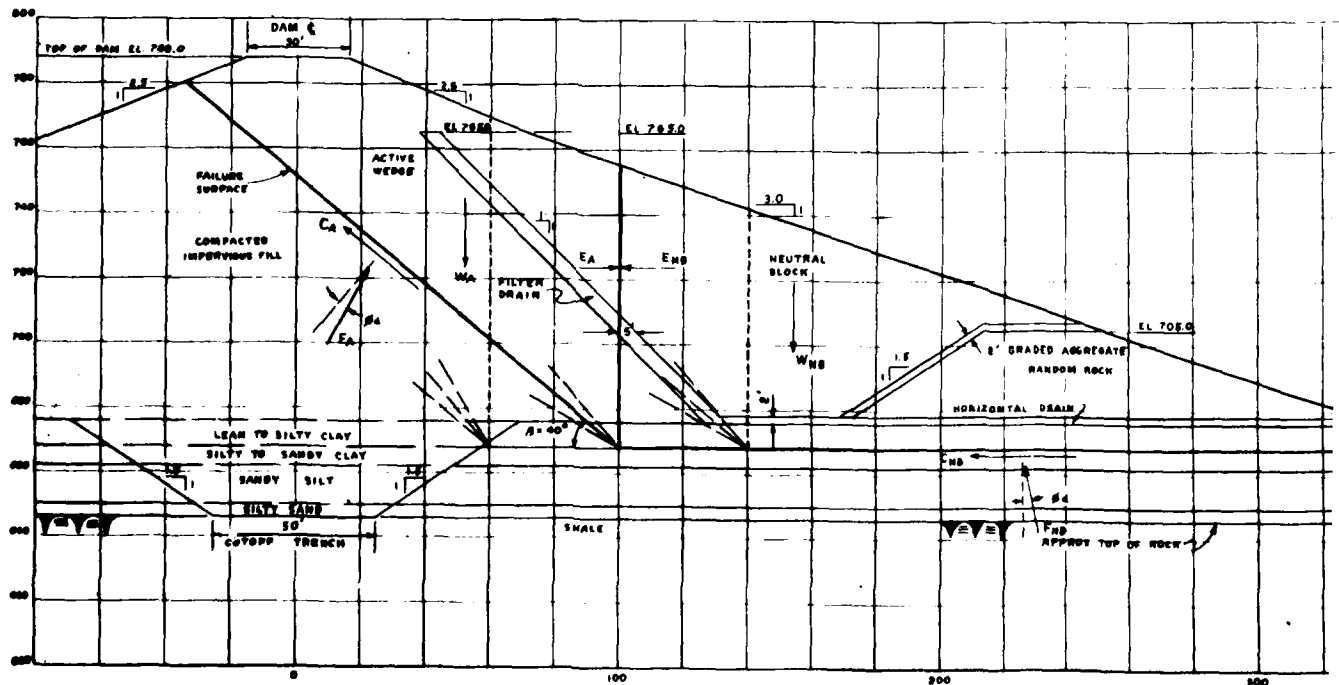
$$H \phi = \text{TAN } \phi^2 \left(40^\circ + \frac{H \phi}{2} \right)$$

$$H \phi = \text{TAN } \phi^2 (40^\circ)$$

$$H \phi = (0)^2$$

$$H \phi = 0$$

$$E_P = 2(0) + 1.25(0) + \frac{0.00}{2}(0)^2 + 0 = 0$$



$$E_D = 2 \times 10^6 \sqrt{N_D} \approx 10^7 \text{ N}^2 \text{ m}^{-1}$$

$$E_p = 2 \pi \epsilon_0 \sqrt{N} \frac{q}{L} = \frac{q}{L} \sqrt{N} \quad N^2 \neq 0$$

$$= \frac{1}{3} \cdot 180 = 60 \text{ } ^\circ$$

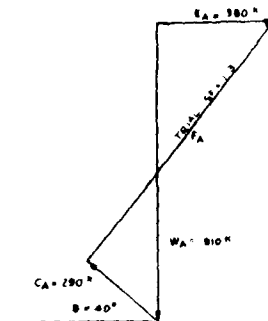
TAN 0

$$N_{\theta} = \tau \tan^2 \left(45^\circ + \frac{\phi}{2} \right)$$

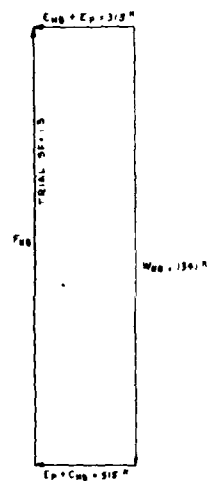
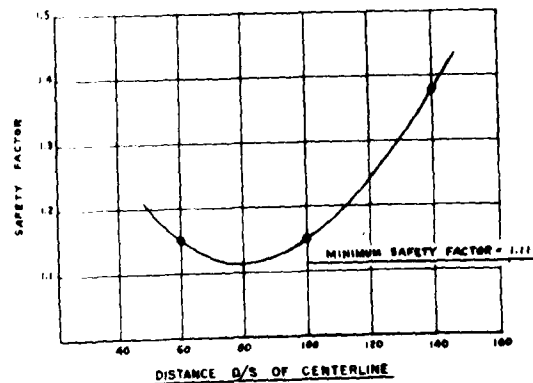
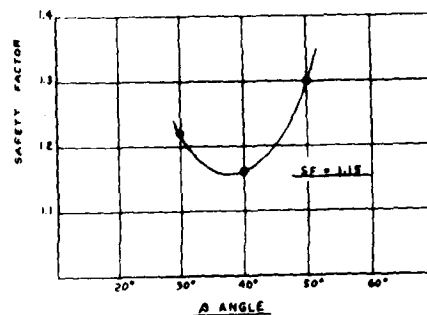
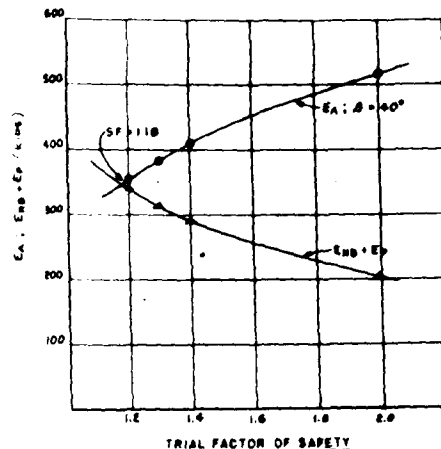
$$N_B = 1.6 \pi^2 (48^\circ)$$

$$N_{\text{eff}} = (1)^2$$

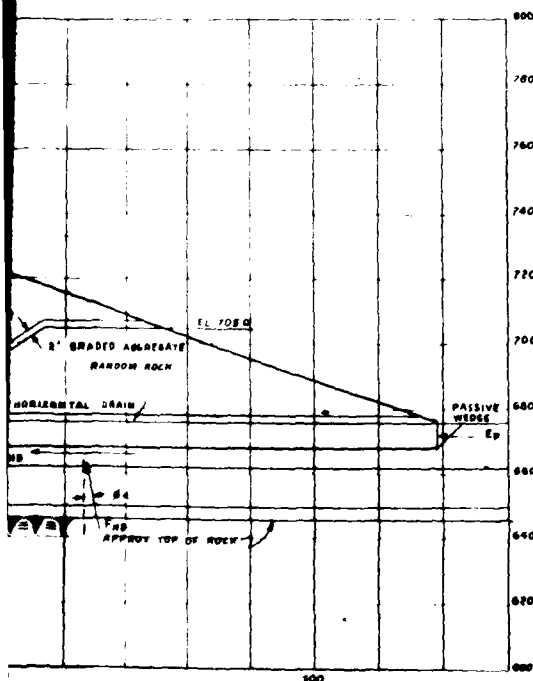
$$f(x) = \frac{1}{2} (x^2 + 1) \ln(x^2 + 1) - \frac{1}{2} x^2$$



VECTOR DIAGRAM
ACTIVE WEDGE
SCALE 1"=200'



VECTOR DIAGRAM
NEUTRAL BLOCK @
PASSIVE WEDGE
SCALE: 1" = 200'



ORDER NO. _____ DATE _____ BY _____		DESCRIPTION _____ BY _____	
U. S. ARMY ENGINEER DISTRICT, LOUISVILLE CORPS OF ENGINEERS LOUISVILLE, KENTUCKY			
DRAWING NO. _____ SCALE _____ DATE _____ BY _____		ORDER NO. 254-60 CAVE RUN RESERVOIR LICKING RIVER, KENTUCKY END OF CONSTRUCTION STA. 25+00	
APPROVAL SIGN. _____ TITLE _____ DATE _____		APPROVED _____ TITLE _____ DATE _____	

NOTES:

1. Slope stability computations were made with an IBM 360 electronic computer. The stability of the critical wedge was checked manually as shown.
2. The computations presented are for a failure plane 40' U.S. from the $\mathcal{Q}$ of dam with $\beta = 47^\circ$ and a trial F.S. = 1.29.
3. Test values used for central block are from shear tests on cube samples from test pit located 200 ft. U.S., Sta. 12+50.

ACTIVE WEDGE

$$W_A = 615.6K$$

$$C_A = \frac{1.16}{1.29} = 0.90K$$

$$C_A = 217K$$

$$\phi_d = 0^\circ$$

CENTRAL BLOCK

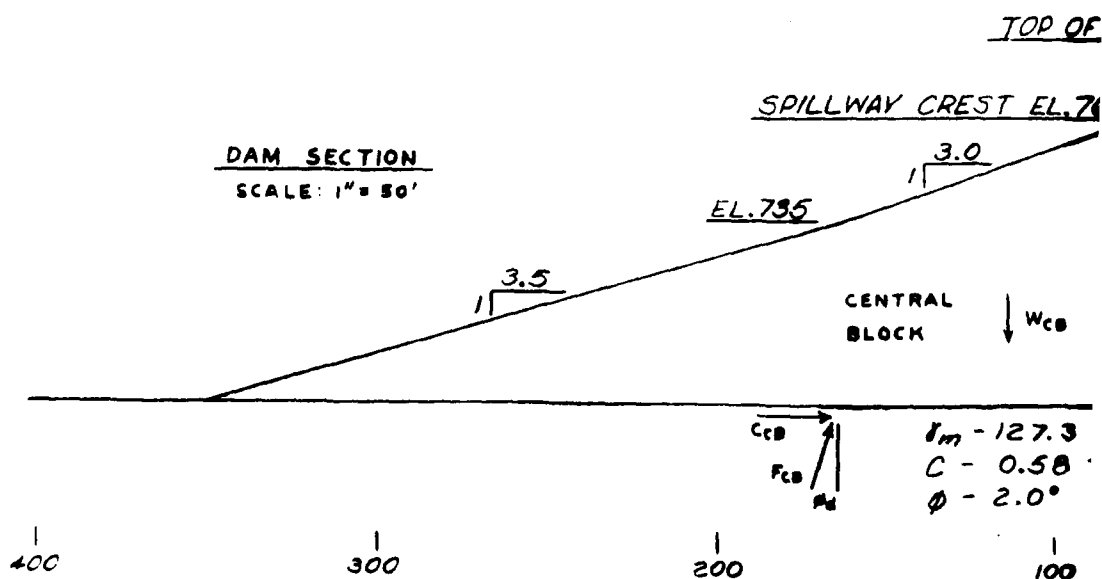
$$W_{CB} = 178K$$

$$C_{CB} = \frac{1.16}{1.29} (308)$$

$$C_{CB} = 277K$$

$$\tan \phi_d = \frac{0.34}{1.29} = 0.26$$

$$\phi_d = 1.5^\circ$$



CHRG. BY _____ DATE _____

JOB NO. _____

NOTES:

1. Slope stability computations were made with an IBM 360 electronic computer. The stability of the critical wedge was checked manually as shown.
2. The computations presented are for a failure plane 40' U.S. from the $\mathcal{Q}$ of dam with $\beta = 47^\circ$ and a trial F.S. = 1.21.
3. Stability computed using assumed ultimate strengths as indicated.

ACTIVE WEDGE

$$W_A = 610.5 \text{ K}$$

$$C_A = \frac{2.2}{1.21} (127)$$

$$C_A = 231 \text{ K}$$

$$\phi_A = 0^\circ$$

CENTRAL BLOCK

$$W_{CB} = 1782.1 \text{ K}$$

$$C_{CB} = \frac{1.2}{1.21} (308)$$

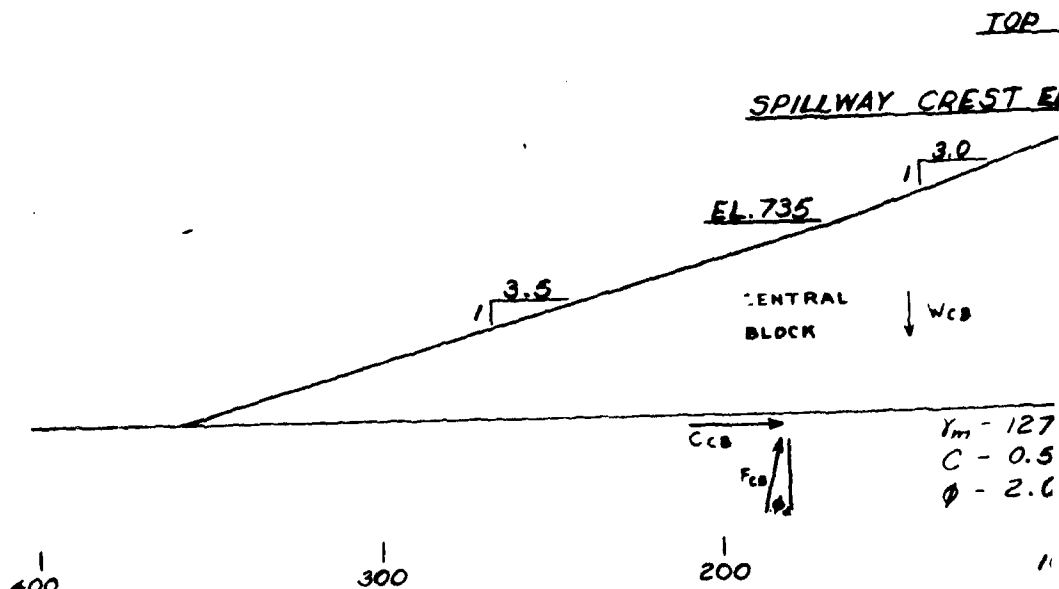
$$C_{CB} = 254 \text{ K}$$

$$\tan \phi_d = \frac{0.35}{1.21} = 0.29$$

$$\phi_d = 1.7^\circ$$

DAM SECTION

SCALE: 1" = 50'



DOE

K

(127)

BLOCK

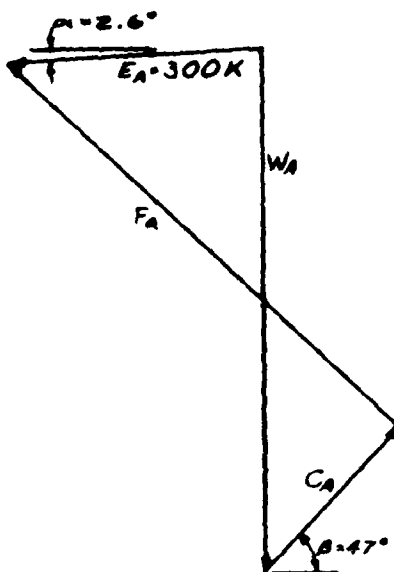
2.1 K

(308)

K

35
21 = .029

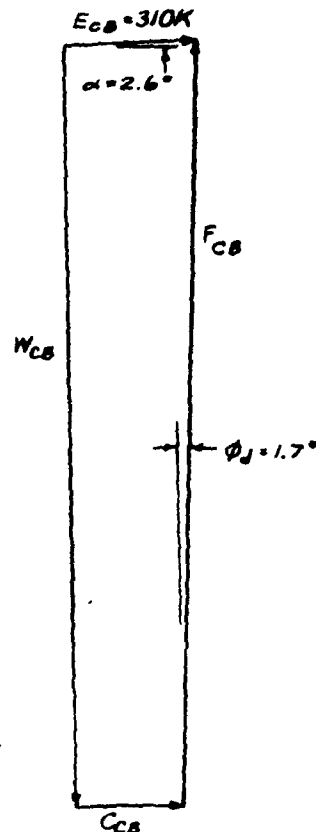
VECTOR DIAGRAMS



ANGLE OF INCLINATION

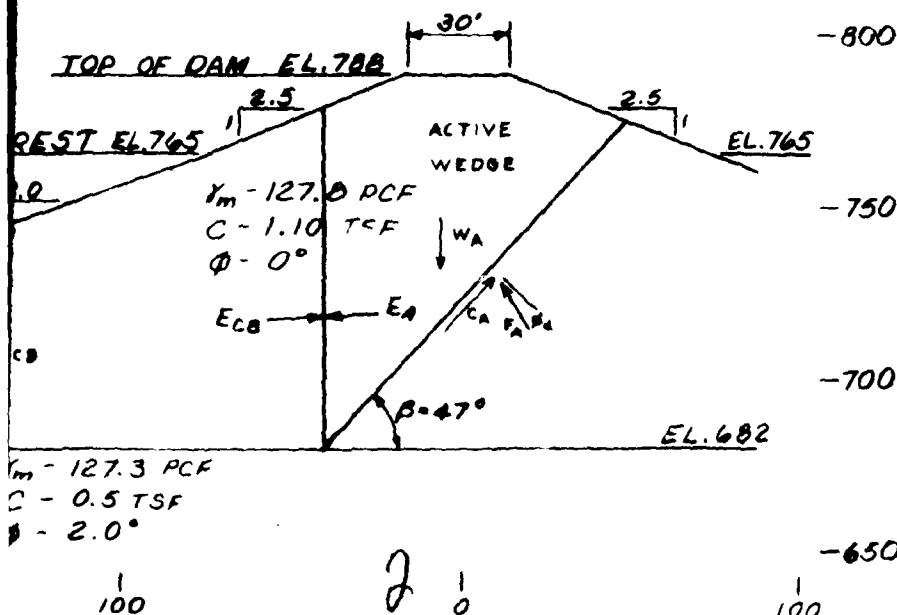
$$\frac{17.5^\circ}{166.5} = \frac{\alpha}{25}, \alpha = 2.6^\circ$$

ACTIVE WEDGE
SCALE: 1" = 200K



FOR EQUILIBRIUM $E_A = E_{CB}$
 $300K \approx 310K$
 $\therefore F.S. = 1.21$

CENTRAL BLOCK
SCALE: 1" = 400K



CAVE RUN LAKE
STABILITY ANALYSIS
WEDGE METHOD
END OF CONSTRUCTION

SAB

30 MAR, 71

EXHIBIT 5

PLATE 42

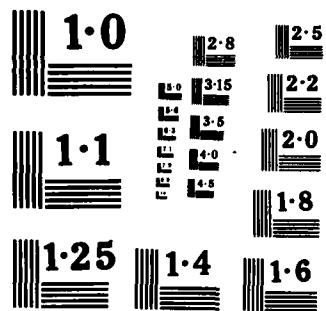
AD-A166 493

EMBANKMENT CRITERIA AND PERFORMANCE REPORT CAVE RUN
LAKE LICKING RIVER BASIN KENTUCKY(U) ARMY ENGINEER
DISTRICT LOUISVILLE KY APR 68

UNCLASSIFIED

F/G 13/2

NL



CHRG. BY _____ DATE _____

JOB NO. _____

Length of berm required to
obtain a F.S. = 1.3 when
 $C = 0.25$ TSF along entire
length of failure plane.

Height of berm

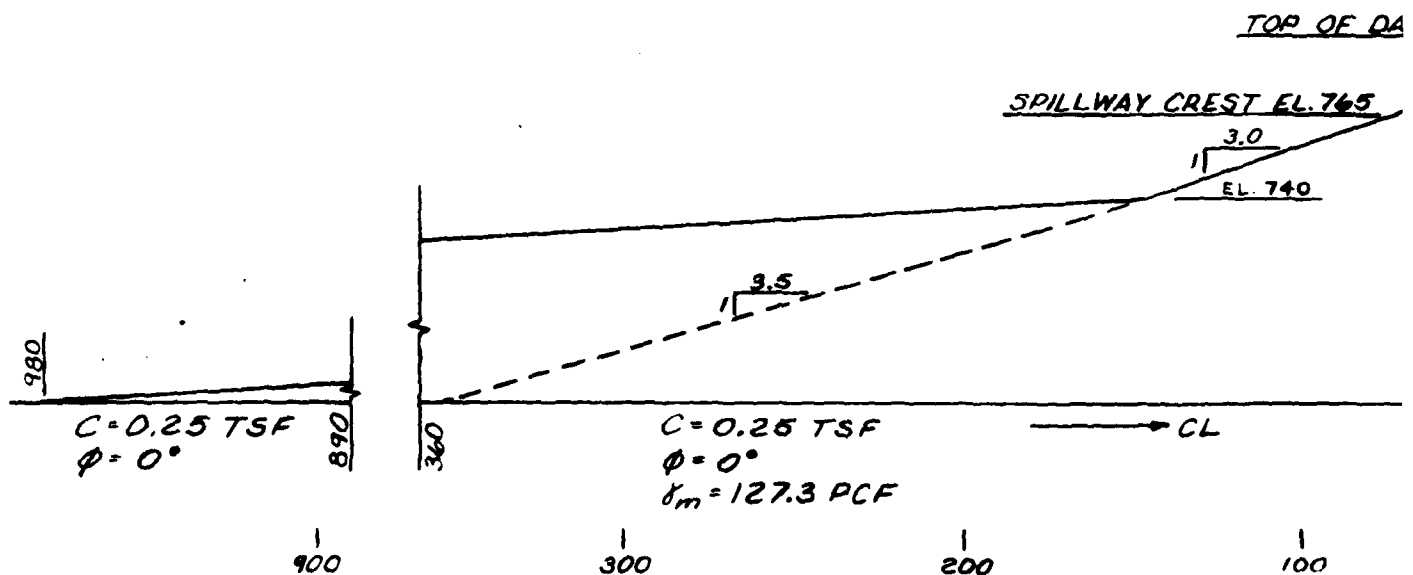
$$F.S. = \frac{CL}{E_A}$$

$$1.3 = \frac{(0.5)(L)}{362}$$

$$L = \frac{(1.3)(362)}{0.5}$$

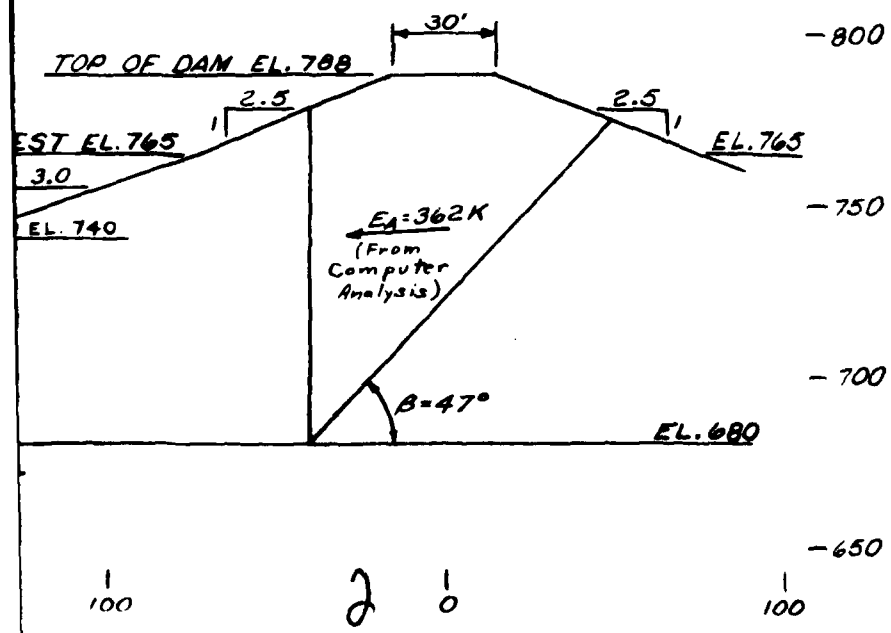
$$L = 940' \quad \therefore \text{Berm length} = 940 - 315 = 625'$$

Conclusion: A berm 625'
to obtain a
 $C = 0.25$ TSF
failure pla.
Vol. of sa



t of berm = 60' from Sheet 2.

A berm 625' long X 60' high is required to obtain a Factor of Safety = 1.3 when $C=0.25$ TSF along entire length of failure plane.
Vol. of said berm = 688 CY/Ft. of width.



CAVE RUN LAKE
STABILITY ANALYSIS
WITH ADDITION OF BERM
SHEET 1 OF 2
SAB 6 APR, 71

CHKD. BY.....DATE.....

JOB NO.

Factor of Safety with No Berm

$$F.S. = \frac{CL}{EA}$$

$$F.S. = \frac{0.25T}{F_1^2} \times \frac{315'}{362K} \times \frac{2K}{T}$$

$$F.S. = \underline{0.435}$$

Determination of Necessary Berm To Obtain F.S. ≥ 1.3

① Assume berm height = 30'

$$E_p = 2HC_d \sqrt{N_d} + \frac{\gamma H^2}{2} N_d, N_d = 1$$

$$E_p = (2 \times 30') \left(\frac{2.2K}{F.S.} \right) (1) + \frac{(127)(30')^2}{2} (1)$$

$$E_p = \frac{132}{F.S.} + 57 \quad CL = (6)(220) = 110$$

$$F.S. = \frac{E_p + CL}{EA} = \frac{\left(\frac{132}{F.S.} + 57 \right) + 110}{362}$$

$$F.S. = \frac{167 \pm \sqrt{167^2 + 4(362)(132)}}{2(362)}$$

$$F.S. = 0.88$$

Determination of Berm Length Necessary To Obtain F.S. = 1.3

C = 0.8 TSF on berm failure plane

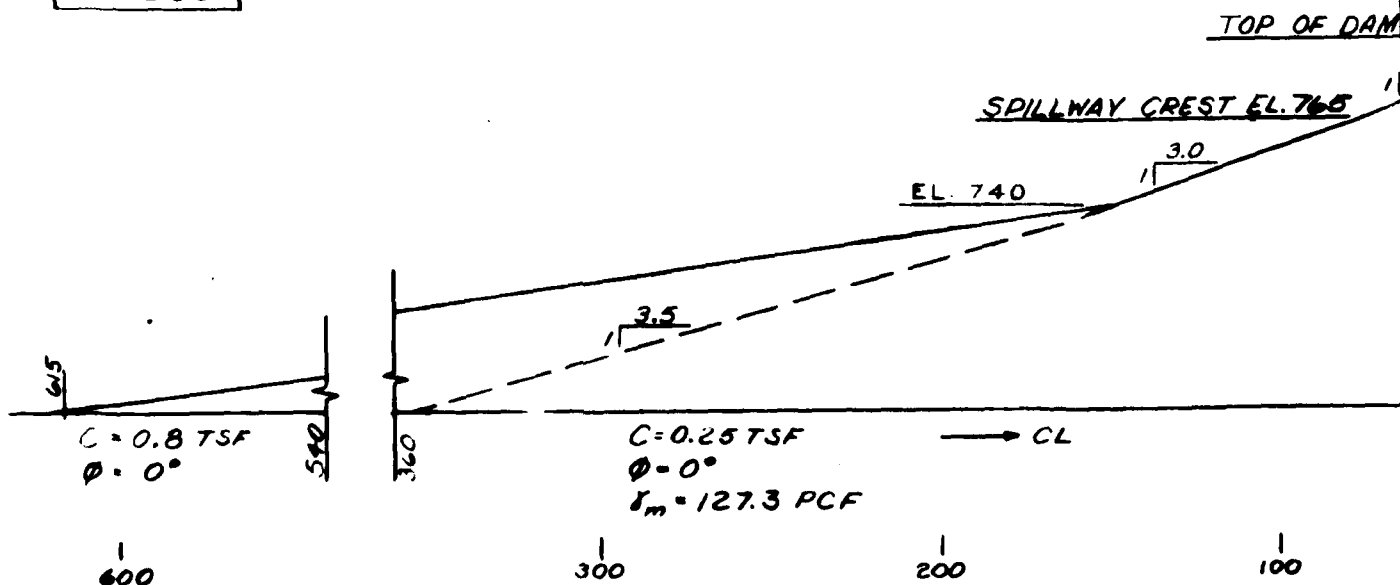
C = 0.25 TSF on central block failure plane

$$F.S. = \frac{CL + CL_{BERM}}{EA}$$

$$1.3 = \frac{(1.5 \times 108) + (1.6)(L)}{362}$$

$$\boxed{L = 260'}$$

Conclusion: A
re
Sa
at



Necessary Berm Height

1. ≥ 1.3

$$h = 30'$$

$$N_d, N_d = 1$$

$$+ \frac{(.127)(30)^2}{2} (1)$$

$$CL = (.6)(220) = 110$$

$$\frac{\frac{220}{F.S.} + 57}{362} + 110$$

② Assume berm height = 50'

$$E_p = (2)(50) \left(\frac{2.2}{F.S.} \right) + .127(50)^2 (.5)$$

$$E_p = \frac{220}{F.S.} + 159 \quad CL = (.5)(138) = 69$$

$$F.S. = \frac{\frac{220}{F.S.} + 228}{362}$$

$$F.S. = \frac{220 \pm \sqrt{(220)^2 + 4(362)(220)}}{2(362)}$$

$$F.S. = 1.15$$

③ Assume berm height = 55'

$$E_p = (2)(55) \left(\frac{2.2}{F.S.} \right) + .127(55)^2 (.5)$$

$$E_p = \frac{242}{F.S.} + 192 \quad CL = 61$$

$$F.S. = \frac{\frac{242}{F.S.} + 253}{362}$$

$$F.S. = 1.24$$

④ Assume berm height = 60'

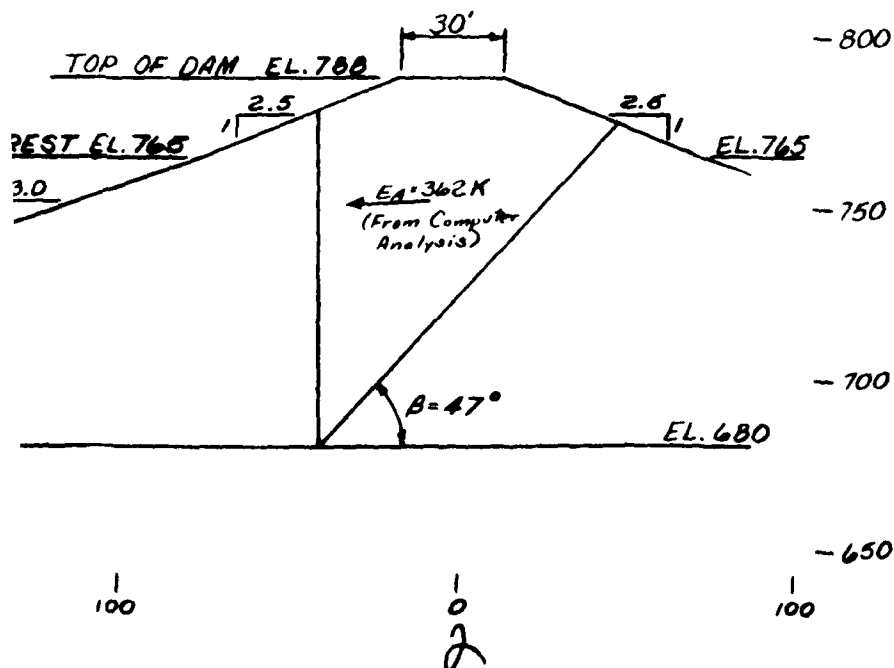
$$E_p = (2)(60) \left(\frac{2.2}{F.S.} \right) + .127(60)^2 (.5)$$

$$E_p = \frac{264}{F.S.} + 228 \quad CL = 54$$

$$F.S. = \frac{\frac{264}{F.S.} + 282}{362}$$

$$F.S. = 1.53$$

Conclusion: A berm 260' long x 60' high is required to obtain a Factor of Safety = 1.3 when $C = 0.8$ TSF along the berm failure plane.
Vol. of berm = 275 CY/ft. of width.



CAVE RUN LAKE
STABILITY ANALYSIS
WITH ADDITION OF BERM
SHEET 2 OF 2

SAB

6 APR, 71

EXHIBIT 5 PLATE 44

CHKD. BY _____ DATE _____ JOB NO. _____

NOTES:

1. Embankment values are from feature design memorandum.
2. Foundation values were recommended by OCE.
3. The depth of excavation was assumed to be in the order of 17-20 feet.

CENTRAL BLOCK Assume $E_{cb} =$

Begin excavating 100' U.S. &

Trial S.F. = 1.0

$$E_{cb} = 60\left(\frac{50}{1.0}\right) + 248\left(\frac{2.2}{1.0}\right) = 578^K$$

Trial S.F. = 1.5

$$E_{cb} = 60\left(\frac{50}{1.5}\right) + 248\left(\frac{2.2}{1.5}\right) = 386^K$$

Trial S.F. = 2.0

$$E_{cb} = 60\left(\frac{50}{2.0}\right) + 248\left(\frac{2.2}{2.0}\right) = 289^K$$

ACTIVE WEDGE

$$W_A = 617^K$$

Trial S.F. = 1.0

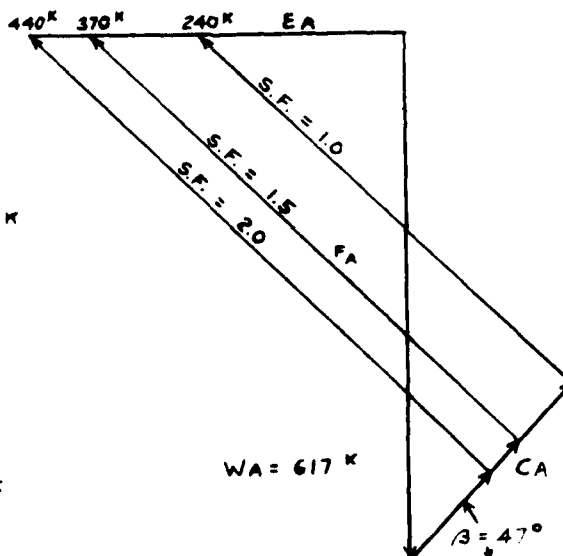
$$C_A = \frac{2.2}{1.0} (127) = 280^K$$

Trial S.F. = 1.5

$$C_A = \frac{2.2}{1.5} (127) = 187^K$$

Trial S.F. = 2.0

$$C_A = \frac{2.2}{2.0} (127) = 140^K$$



VECTOR DIAGRAM

ACTIVE WEDGE

SCALE: 1" = 200^K

Begin excavating 150' U.S. &

Trial S.F. = 1.0

$$E_{cb} = 110\left(\frac{50}{1.0}\right) + 198\left(\frac{2.2}{1.0}\right) = 491^K$$

Trial S.F. = 1.5

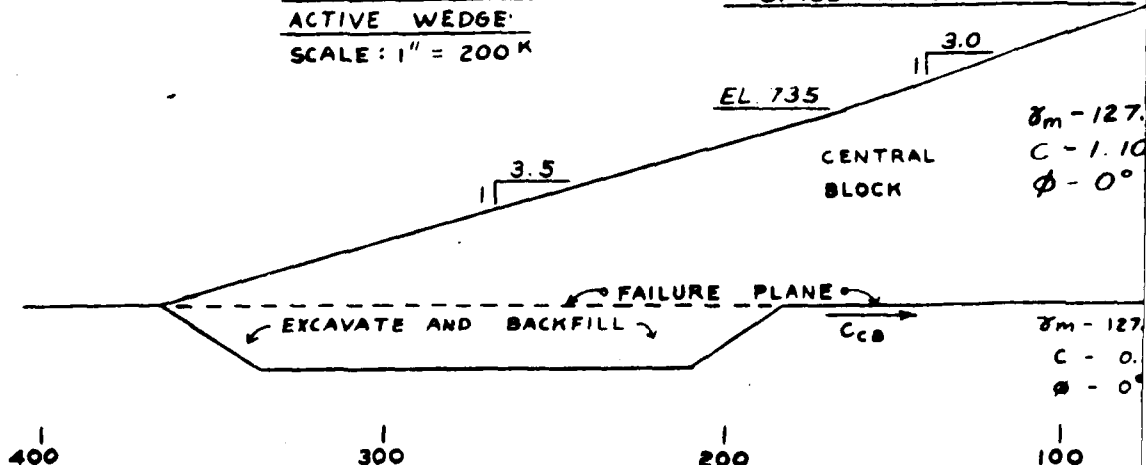
$$E_{cb} = 110\left(\frac{50}{1.5}\right) + 198\left(\frac{2.2}{1.5}\right) = 327^K$$

Trial S.F. = 2.0

$$E_{cb} = 110\left(\frac{50}{2.0}\right) + 198\left(\frac{2.2}{2.0}\right) = 245^K$$

TOP OF D

SPILLWAY CREST EL. 765



Assume $E_{cb} = C_{cb}$ since $\tan \theta = 0$

S. 6 Begin excavating 200' U.S. 6

Trial S.F. = 1.0

$$B\left(\frac{2.2}{1.0}\right) = 578^K \quad E_{cb} = 160\left(\frac{30}{1.0}\right) + 148\left(\frac{2.2}{1.0}\right) = 406^K$$

Trial S.F. = 1.5

$$= 386^K \quad E_{cb} = 160\left(\frac{30}{1.5}\right) + 148\left(\frac{2.2}{1.5}\right) = 270^K$$

Trial S.F. = 2.0

$$= 289^K \quad E_{cb} = 160\left(\frac{30}{2.0}\right) + 148\left(\frac{2.2}{2.0}\right) = 203^K$$

150' U.S. 6

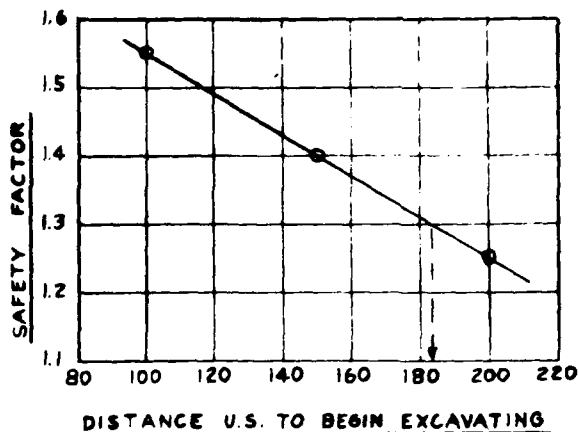
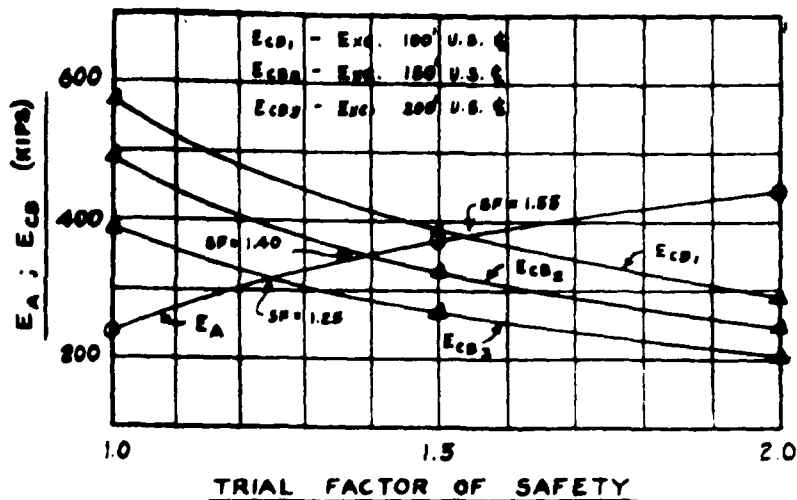
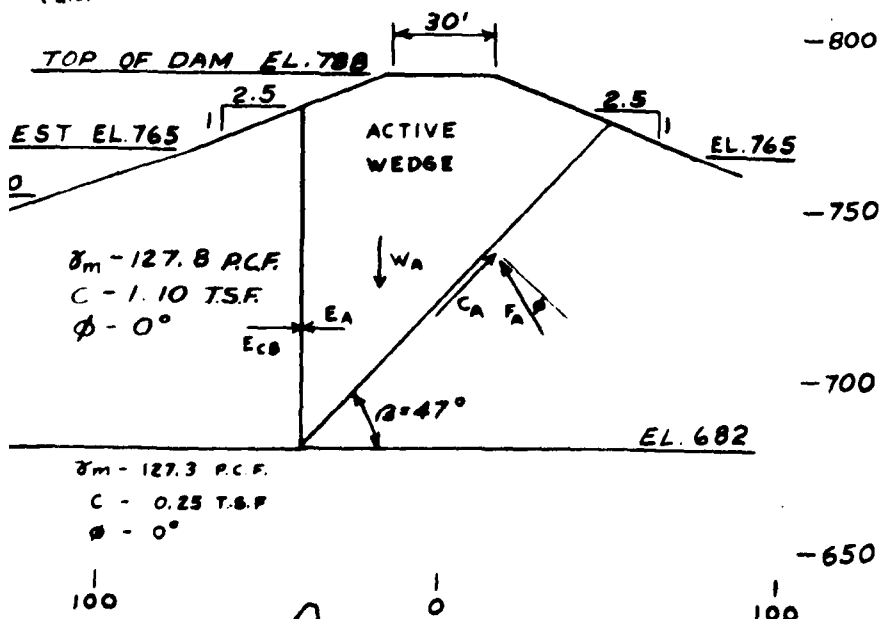
$$B\left(\frac{2.2}{1.0}\right) = 491^K$$

$$B\left(\frac{2.2}{1.5}\right) = 327^K$$

$$98\left(\frac{2.2}{2.0}\right) = 245^K$$

DAM SECTION

SCALE: 1" = 50'



FOR SAFETY FACTOR OF 1.30
BEGIN EXCAVATING 183' U.S. 6

CAVE RUN LAKE

EXCAVATING FOUNDATION FOR
STABILITY ANALYSIS BY
WEDGE METHOD

D.L.T.

7 APR 71

EXHIBIT 5 PLATE 45

CHKD. BY _____ DATE _____

JOB NO. _____

NOTES :

1. The computations presented are for the lateral earth pressure for full embankment height using an at-rest pressure coefficient of 0.5.
2. Embankment values are from feature design memorandum.
3. Foundation values were recommended by OCE.
4. The depth of excavation was assumed to be in the order of 17-20 feet.

DRIVING FORCE

$$E_A = \frac{1}{2} K_0 \gamma_m H^2 \quad \text{WHERE } E_A$$

$$E_A = \frac{1}{2} (5) (127.8) (106)^2$$

$$E_A = 358 \text{ K}$$

RESISTING FORCE

Assume $E_{CB} = C_{CB}$ since

Begin excavating 100' u.s. &

$$E_{CB} = 248(2.2) + 100(.5)$$

$$E_{CB} = 595 \text{ K}$$

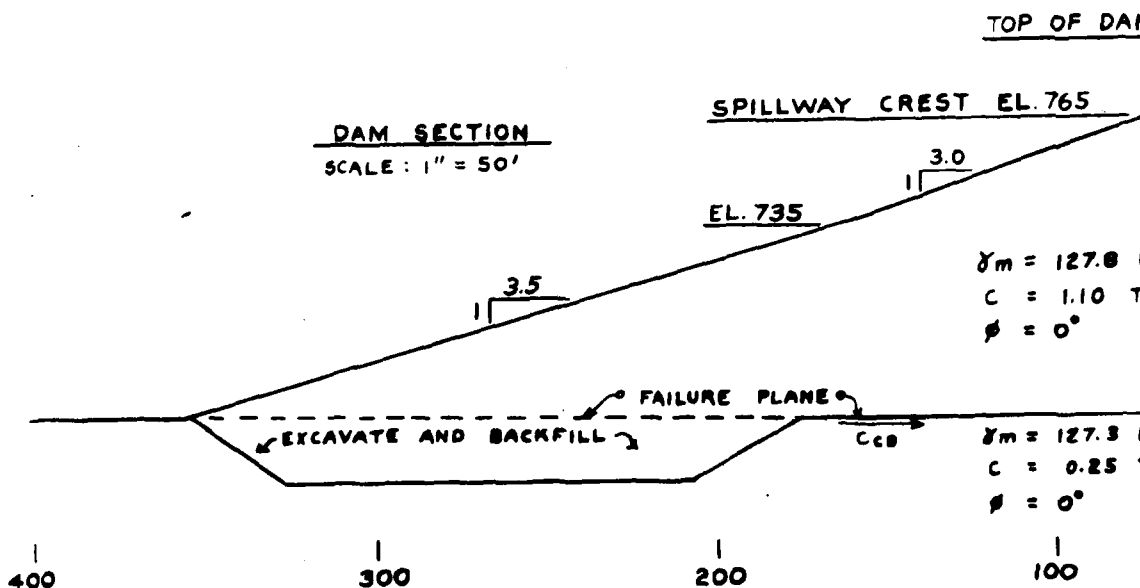
$$S.F. = \frac{E_{CB}}{E_A} = \frac{595 \text{ K}}{358 \text{ K}} = 1.66$$

Begin excavating 183' u.s. &

$$E_{CB} = 165(2.2) + 183(.5)$$

$$E_{CB} = 455 \text{ K}$$

$$S.F. = \frac{E_{CB}}{E_A} = \frac{455 \text{ K}}{358 \text{ K}} = 1.27$$



ICE

WHERE: EA - lateral earth pressure
 K_0 - at-rest pressure coefficient
 γ_m - moist unit weight emb.
H - embankment height

IRCE

+ Ccb since $\tan \phi = 0$

ng 100' U.S. £

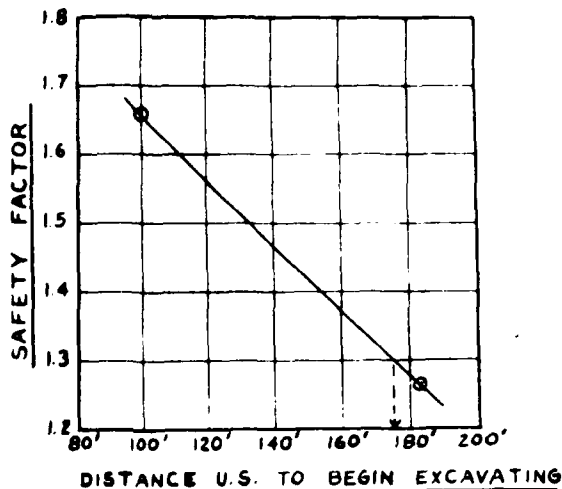
+ 100(.5)

$$\frac{595K}{358K} = 1.66$$

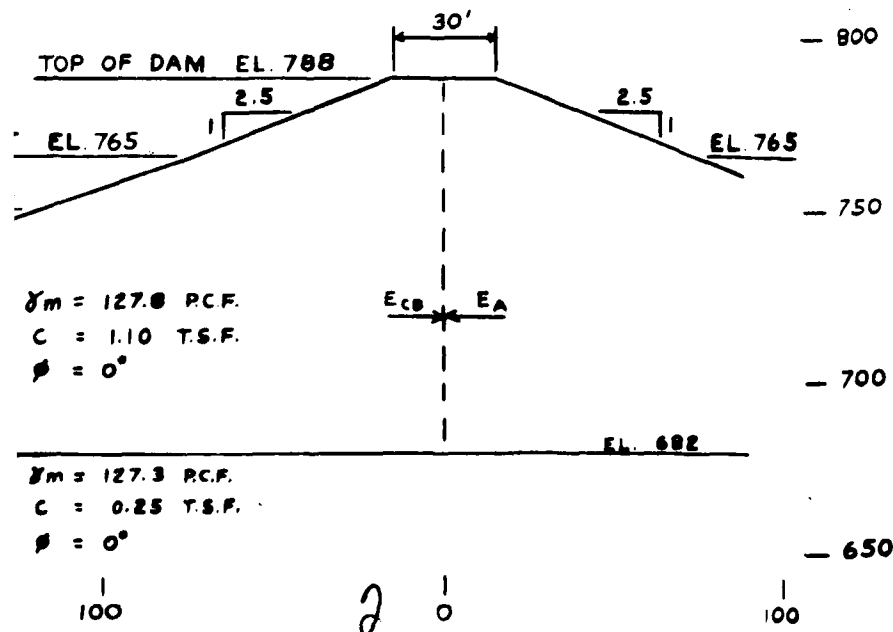
g 183' U.S. £

+ 183(.5)

$$\frac{455K}{358K} = 1.27$$



FOR SAFETY FACTOR OF 1.30
BEGIN EXCAVATING 177' U.S. £



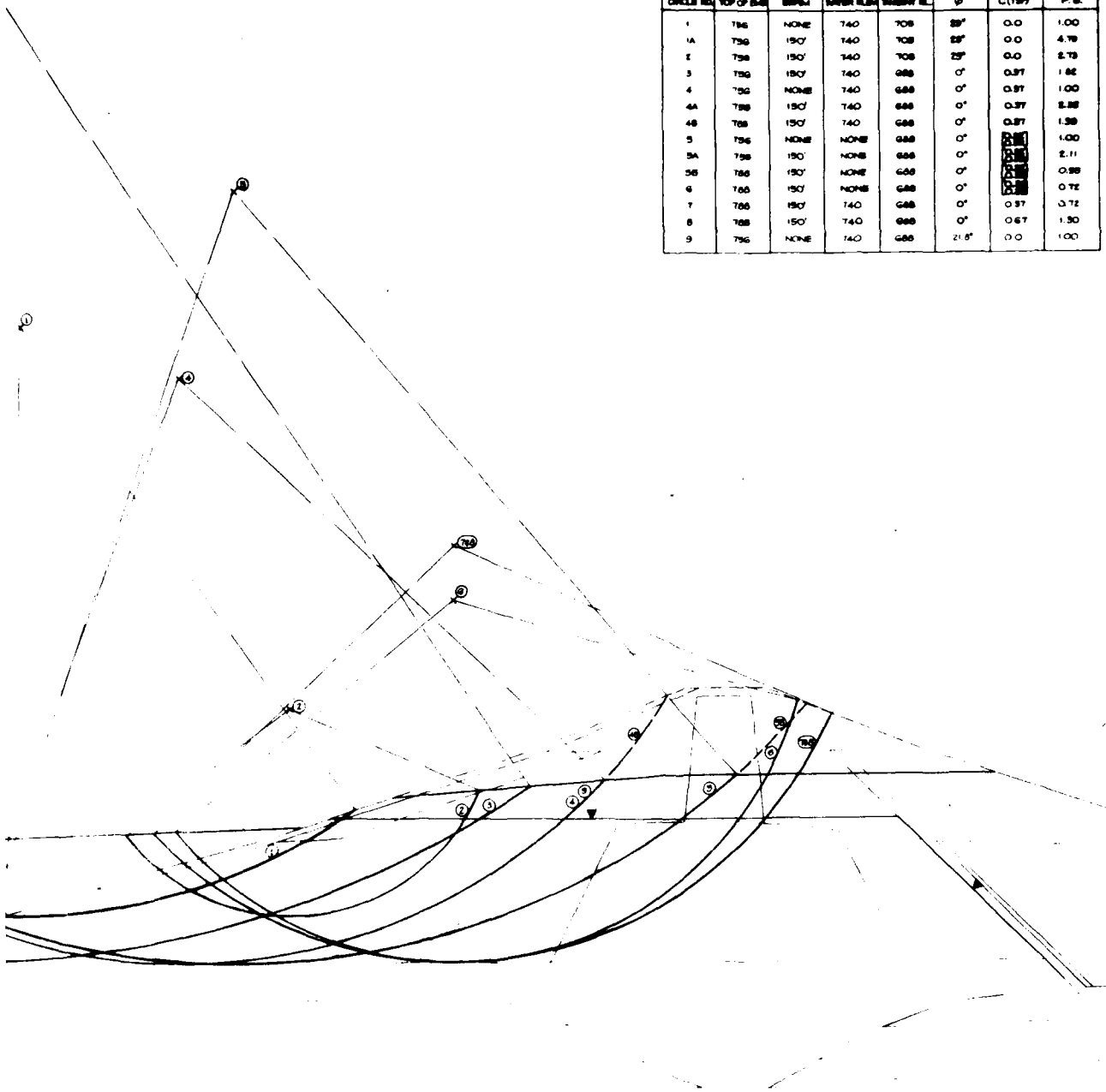
CAVE RUN LAKE
EXCAVATING FOUNDATION FOR
STABILITY ANALYSIS USING
LATERAL EARTH PRESSURE

D.L.T. 6 APR 71
EXHIBIT 5 PLATE 46

1

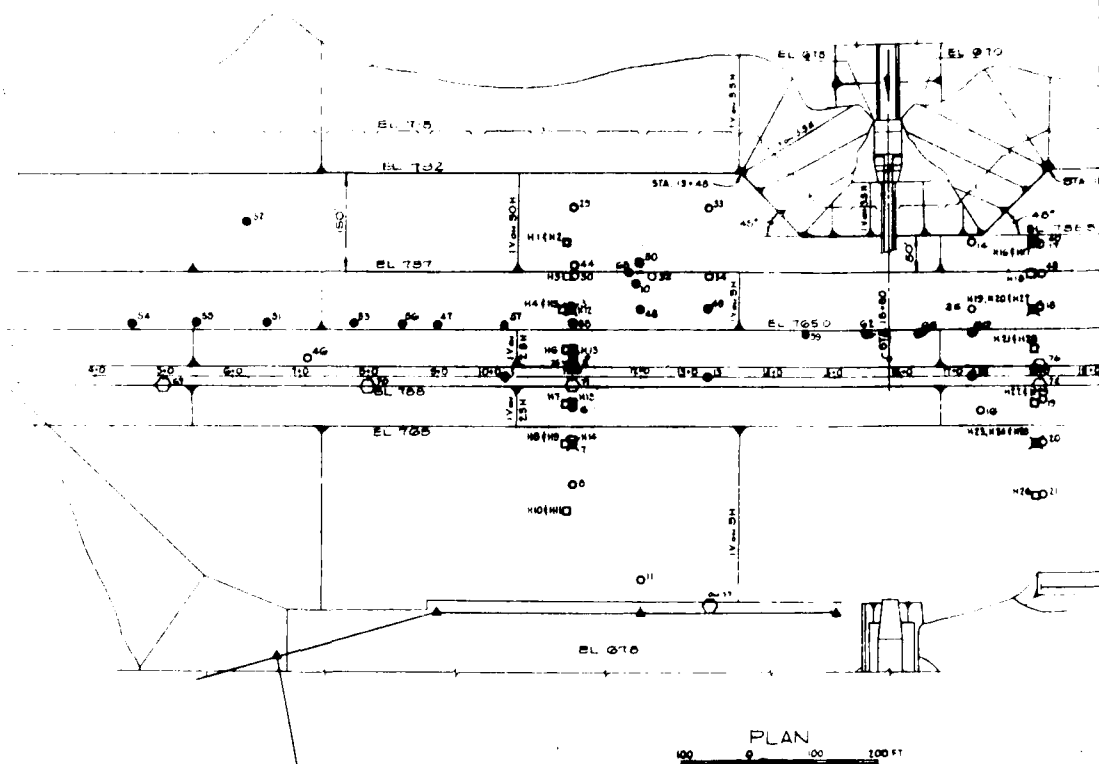
U. S. ARMY

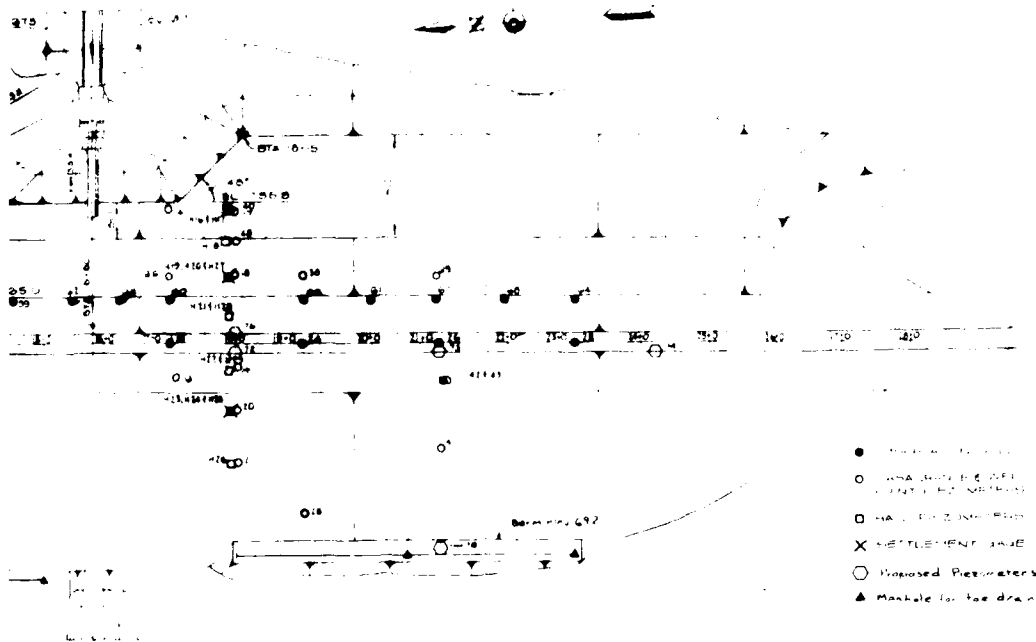
CIRCLE NO.	TOP OF BANK	DEPTH	WATER LEVEL	TANGENT EL.	θ	C (FPS)	P. S.
1	796	NONE	740	708	28°	0.0	1.00
1A	796	150'	740	708	28°	0.0	4.78
2	796	150'	740	708	28°	0.0	2.73
3	796	150'	740	688	0°	0.37	1.82
4	796	NONE	740	688	0°	0.37	1.00
4A	796	150'	740	688	0°	0.37	2.25
4B	796	150'	740	688	0°	0.37	1.38
5	796	NONE	NONE	688	0°	0.37	1.00
5A	796	150'	NONE	688	0°	0.37	2.11
5B	796	150'	NONE	688	0°	0.37	0.98
6	786	150'	NONE	688	0°	0.37	0.72
7	786	150'	740	688	0°	0.37	0.72
8	786	150'	740	688	0°	0.67	1.30
9	796	NONE	740	688	21.8°	0.0	1.00



DESIGNED	DATE	DESCRIPTION	BY
U. S. ARMY ENGINEER DISTRICT, LOUISVILLE CORPS OF ENGINEERS LOUISVILLE DISTRICT			
DRAWN	TRACED	CAVE RUN LAKE	
CHECKED	W.F.S.	STABILITY ANALYSES	
SUBMITTED		UPSTREAM BERM	
SCALE	DATE	DRAWING NUMBER	

CORPS OF ENGINEERS

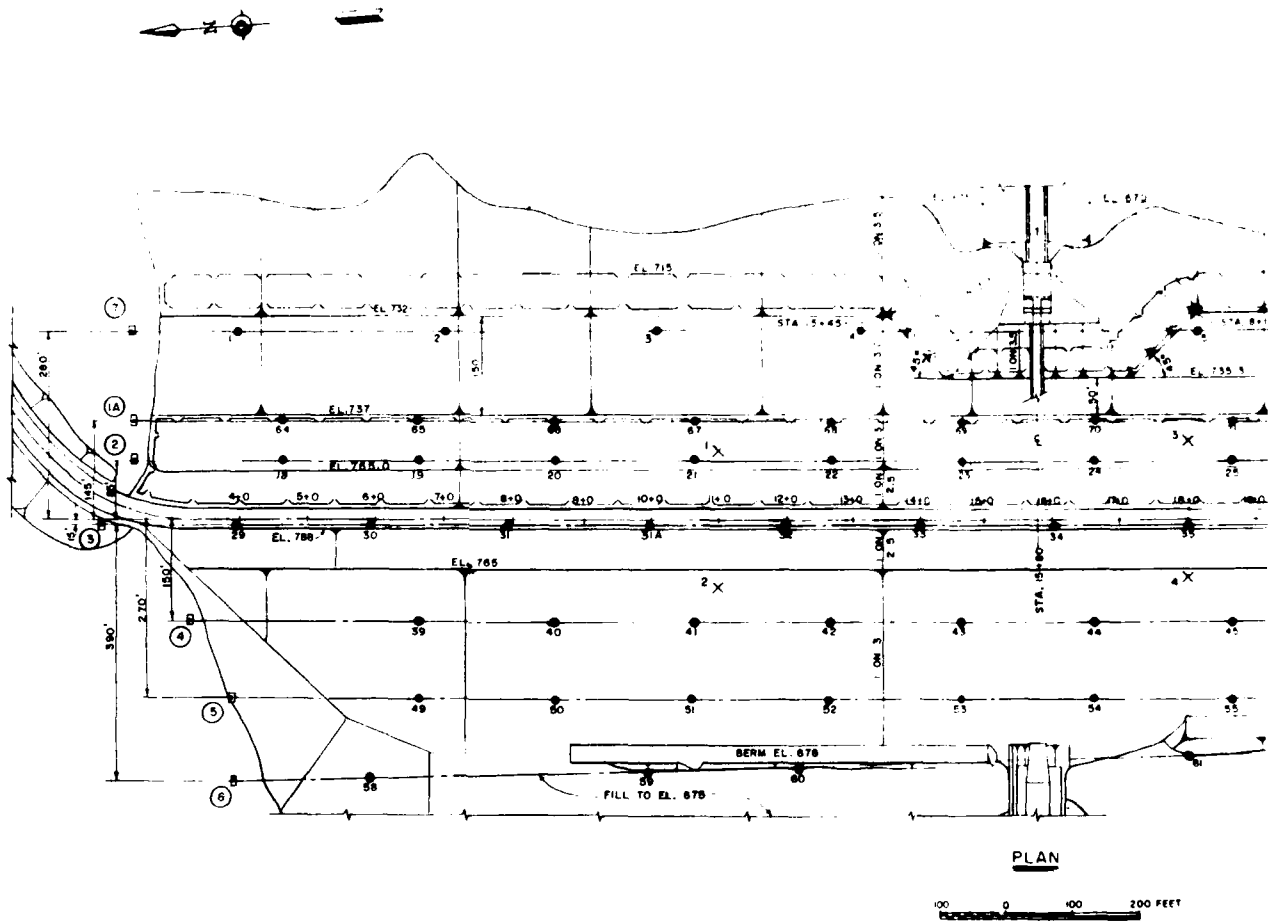


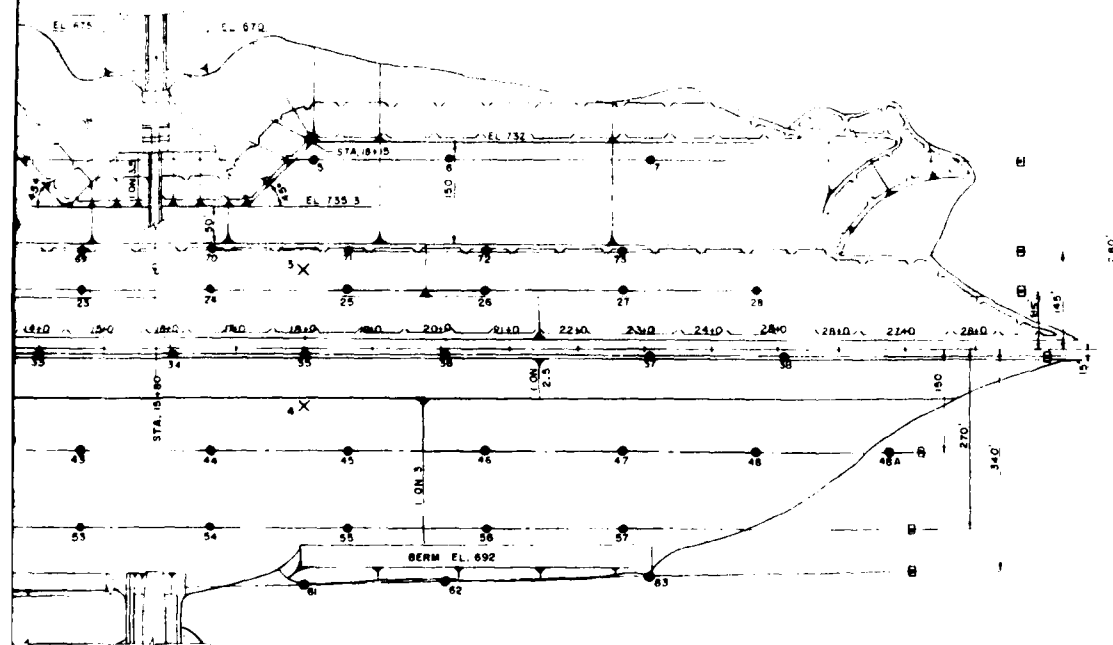


- Proposed Piezometer
- Proposed Piezometer
- X Settlement Gage
- Proposed Piezometer
- ▲ Marker for toe drain

DESIGNED:	17 Nov 58	Proposed Piezometers toe drain	PAS
REVISION	DATE	DESCRIPTION	BY
	23 Oct 60	Corrected Piezometer locations	PAS
U. S. ARMY ENGINEER DISTRICT, LOUISVILLE CORPS OF ENGINEERS LOUISVILLE, KENTUCKY			
DRAWN: ☒ TRACED: ☒ CHECKED: ☒ SUBMITTED: ☒ SCALE: ☒		OHIO RIVER BASIN CAVE RUN LAKE LICKING RIVER, KENTUCKY PIEZOMETER & SETTLEMENT GAUGE PLAN DATE: DRAWING NUMBER:	

CORPS OF ENGINEERS





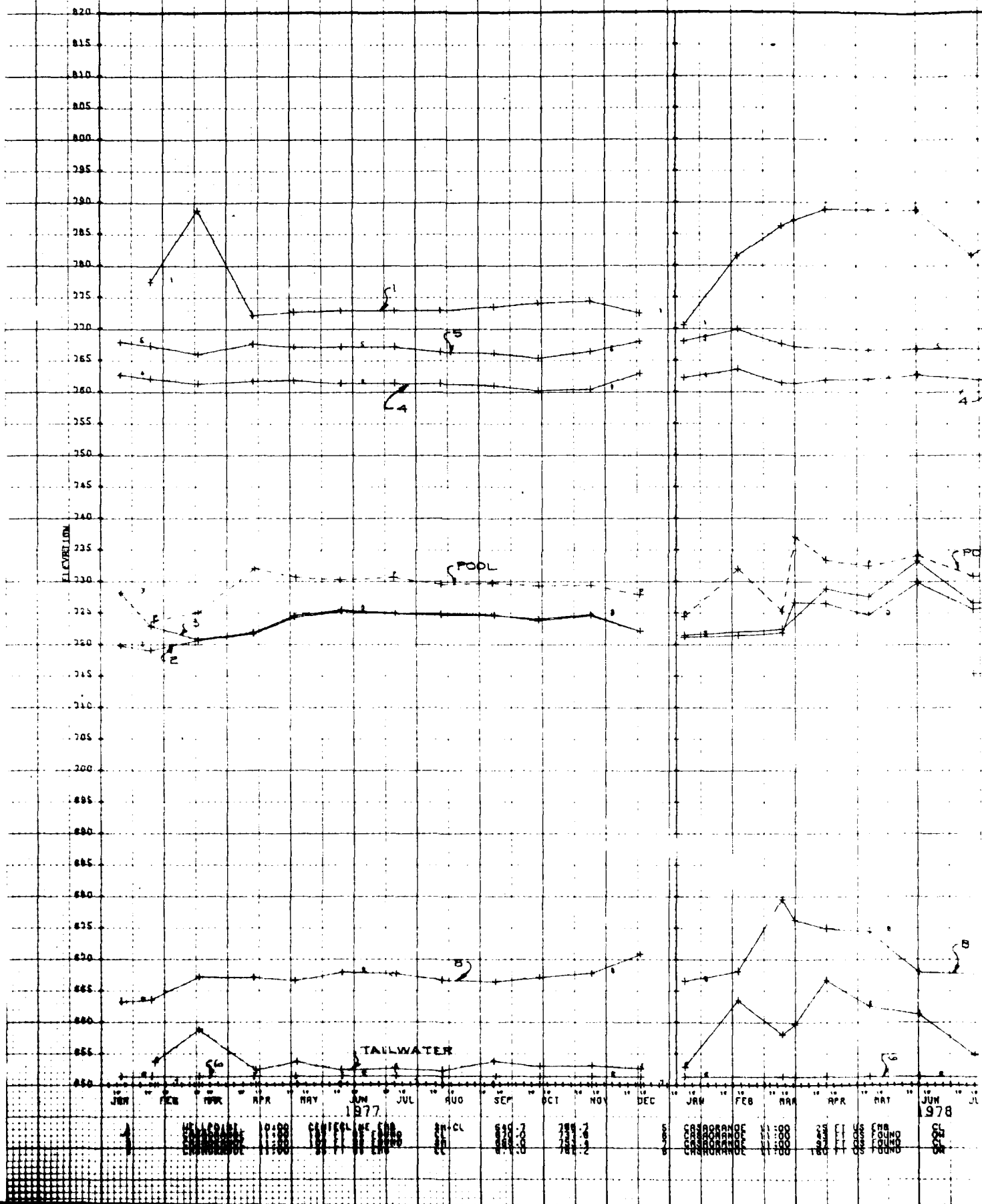
PLAN

100 0 100 200 FEET

LEGEND

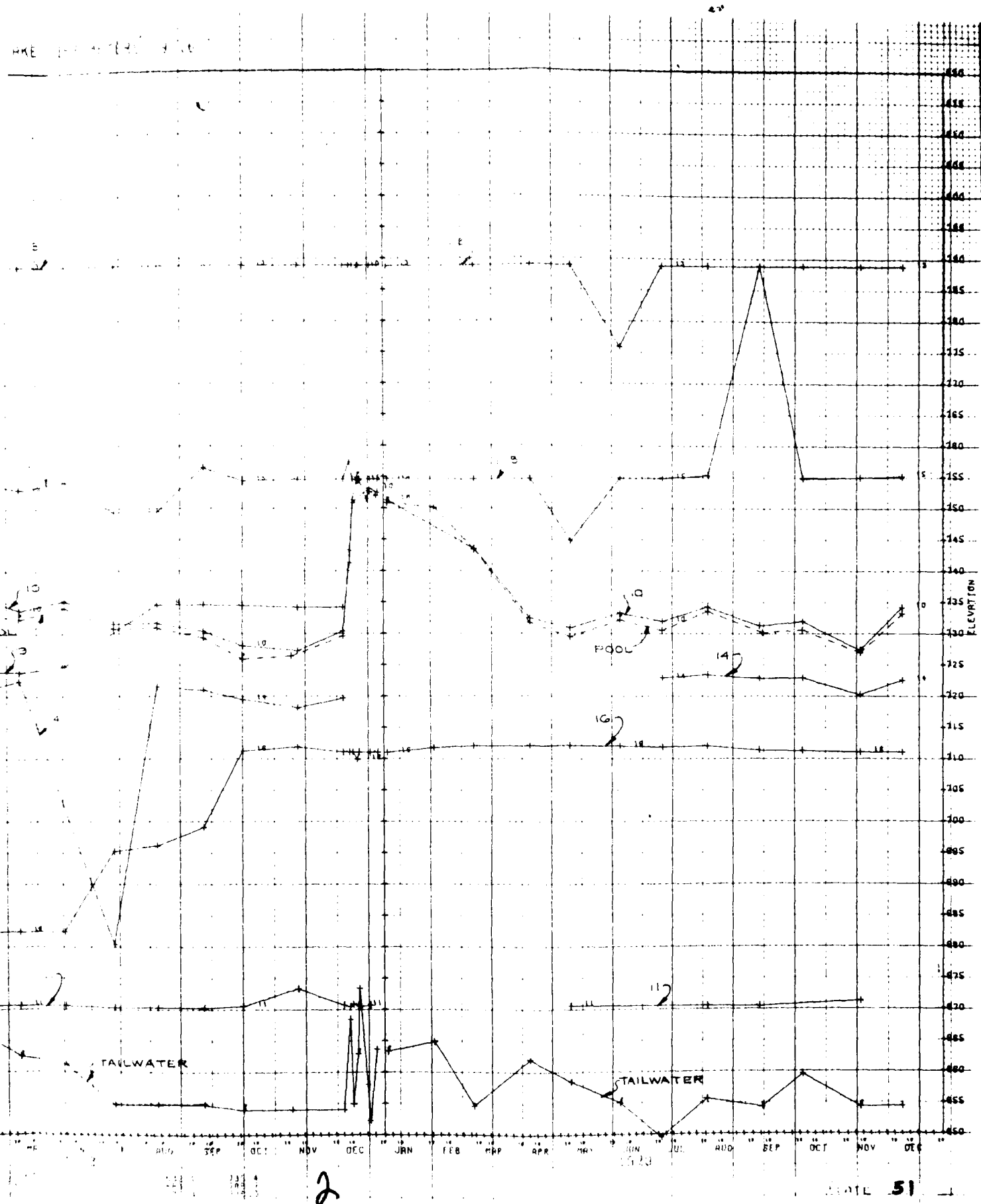
- REFERENCE MONUMENT
- MOVEMENT MONUMENT
- X SETTLEMENT GAGE

DIVISION		DATE	DESCRIPTION	BY
U. S. ARMY ENGINEER DISTRICT, LOUISVILLE CORPS OF ENGINEERS LOUISVILLE, KENTUCKY				
DESIGNED		OHIO RIVER BASIN CAVE RUN LAKE LICKING RIVER, KENTUCKY MOVEMENT MONUMENTS & SETTLEMENT GAGE PLAN		
DRAWN	RECHECK			
CHECKED	APPROVED			
SCALE 1" = 100'		DATE	JUNE, 1970	
		DRAWING NUMBER		



CBSACRANDE	12:00	200	FT	US	EMB
CBSACRANDE	12:00	100	FT	US	EMB
CBSACRANDE	12:00	100	FT	US	EMB
HEL POINT	13:00	CENTERLINE EMB			

WELL POINT	17:00	01	8	01
WELL POINT	17:00	02	8	02
WELL POINT	17:00	03	8	03



[illegible]

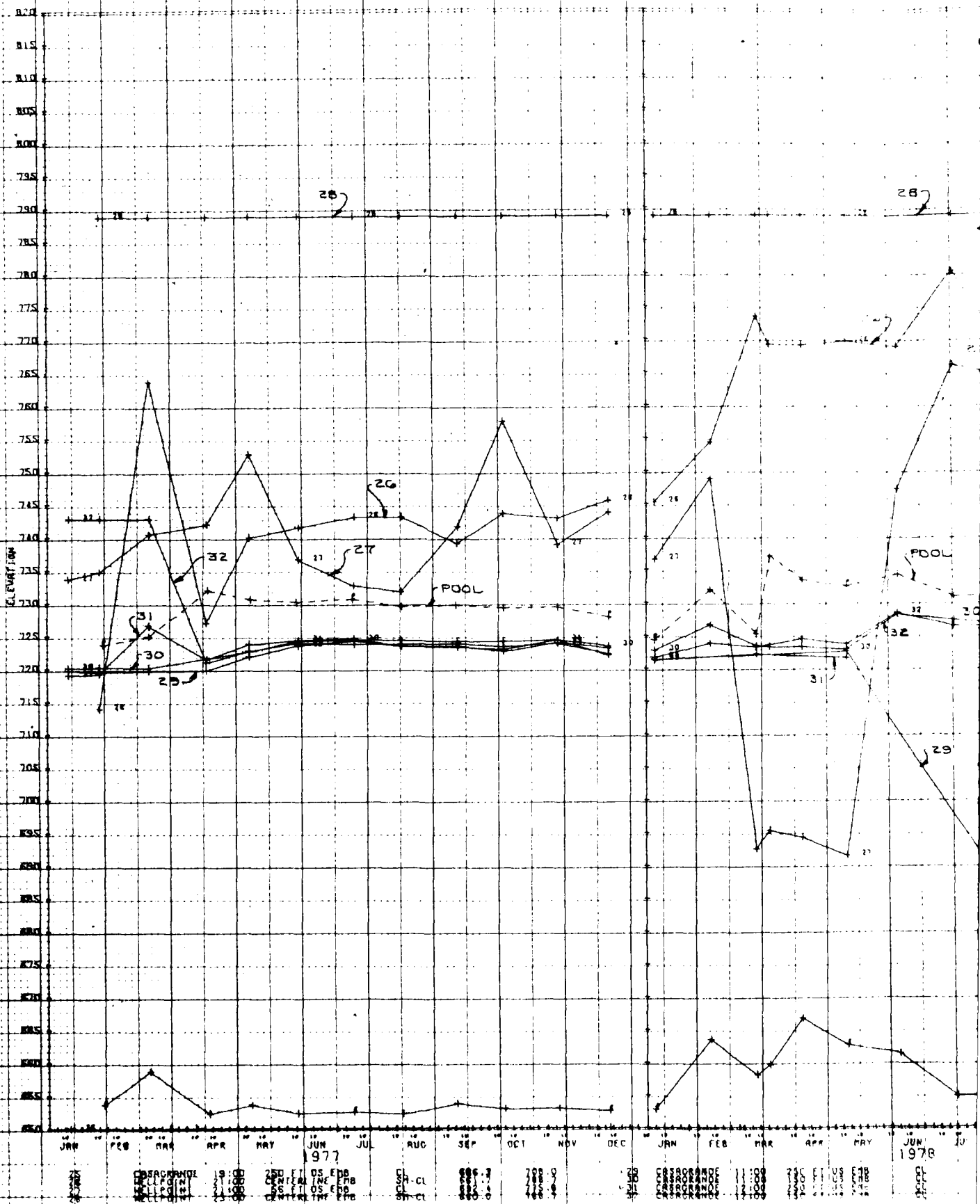
LAKE PIEZOMETERS 17-24

POCU

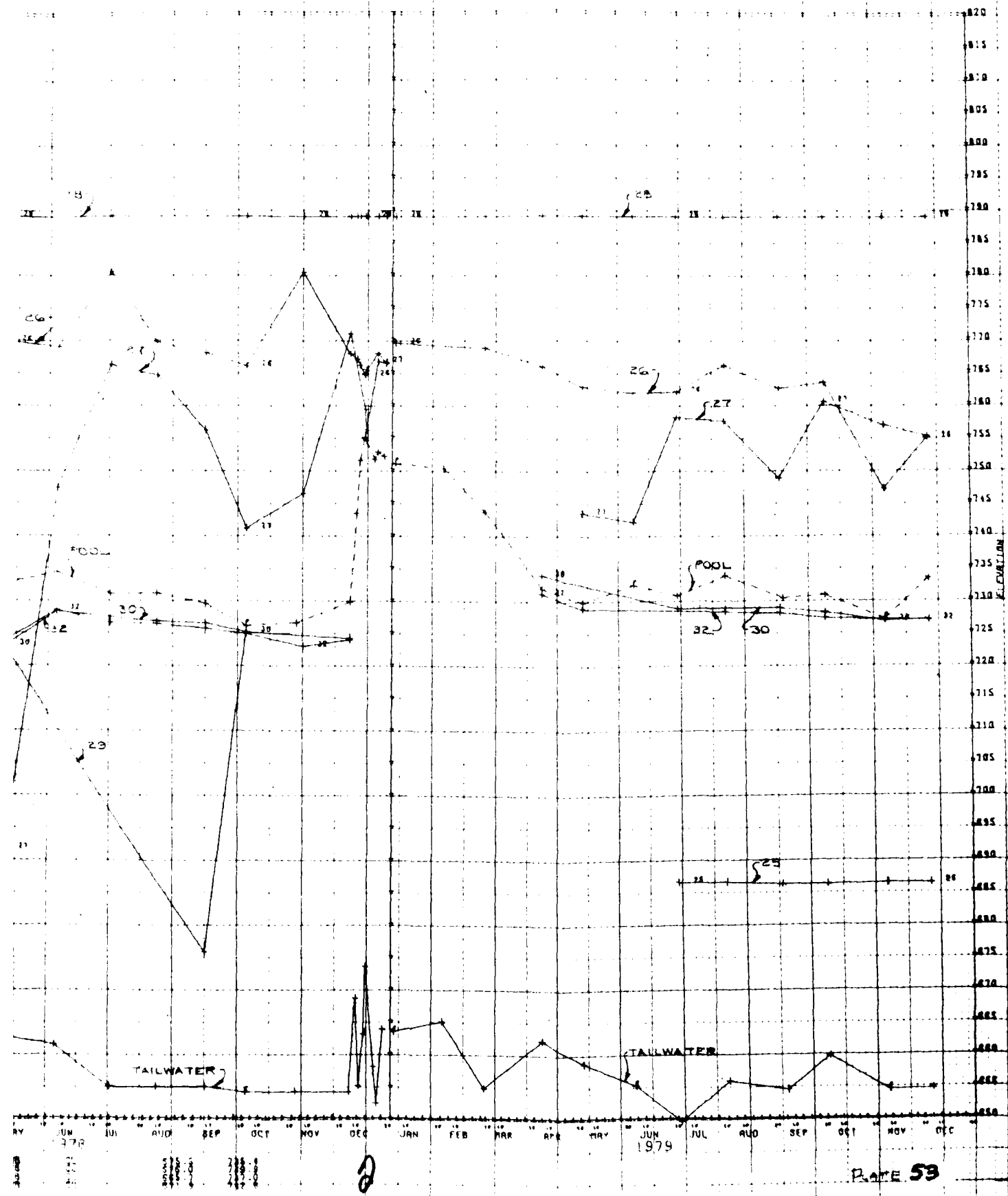
TAILWATER

2

Rate 52



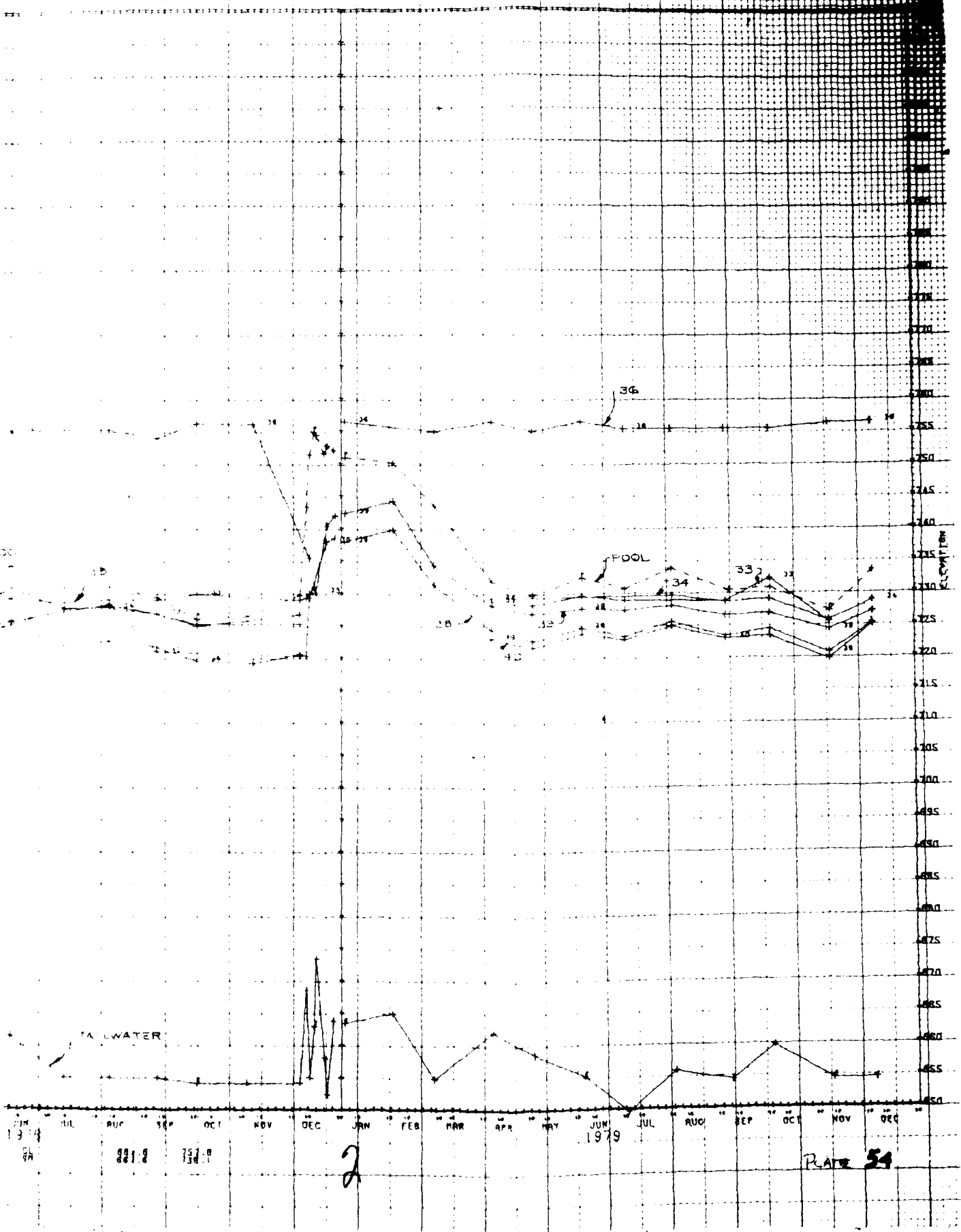
E. H. 100-115 25-32



This is a detailed cross-section profile of a river channel, likely for engineering or hydrological purposes. The vertical axis on the left represents elevation in feet, ranging from 650 to 870 in increments of 5 feet. The vertical axis on the right represents elevation in feet, ranging from 750 to 870 in increments of 5 feet. The horizontal axis represents the distance along the channel. The profile shows a main channel with a 'POOL' area and a 'TAILWATER' area. Various numbered points (30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40) are marked along the channel bed and water surface, indicating specific locations or measurements. The channel bed is marked with a dashed line, and the water surface is indicated by a solid line. The profile is plotted on a grid with horizontal and vertical lines.

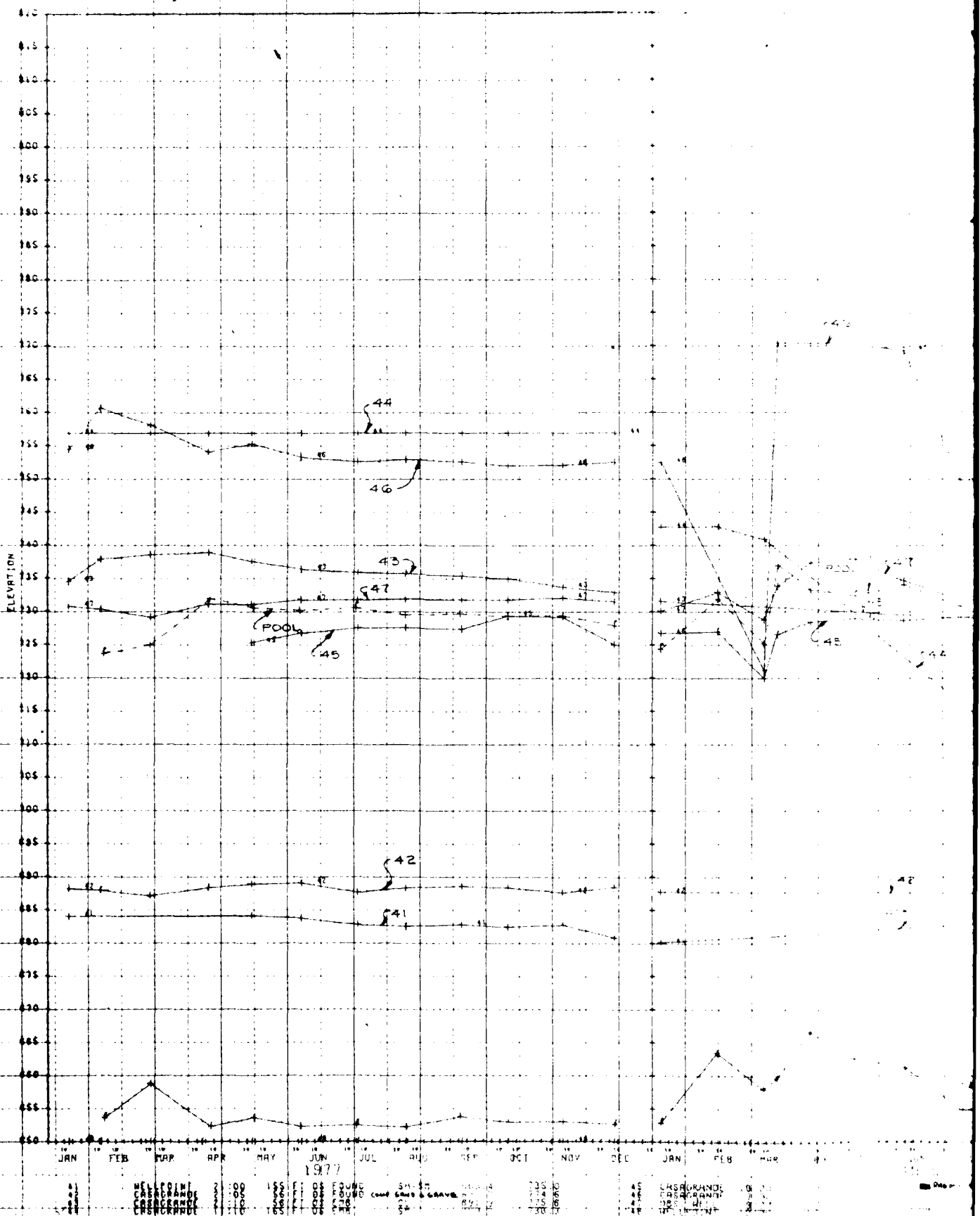
JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN		
1977																		1978	
23	ERASACRANDE	13:00	280	FT	US	FOUN		235	4		38	ERASACRANDE	13:00	280	FT	US	FOUN	31	
24	ERASACRANDE	13:00	280	FT	US	FOUN		235	4			ERASACRANDE	13:00	280	FT	US	FOUN	31	
25	ERASACRANDE	13:00	280	FT	US	FOUN		235	4			ERASACRANDE	13:00	280	FT	US	FOUN	31	

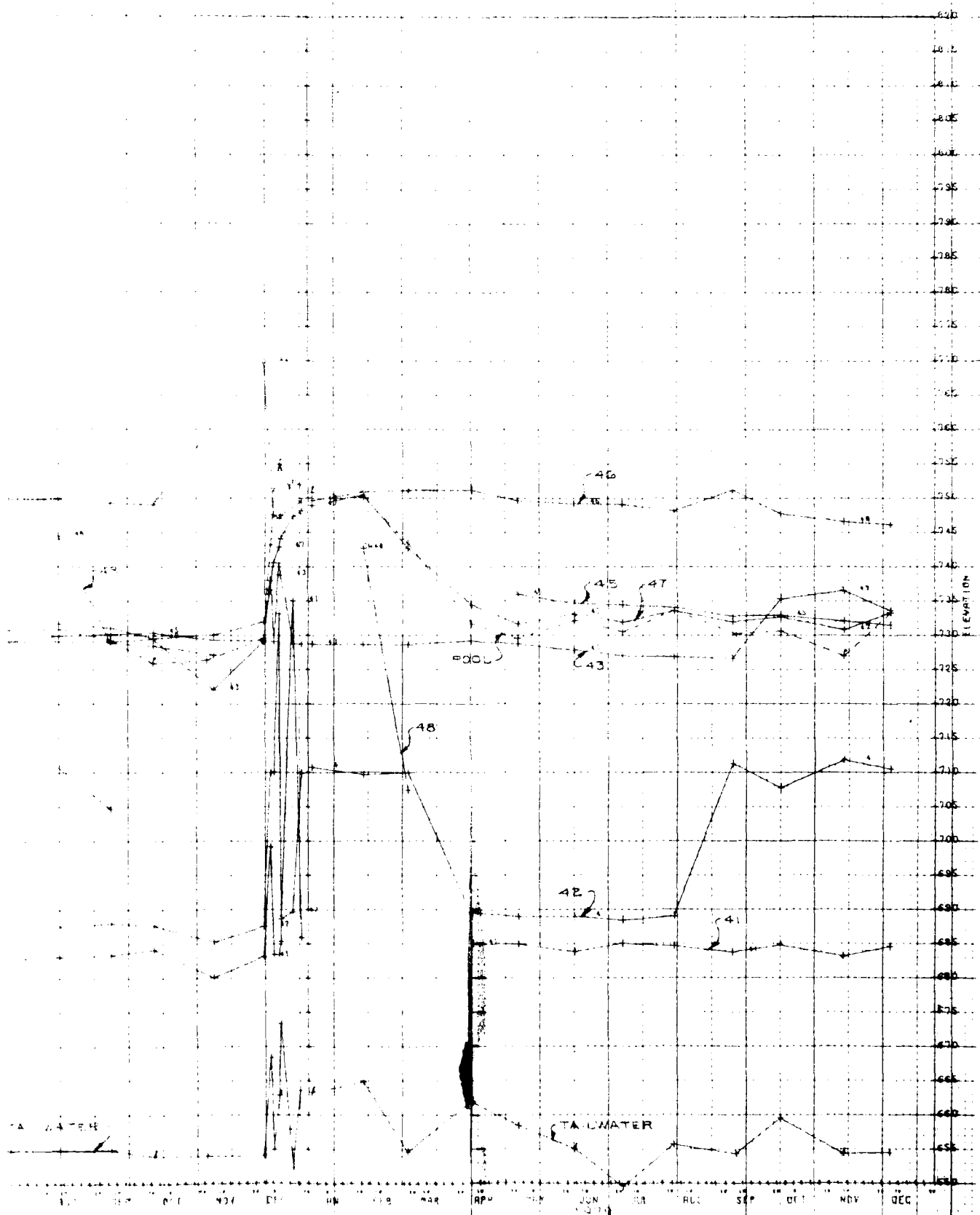
10-18-1979



2

PLATE 54





2

PLATE 55

UN LAKE FIELDS 49-56

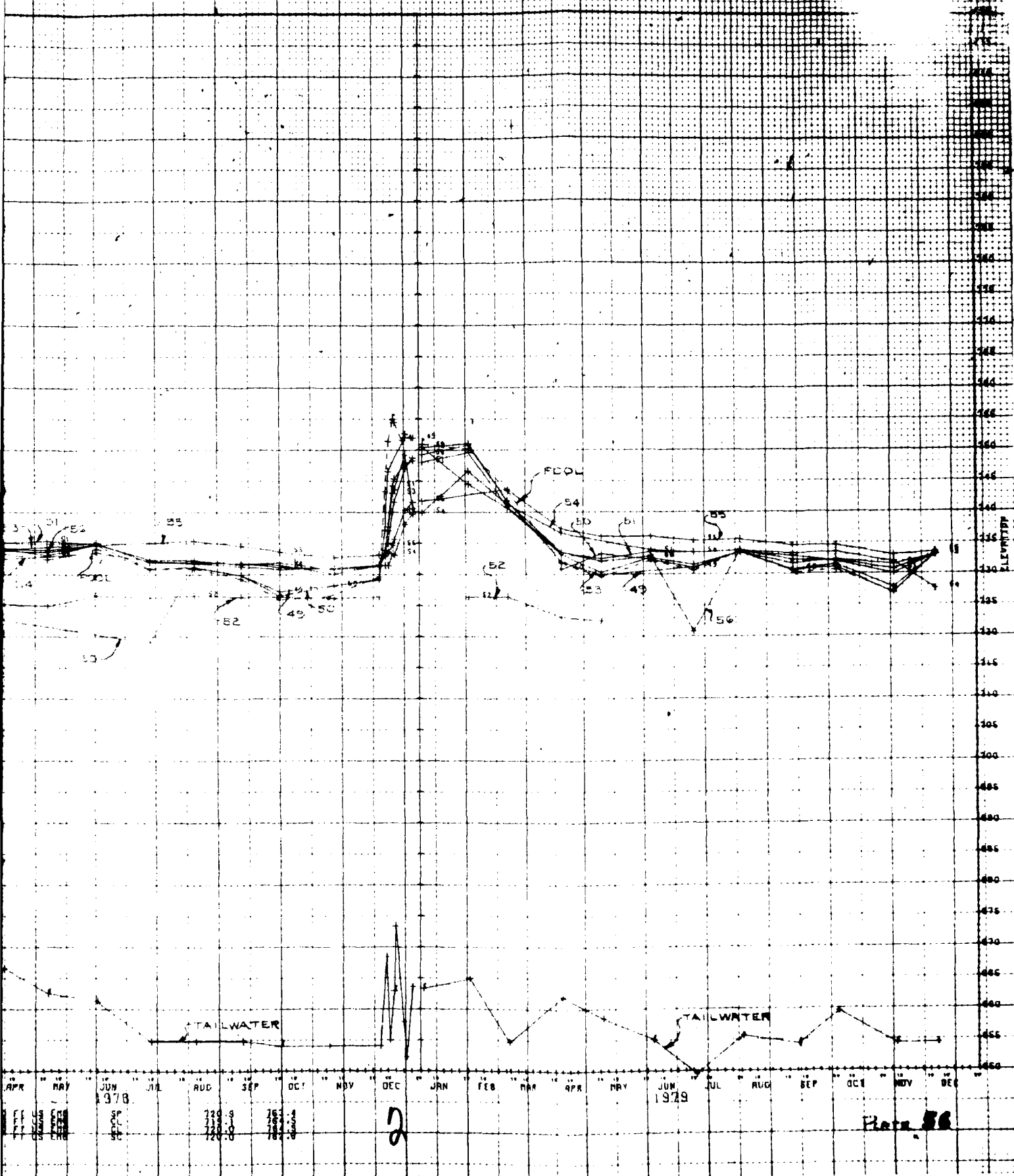
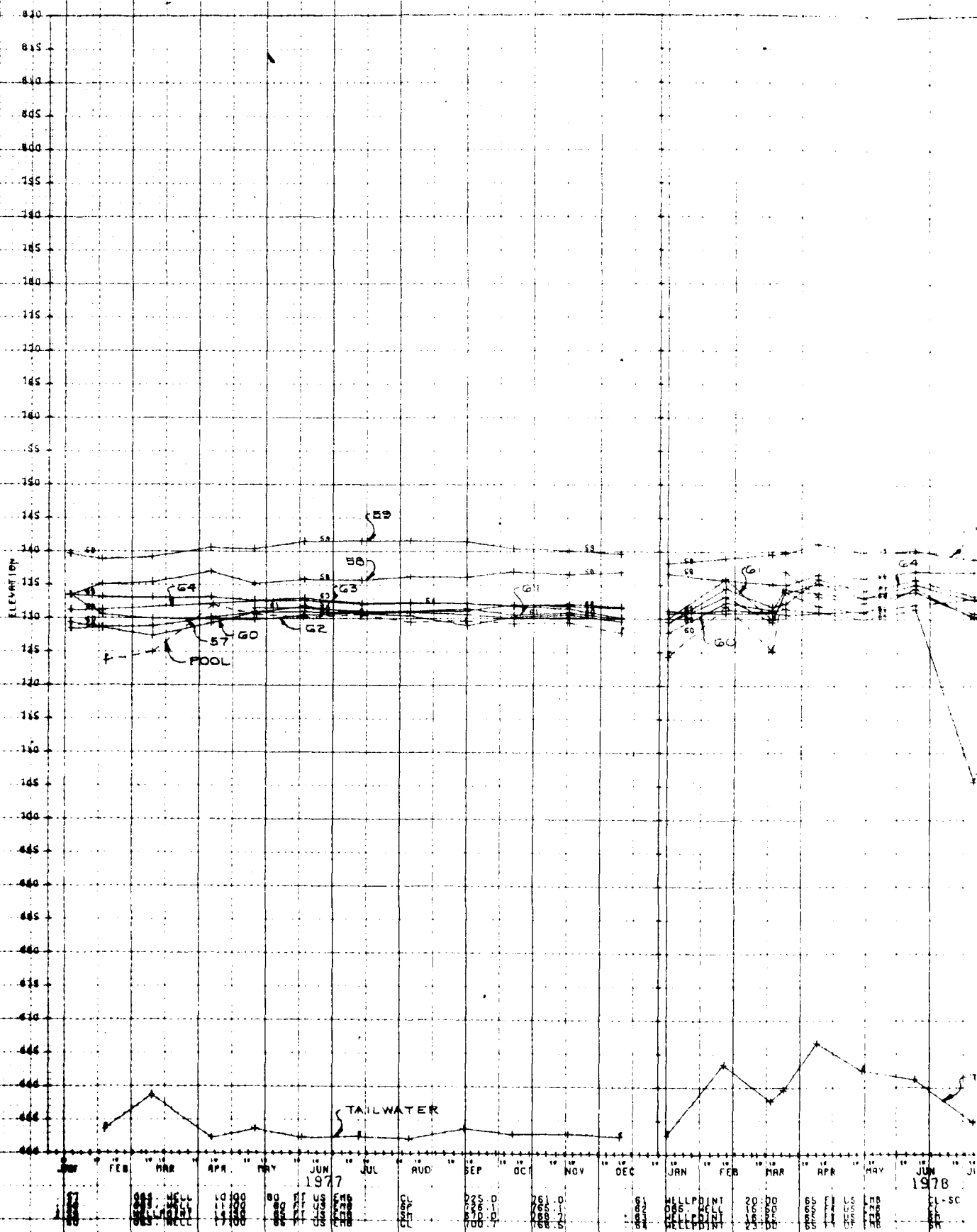
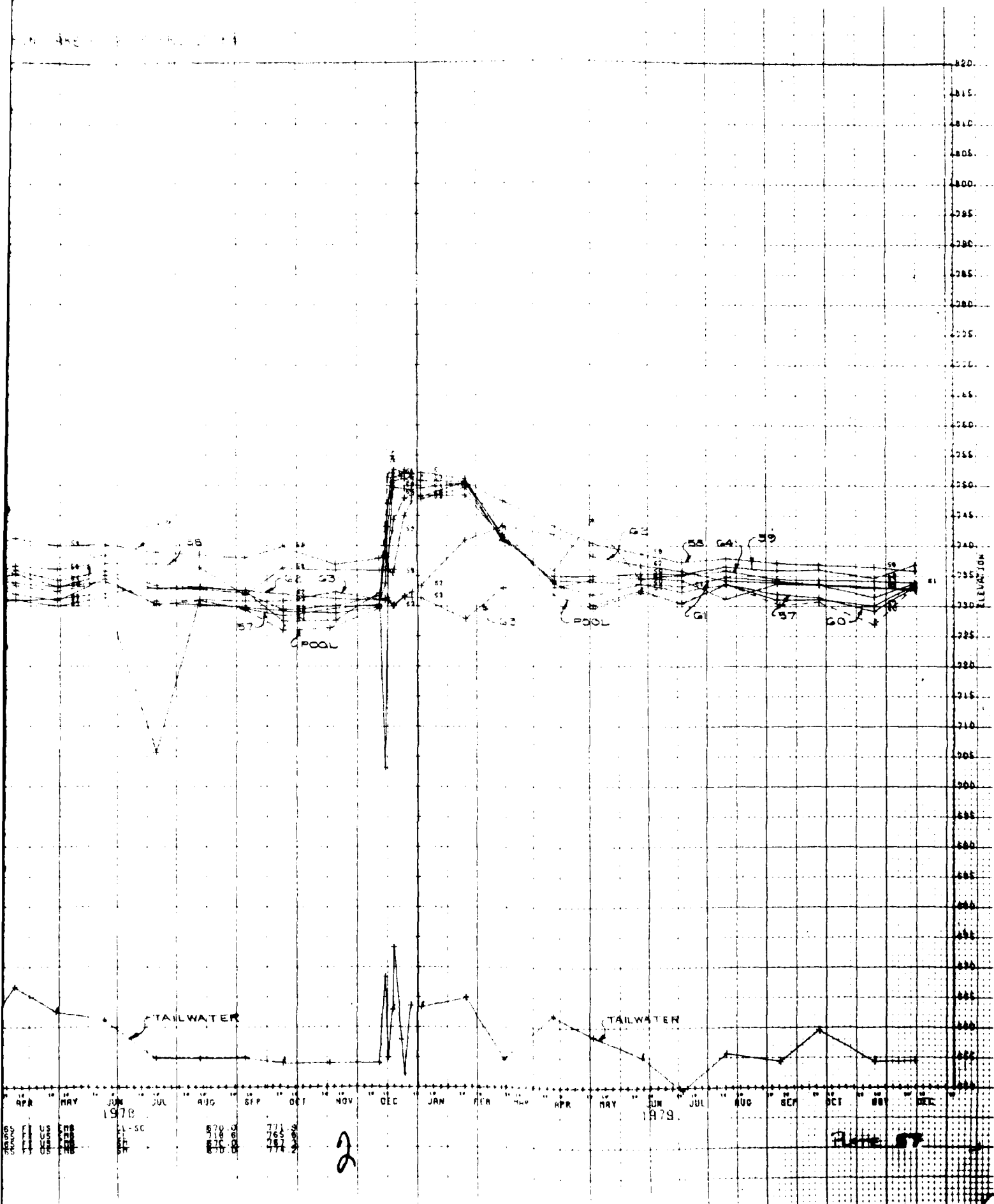


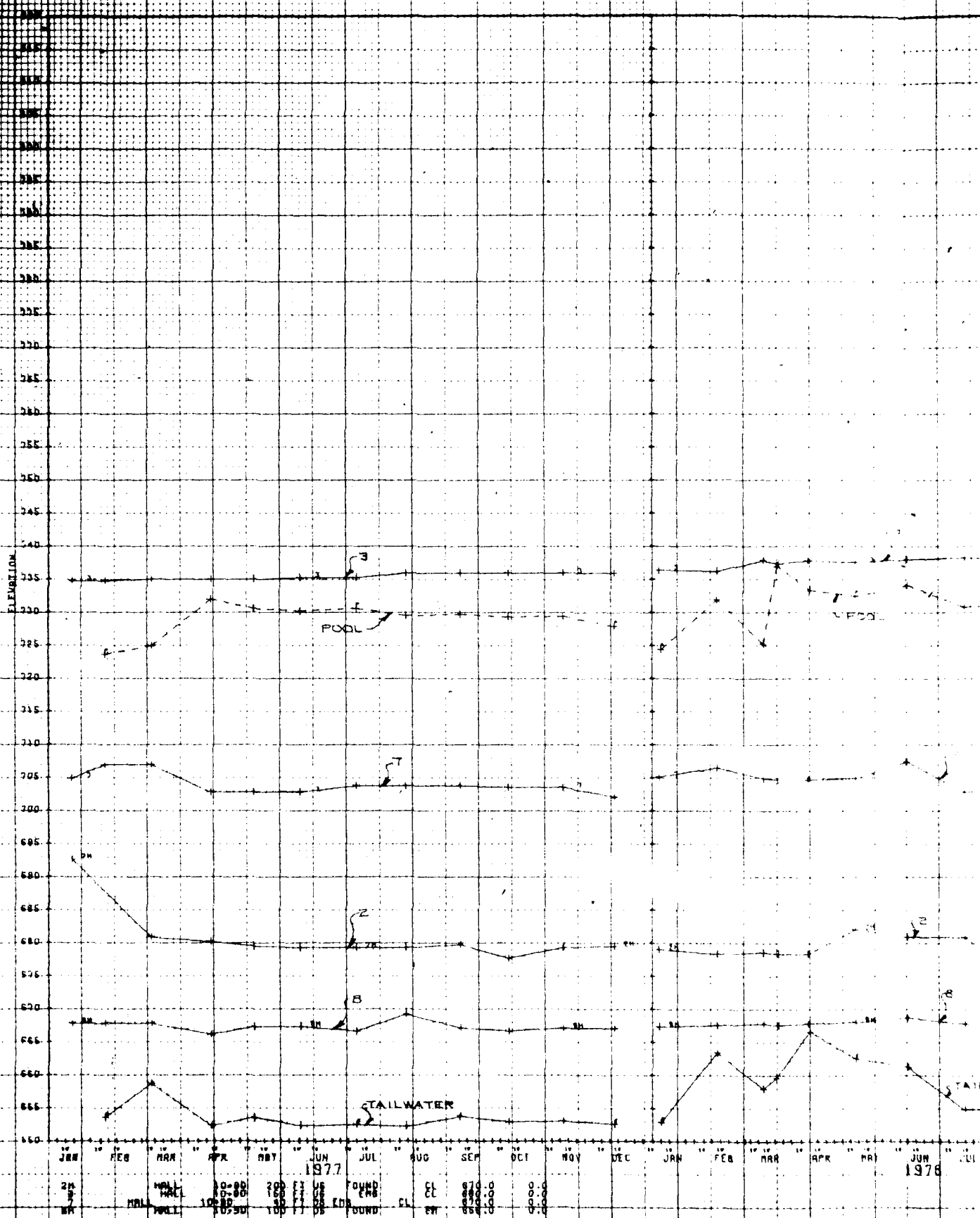
Plate 56





APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1978																				
CL-SC																				
570.0																				
518.0																				
570.0																				

PLATE 57



N LAKE HALL #216 1-8

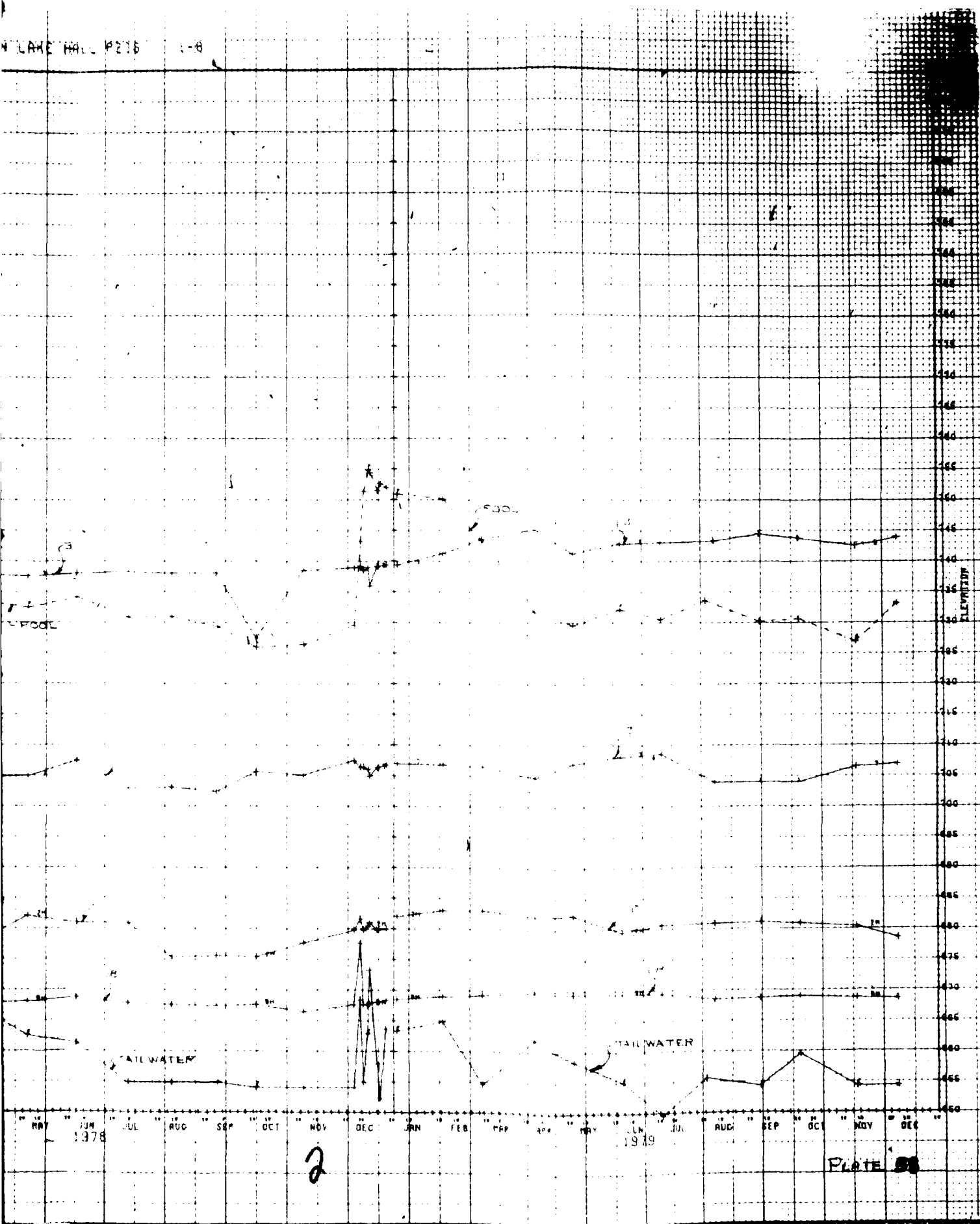
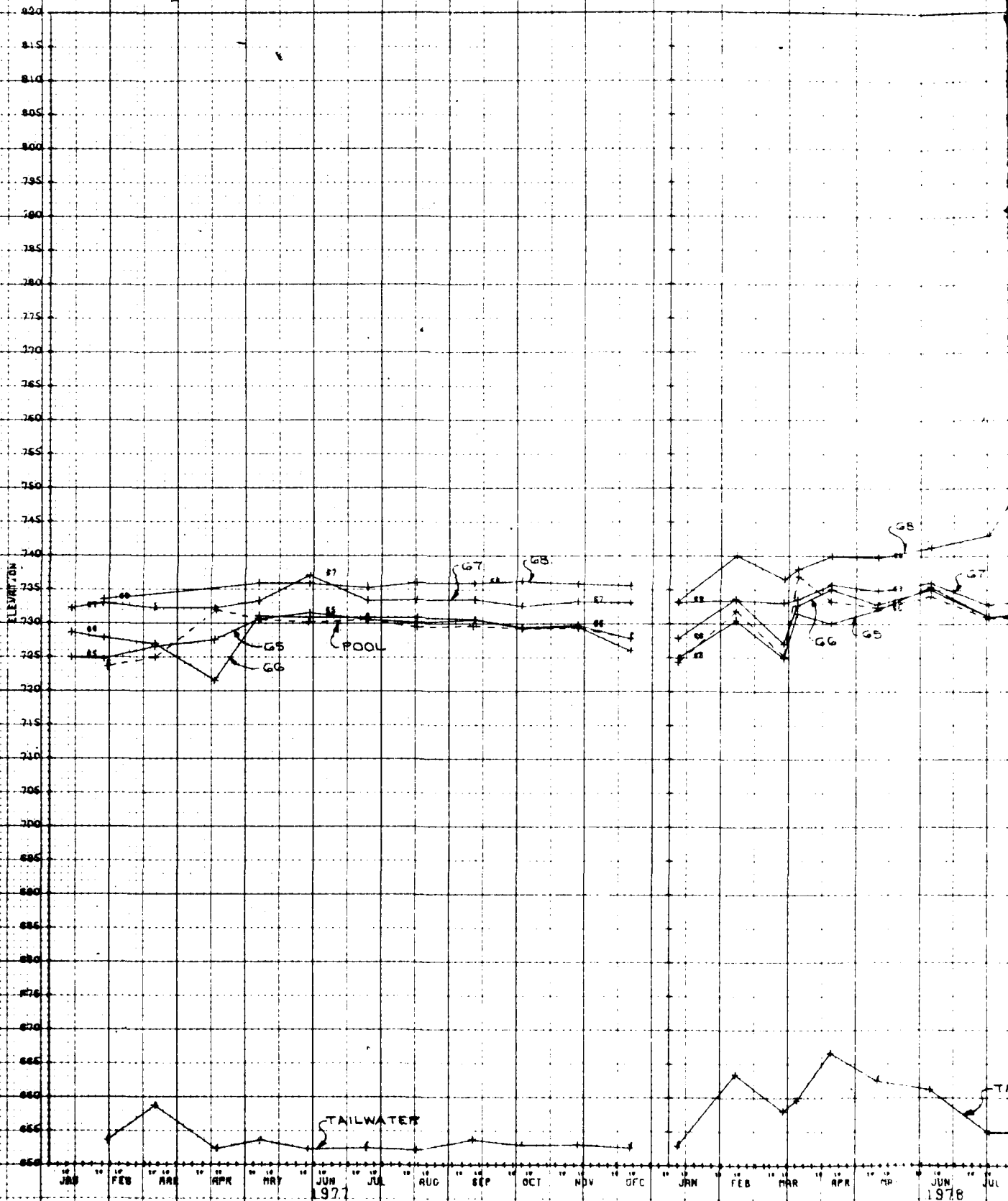


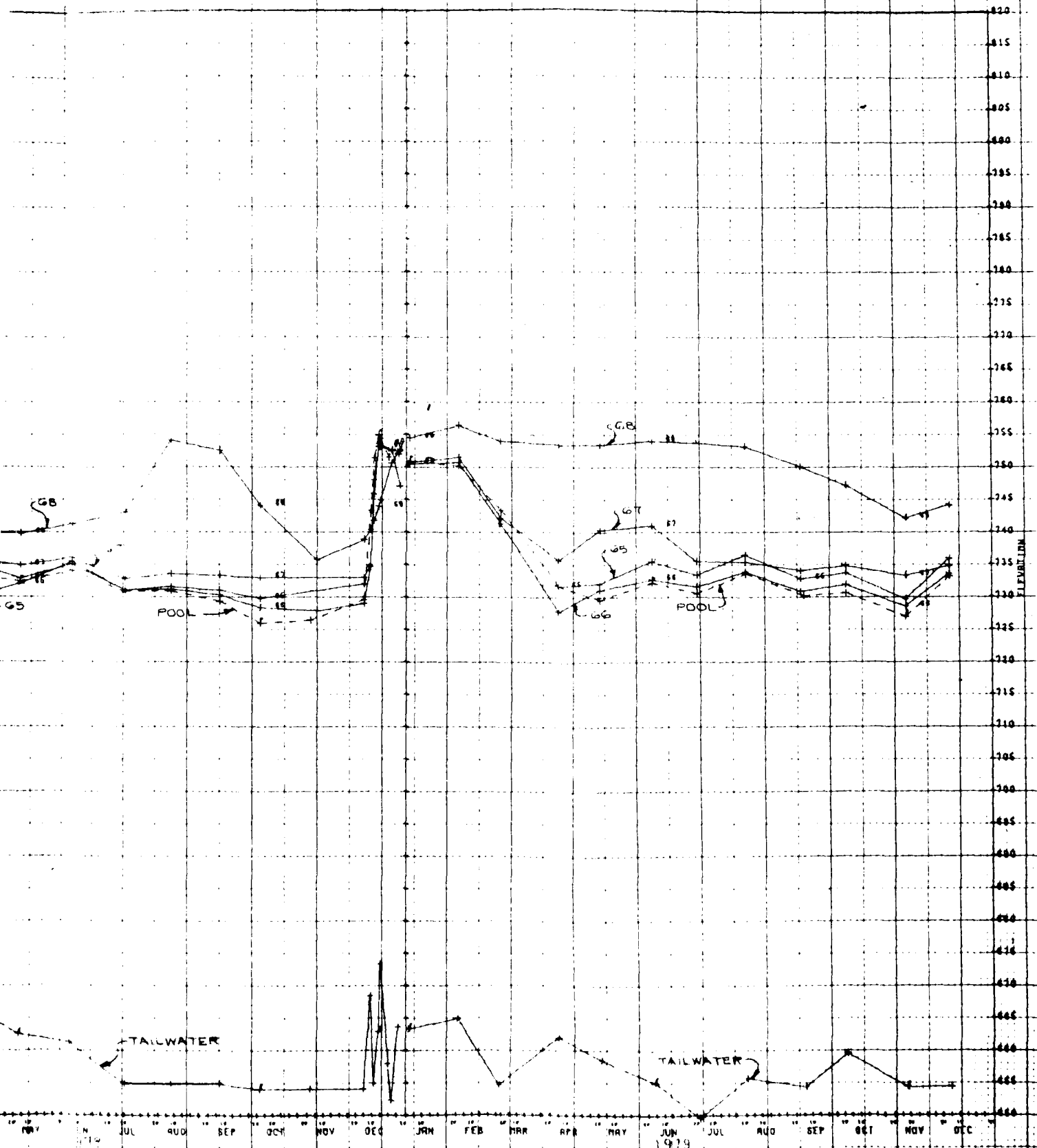
PLATE 58

CAVE RUN LAKE ELEVATION



DATE	GAUGE	ELEVATION (FEET)	REMARKS
JAN 1977	G5	725.0	
FEB 1977	G5	728.0	
MAR 1977	G5	725.0	
APR 1977	G5	722.0	
MAY 1977	G5	728.0	
JUN 1977	G5	732.0	
JUL 1977	G5	730.0	
AUG 1977	G5	730.0	
SEP 1977	G5	730.0	
OCT 1977	G5	728.0	
NOV 1977	G5	728.0	
DEC 1977	G5	728.0	
JAN 1978	G5	725.0	
FEB 1978	G5	730.0	
MAR 1978	G5	725.0	
APR 1978	G5	735.0	
MAY 1978	G5	732.0	
JUN 1978	G5	735.0	
JUL 1978	G5	730.0	

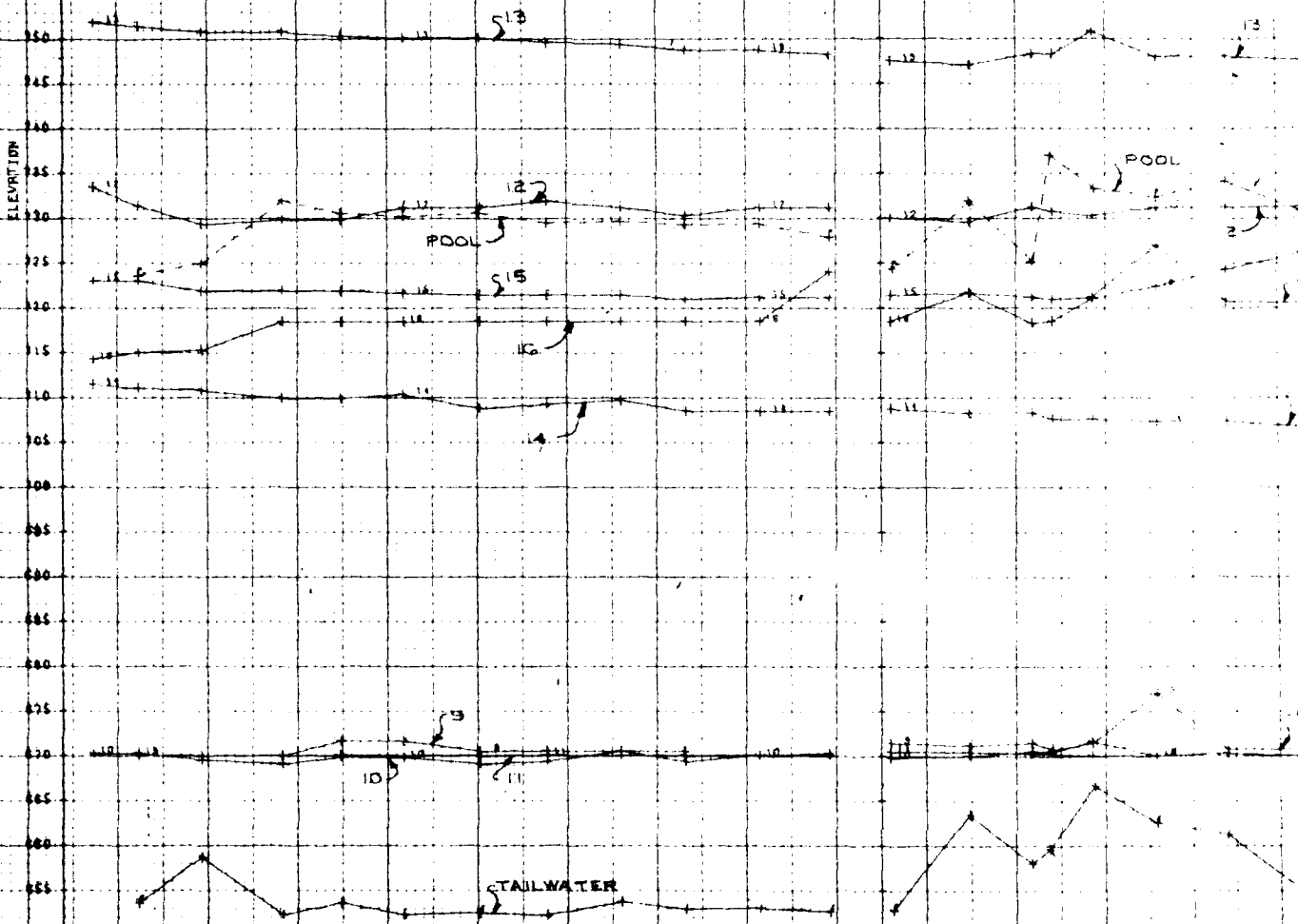
LAKE A ELEVATION DATA



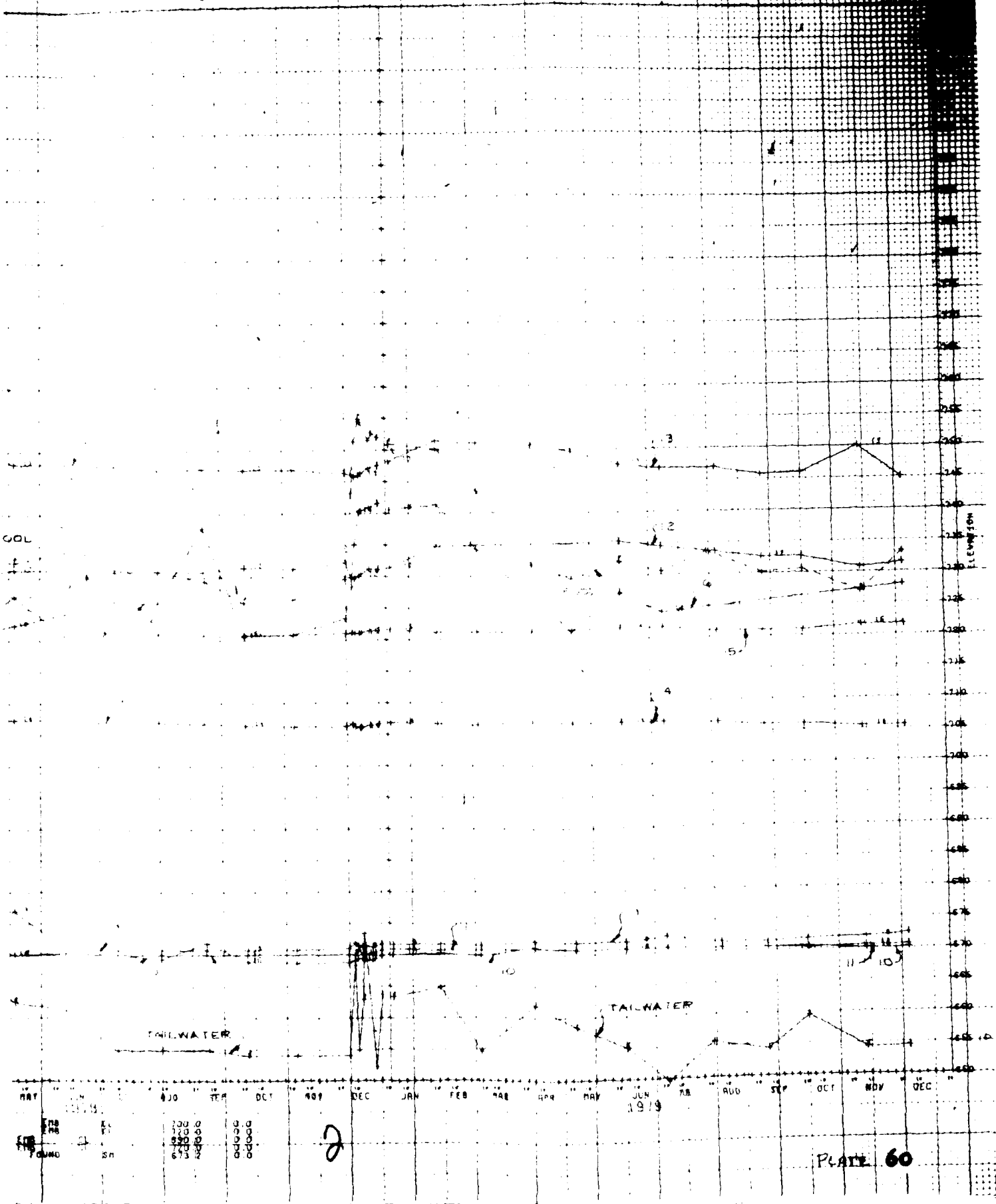
2

PLATE 59

ELEVATION

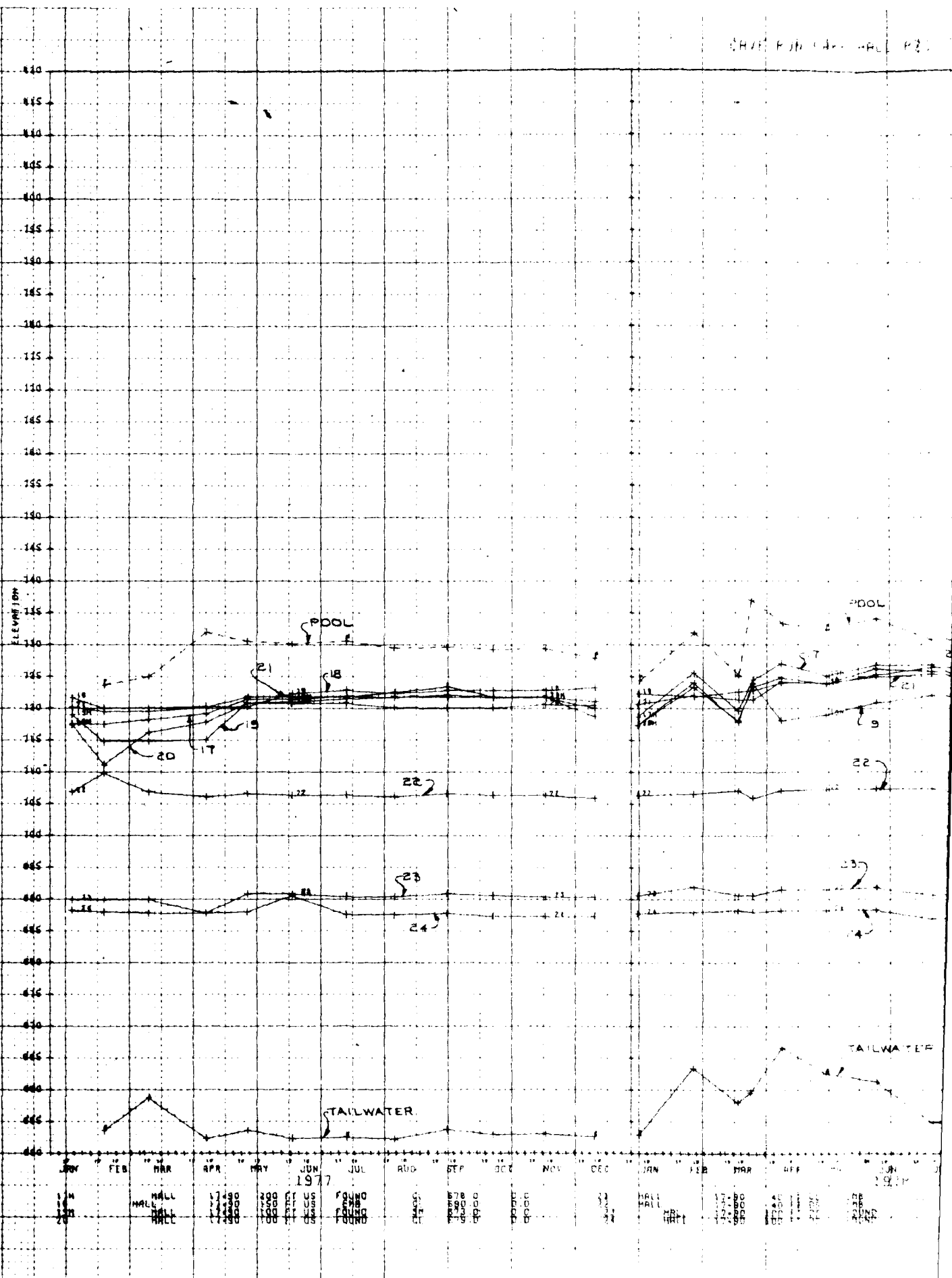
[illegible]

LAKE HAP.



CHIEF P. 10 (4) - R. 10 (2)

ELEVATION



DATE	16	17	18	19	20	21	22	23	24	TAILWATER
JAN 1977	1380	1375	1370	1365	1360	1355	1350	1345	1340	1335
FEB	1380	1375	1370	1365	1360	1355	1350	1345	1340	1335
MAR	1380	1375	1370	1365	1360	1355	1350	1345	1340	1335
APR	1380	1375	1370	1365	1360	1355	1350	1345	1340	1335
MAY	1380	1375	1370	1365	1360	1355	1350	1345	1340	1335
JUN 1977	1380	1375	1370	1365	1360	1355	1350	1345	1340	1335
JUL	1380	1375	1370	1365	1360	1355	1350	1345	1340	1335
AUG	1380	1375	1370	1365	1360	1355	1350	1345	1340	1335
SEP	1380	1375	1370	1365	1360	1355	1350	1345	1340	1335
OCT	1380	1375	1370	1365	1360	1355	1350	1345	1340	1335
NOV	1380	1375	1370	1365	1360	1355	1350	1345	1340	1335
DEC	1380	1375	1370	1365	1360	1355	1350	1345	1340	1335
JAN 1978	1380	1375	1370	1365	1360	1355	1350	1345	1340	1335

IN 1961 11 24

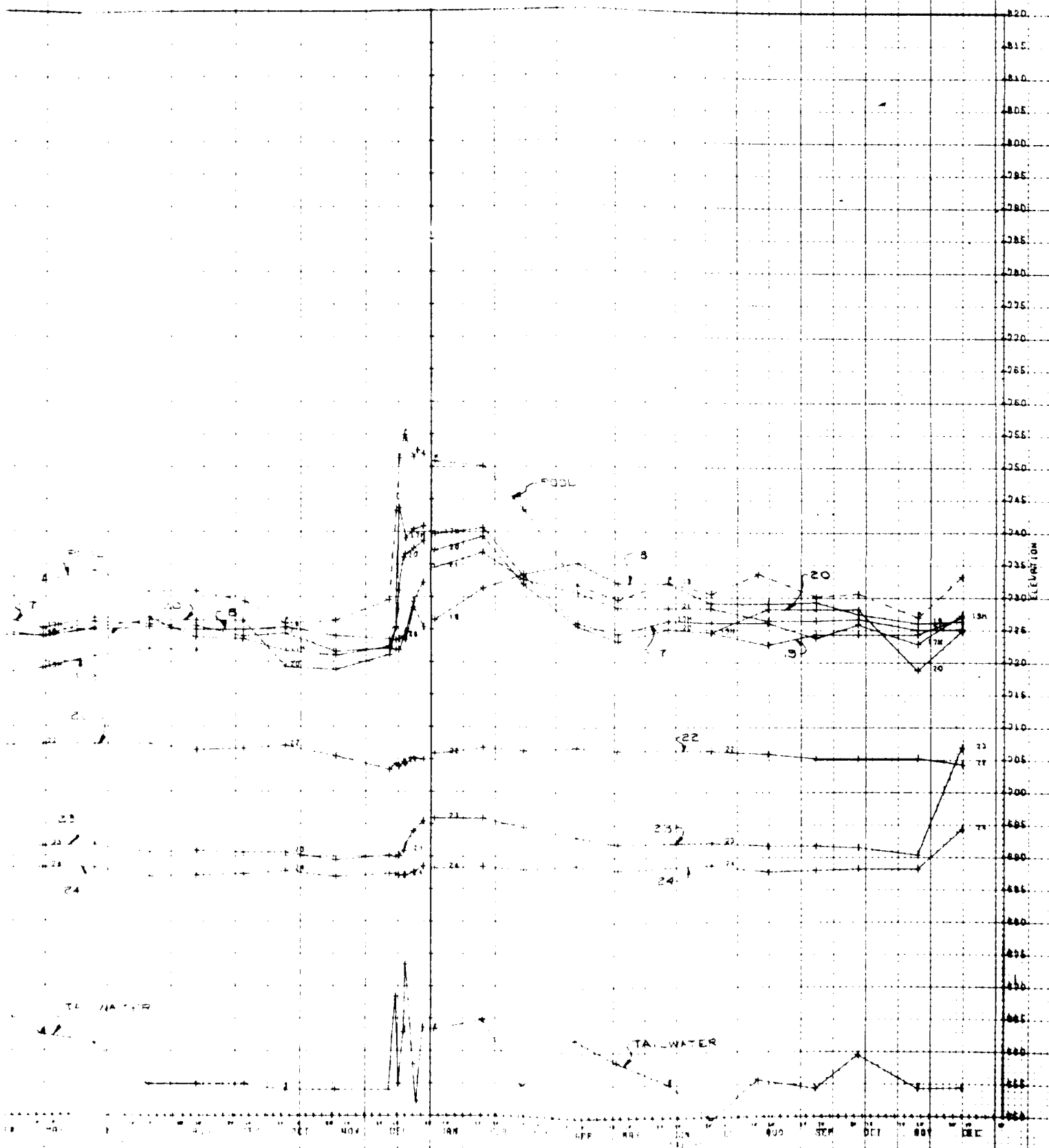
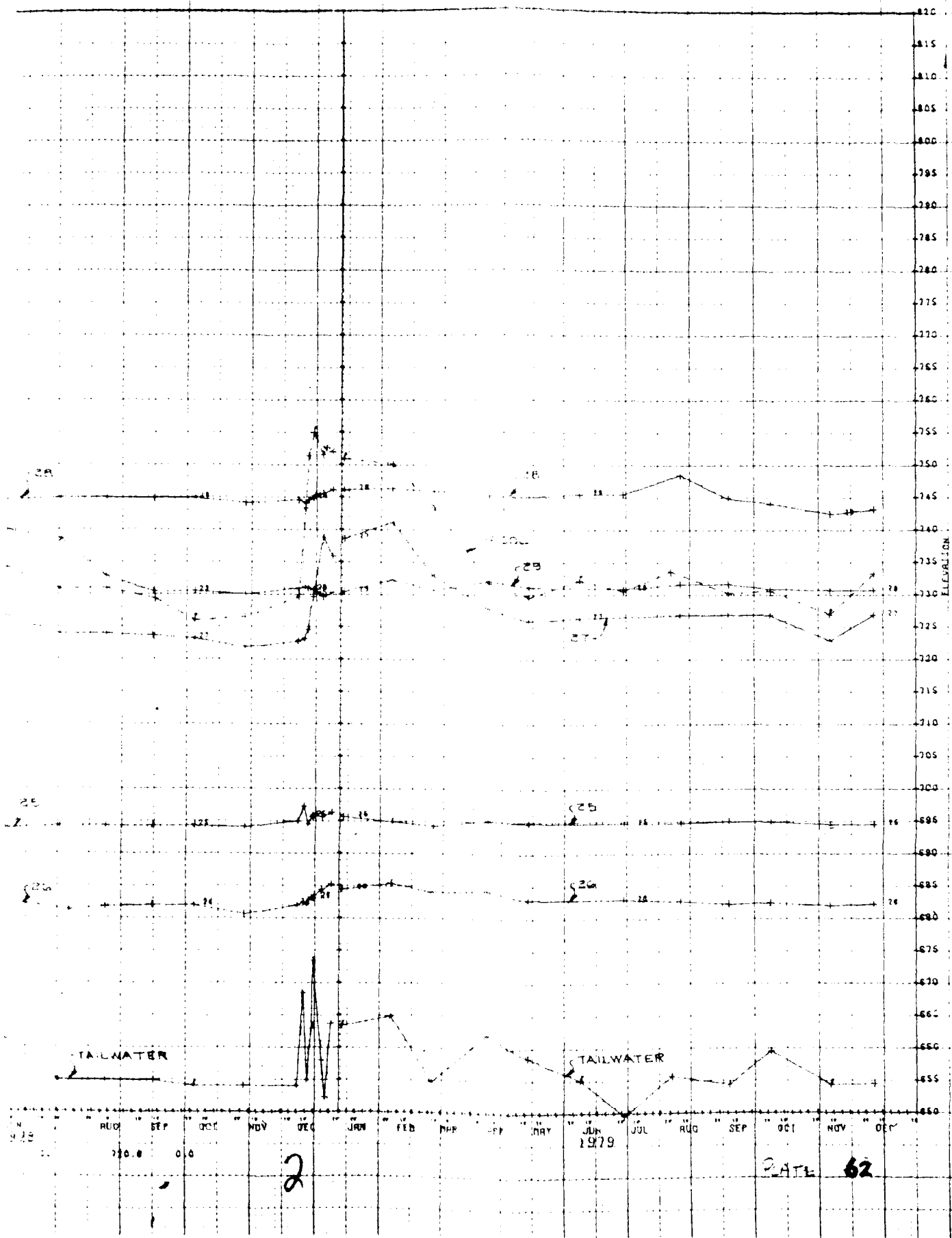


FIG. 2
ELEVATION
IN 1961

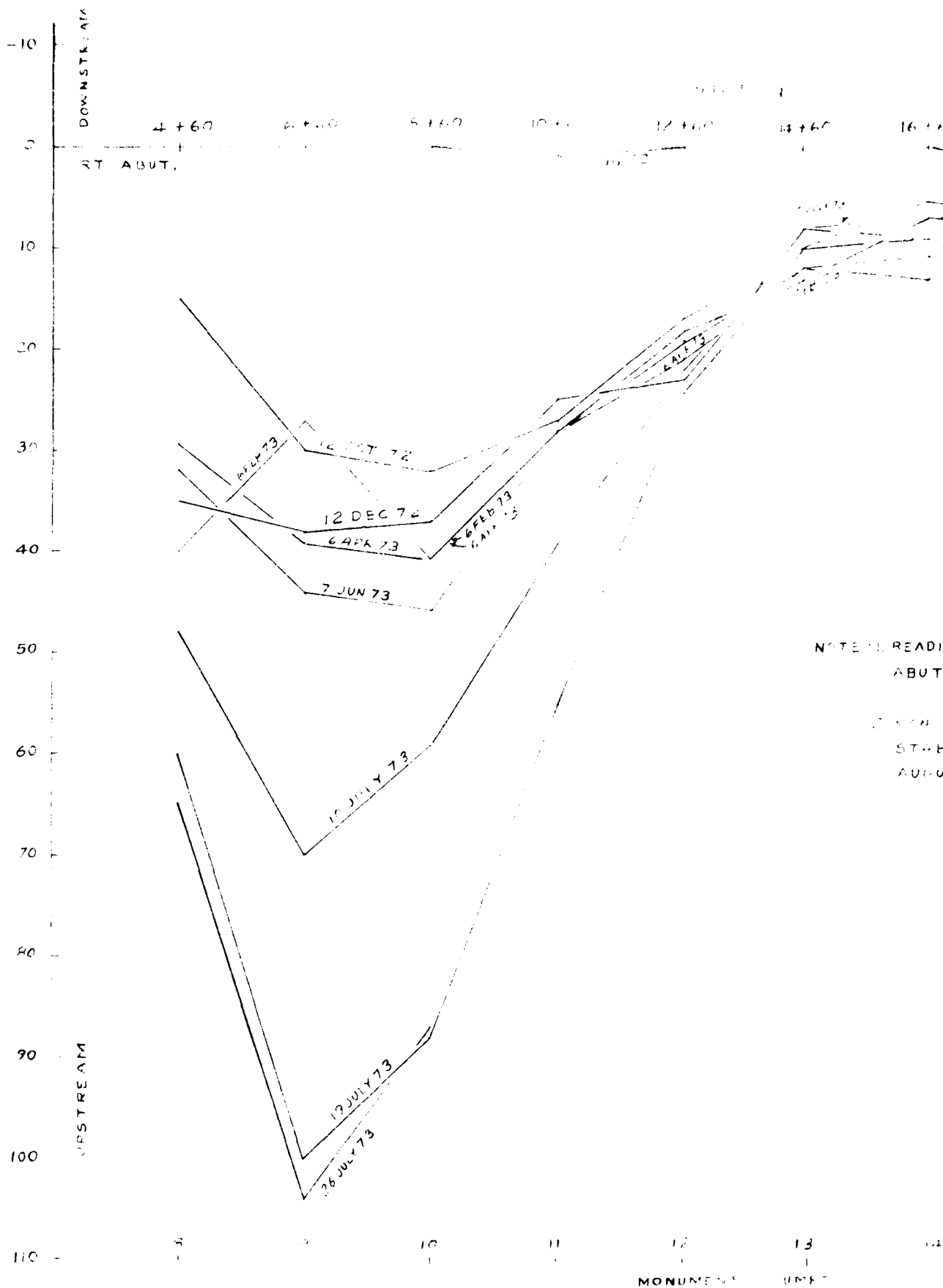
2

PLATE 61

100-25



HORIZONTAL CUMULATIVE MOVEMENT
(HUNDREDS OF A FOOT)



16 FEB 72 18 AUG 72 20 FEB 73 20 FEB 73

5 AUG 72

12 OCT 72

12 DEC 72

6 APR 73

FEB 73

26 JUL 73

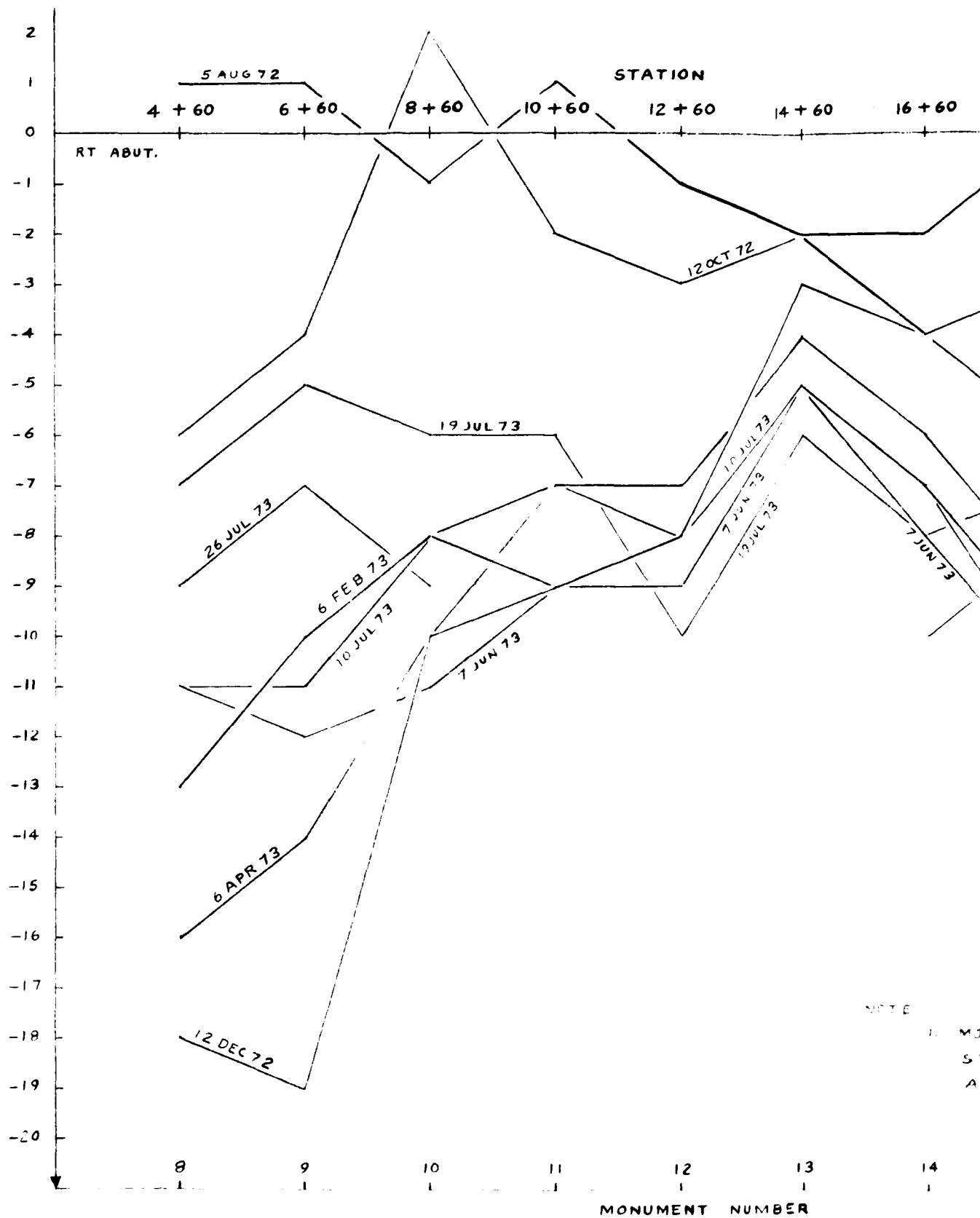
10 FEB 73

1 APR 73

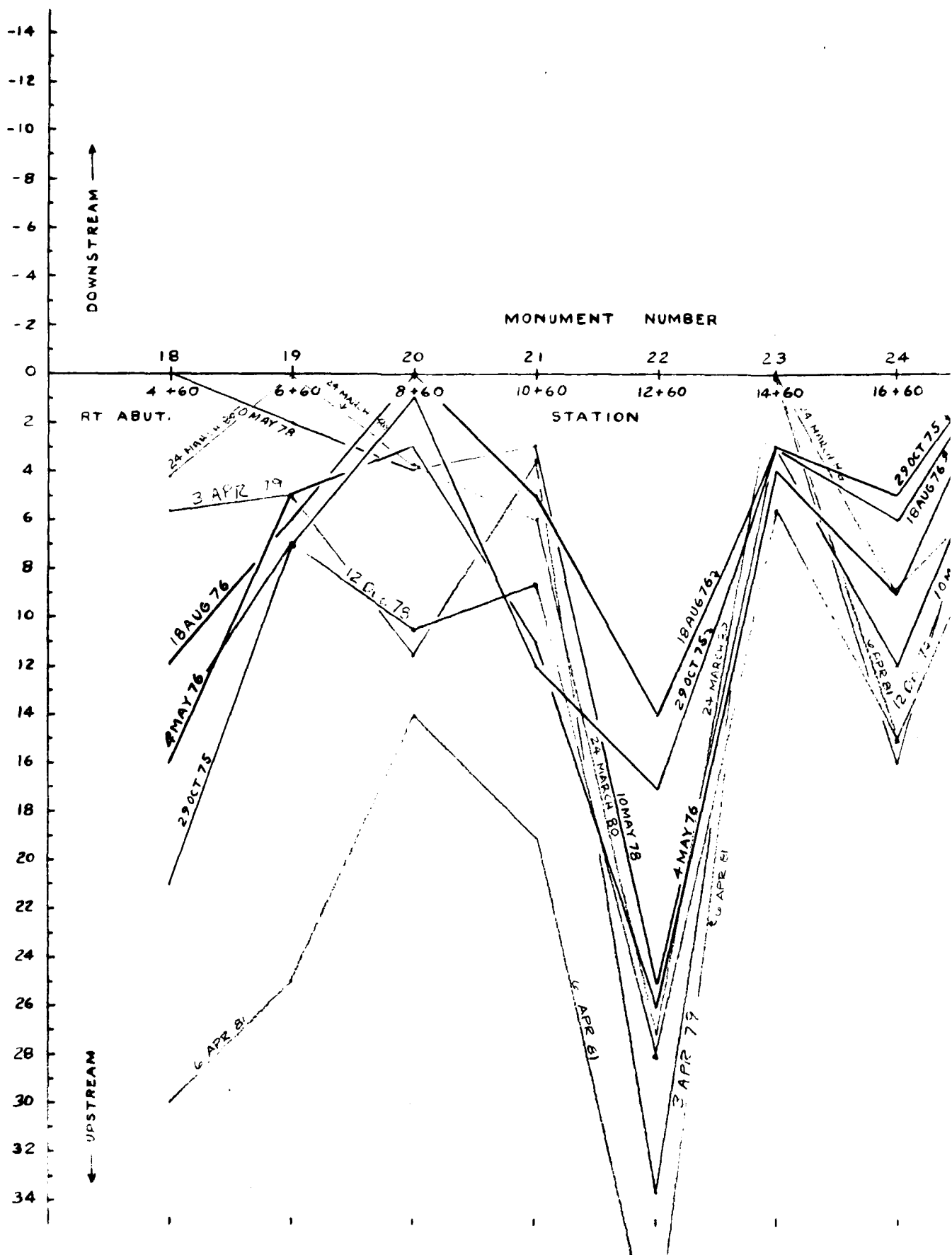
CONFIDENTIAL COVERED BY
STABILITY PERM SINCE
AUGUST 1973

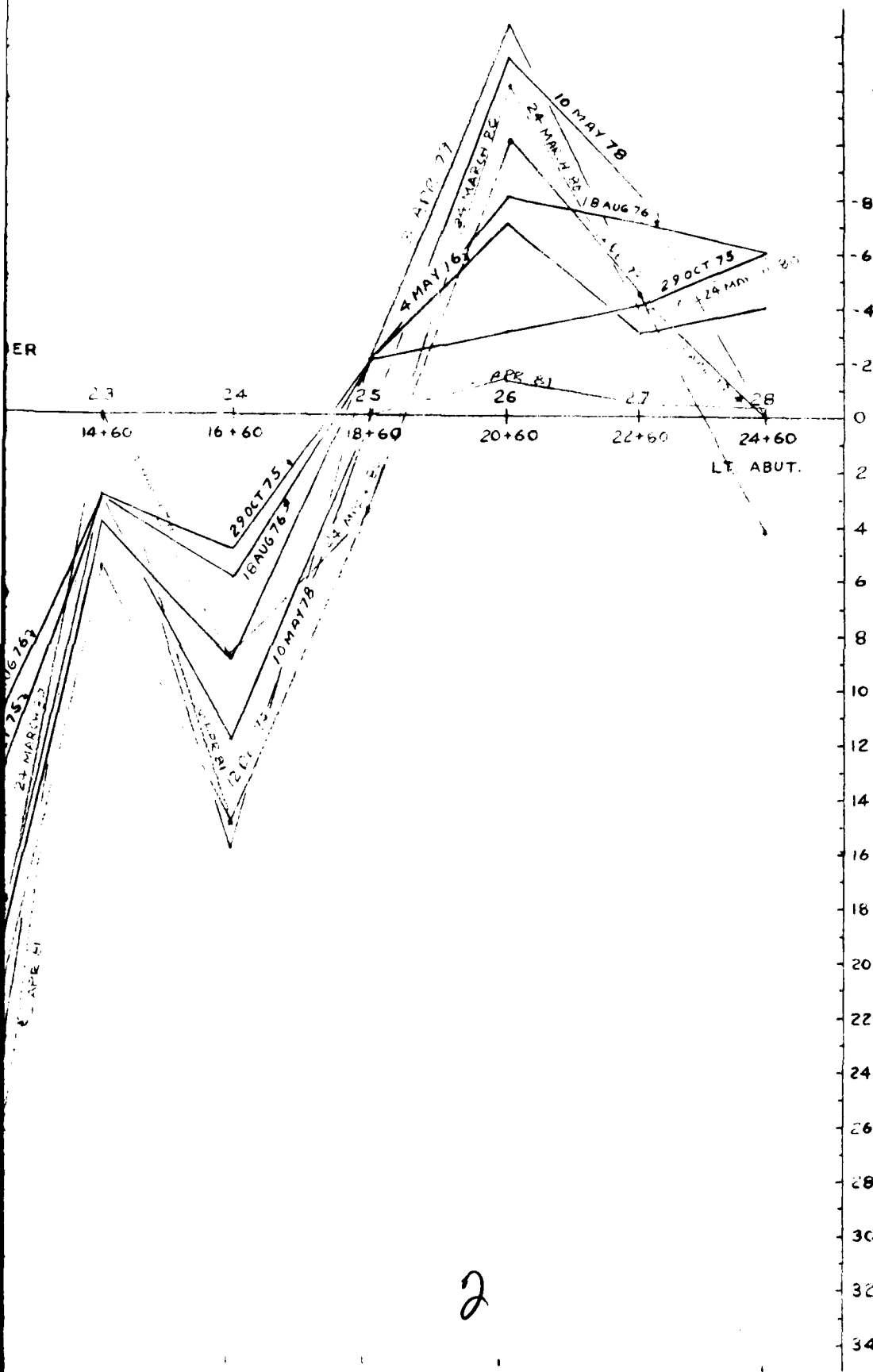
2

VERTICAL CUMULATIVE MOVEMENT
(HUNDREDS OF A FOOT)



HORIZONTAL CUMULATIVE MOVEMENT
(HUNDREDS OF A FOOT)





ALL MEASUREMENTS
TAKEN FROM LEFT
TO RIGHT ABUTMENT

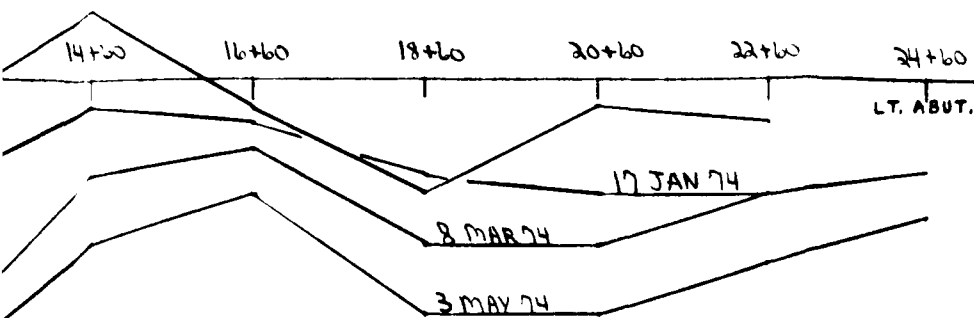
CAVE RUN LAKE
MOVEMENT MONUMENTS
85' UPSTREAM &
ROW 2
HORIZONTAL MOVEMENT

APPENDIX V PLATE 65

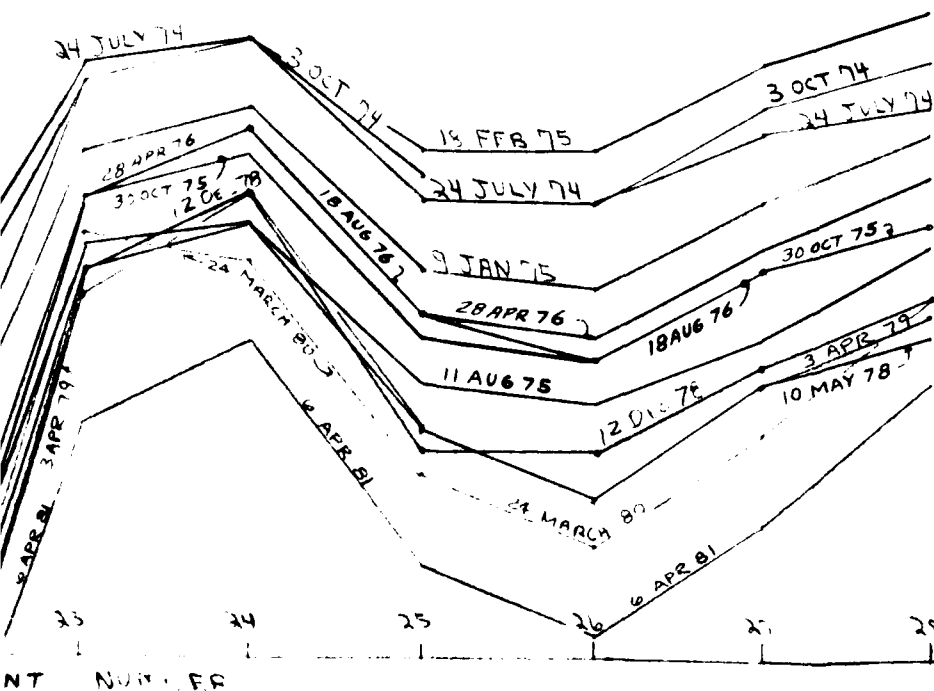
MONUMENT

NUM. FR.

STATION



INITIAL READING	
MON. NO.	ELEV.
18	761.28
19	761.63
20	760.80
21	760.24
22	761.80
23	761.02
24	761.02
25	760.40
26	760.37
27	760.68
28	762.15

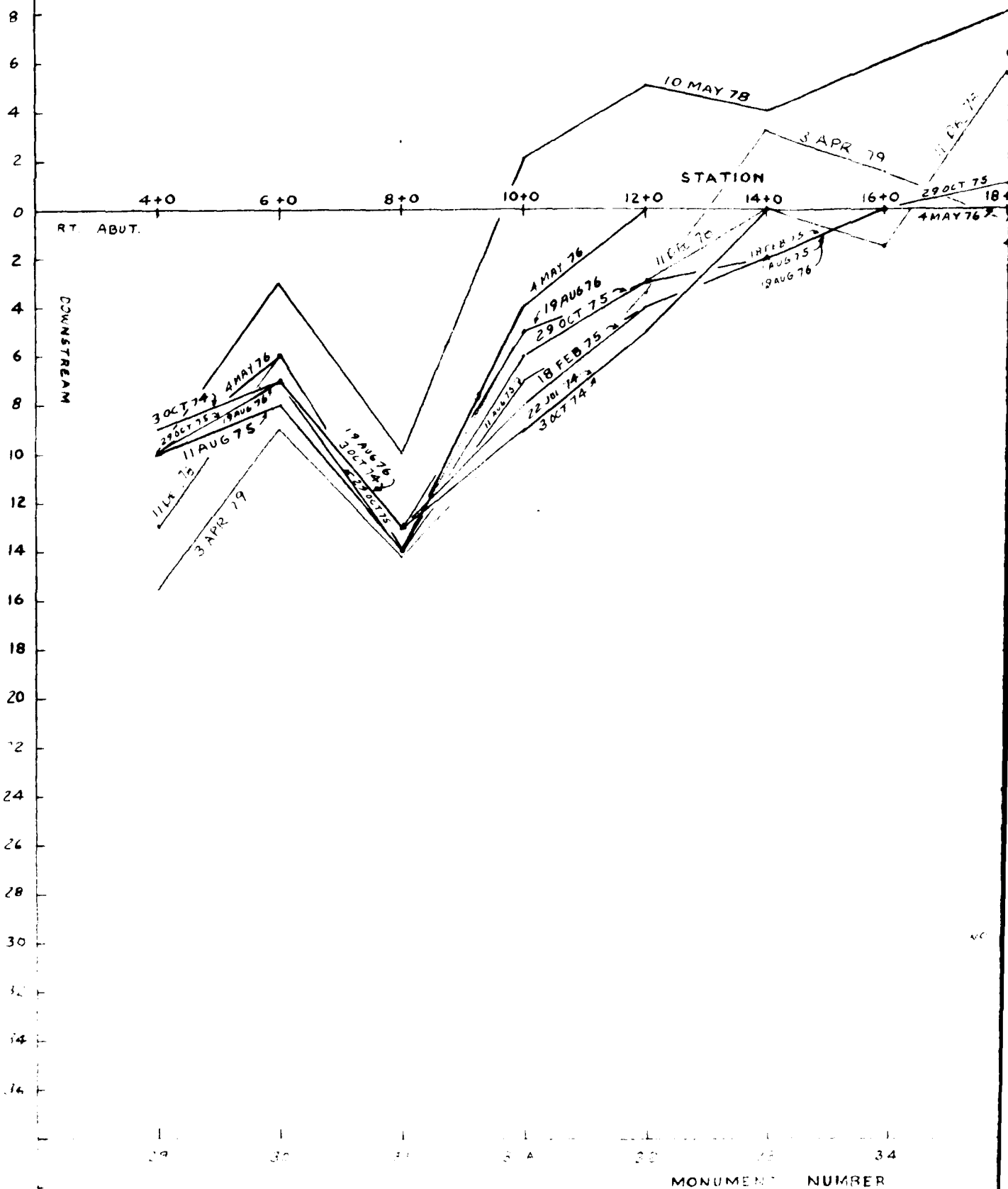


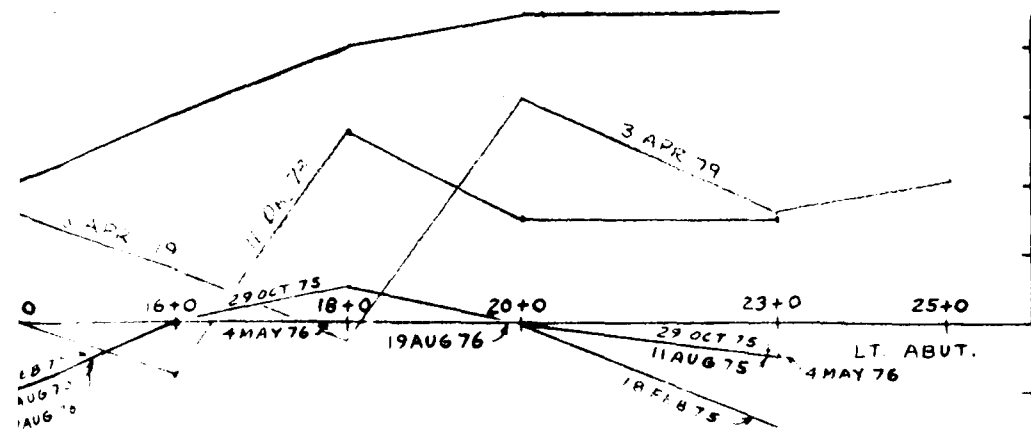
CAVE RUN LAKE
MOVEMENT MONUMENTS
85' DIAMETER &
ROW 2
VERTICAL MOVEMENT

2

APPENDIX V PLATE 66

HORIZONTAL MOVEMENT
(HUNDREDS OF A FOOT)



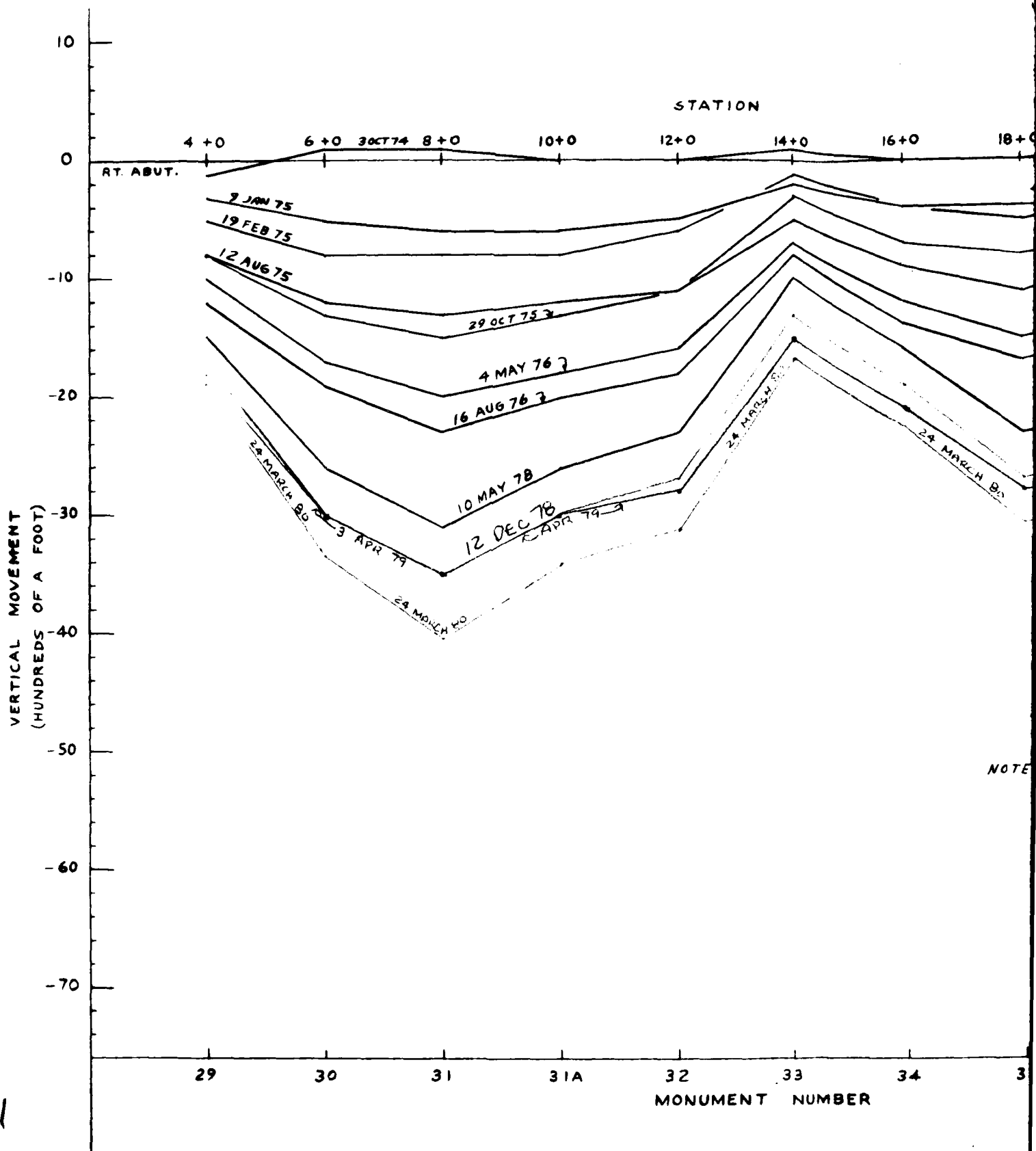


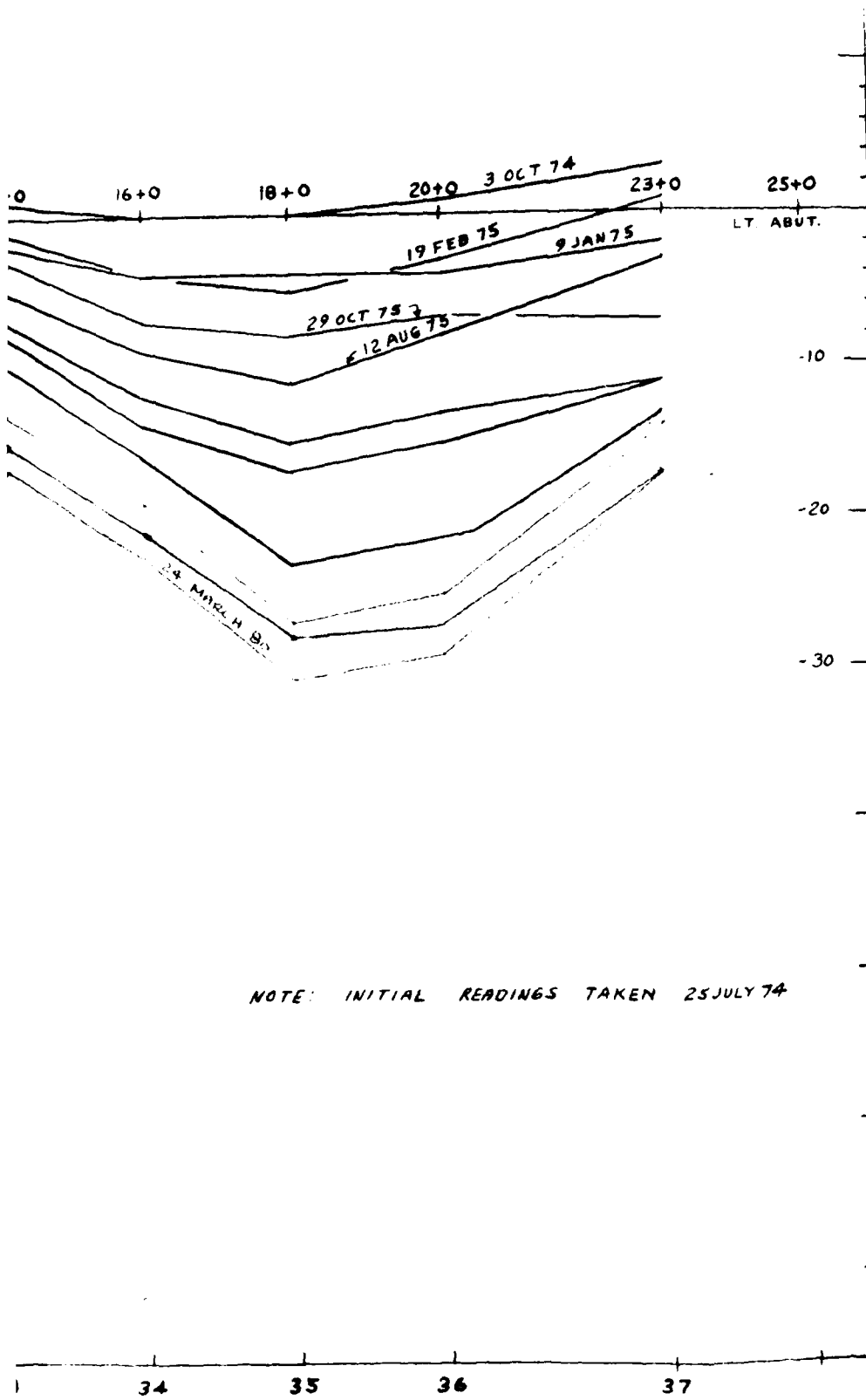
NOTE: READINGS TAKEN FROM RIGHT
TO LEFT ABUTMENT

CALC. RUN LAKES
MOVEMENT MONITORING
10/10/75
ROW 3
HORIZONTAL MOVEMENT

2

APPENDIX V





NOTE: INITIAL READINGS TAKEN 25 JULY 74

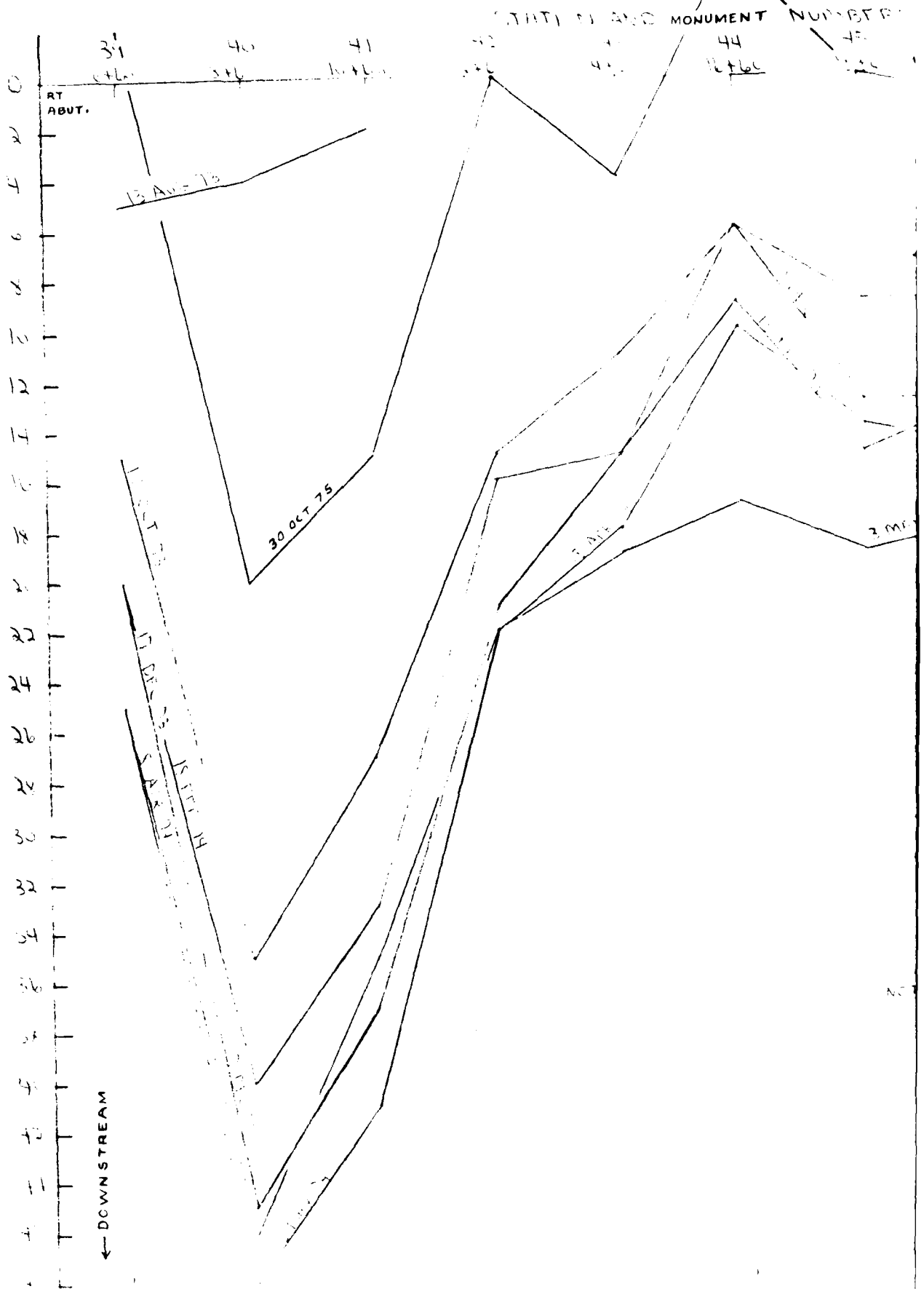
INITIAL READING	
MON. NO.	ELEV.
29	788.50
30	788.44
31	788.62
31A	788.40
32	788.50
33	788.66
34	788.61
35	788.68
36	788.87
37	788.74

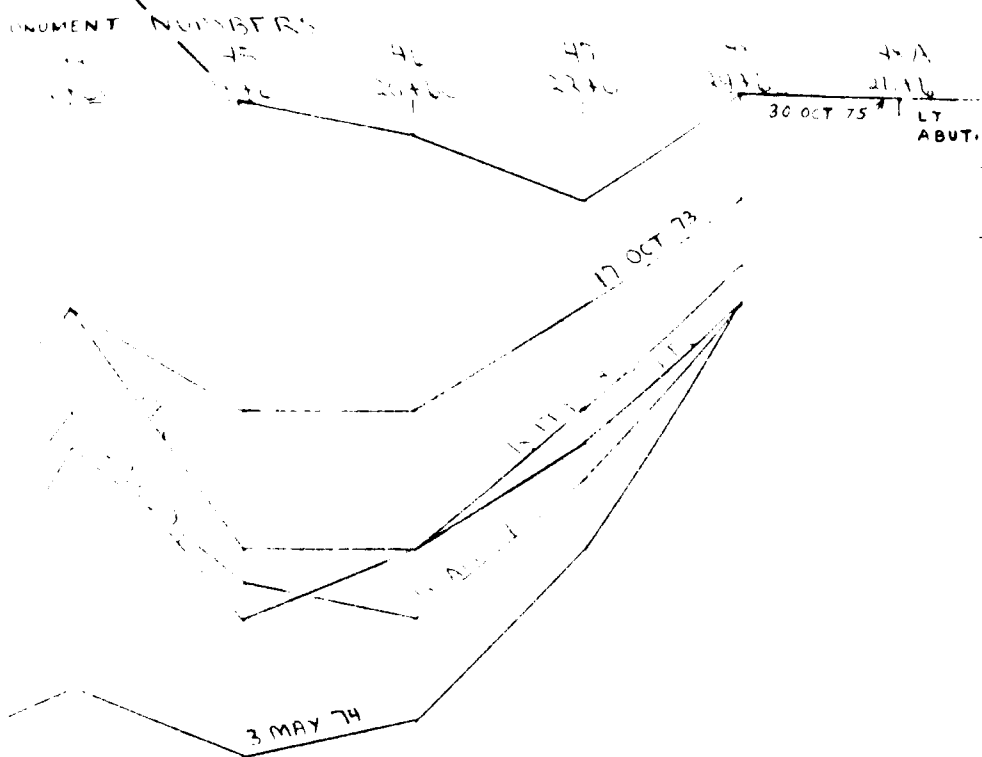
CAVE RUN LAKE
MOVEMENT MONUMENTS
15'D/S &
ROW 3
VERTICAL MOVEMENT

ATTACHED V PLATE 68

2

HORIZONTAL - CUMULATIVE MOVEMENT
(HUNDREDS OF A FOOT)





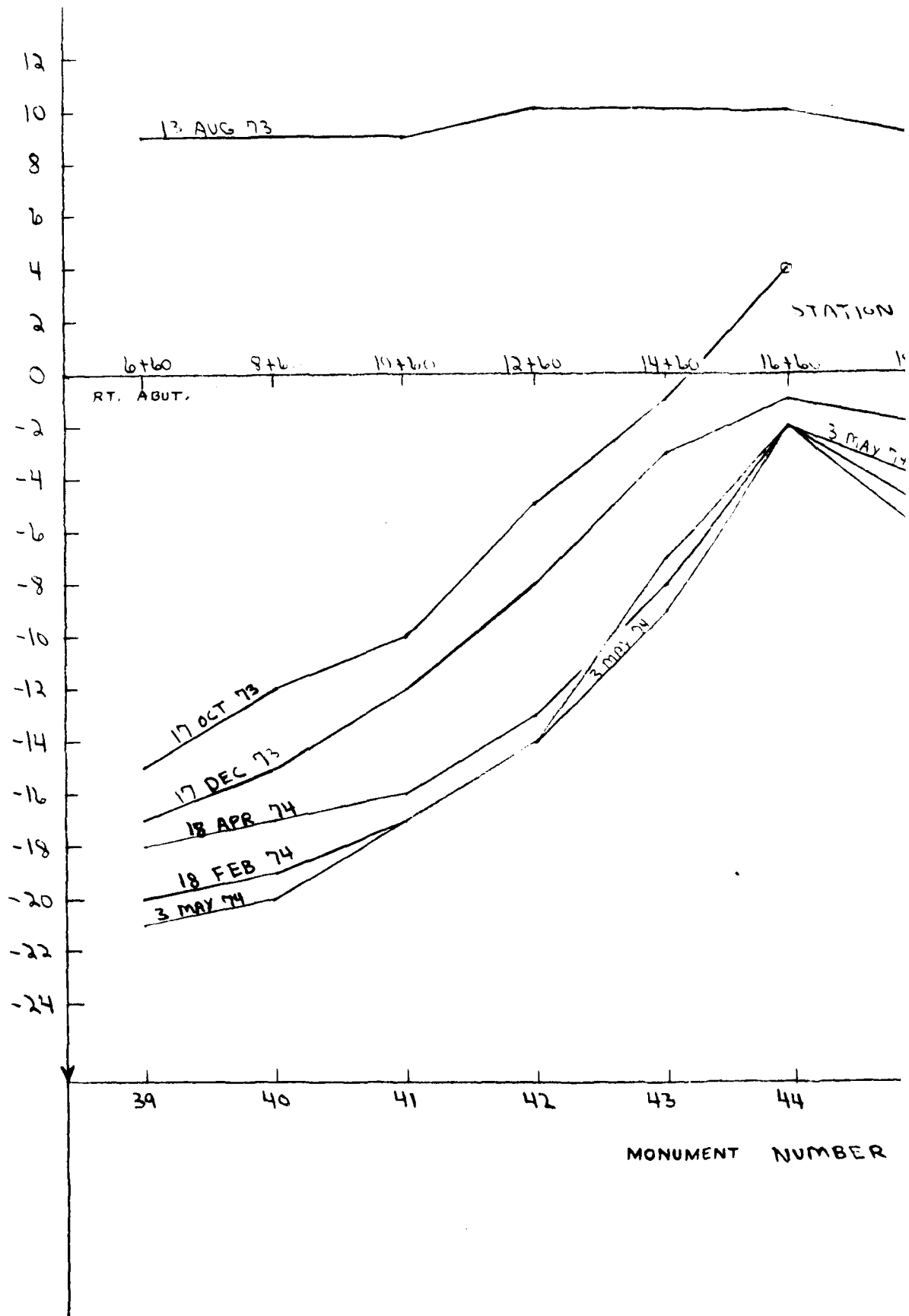
NOTE: READINGS TAKEN FROM LEFT
ABUTMENT TO RIGHT EXCEPT
ON 30 OCT 75

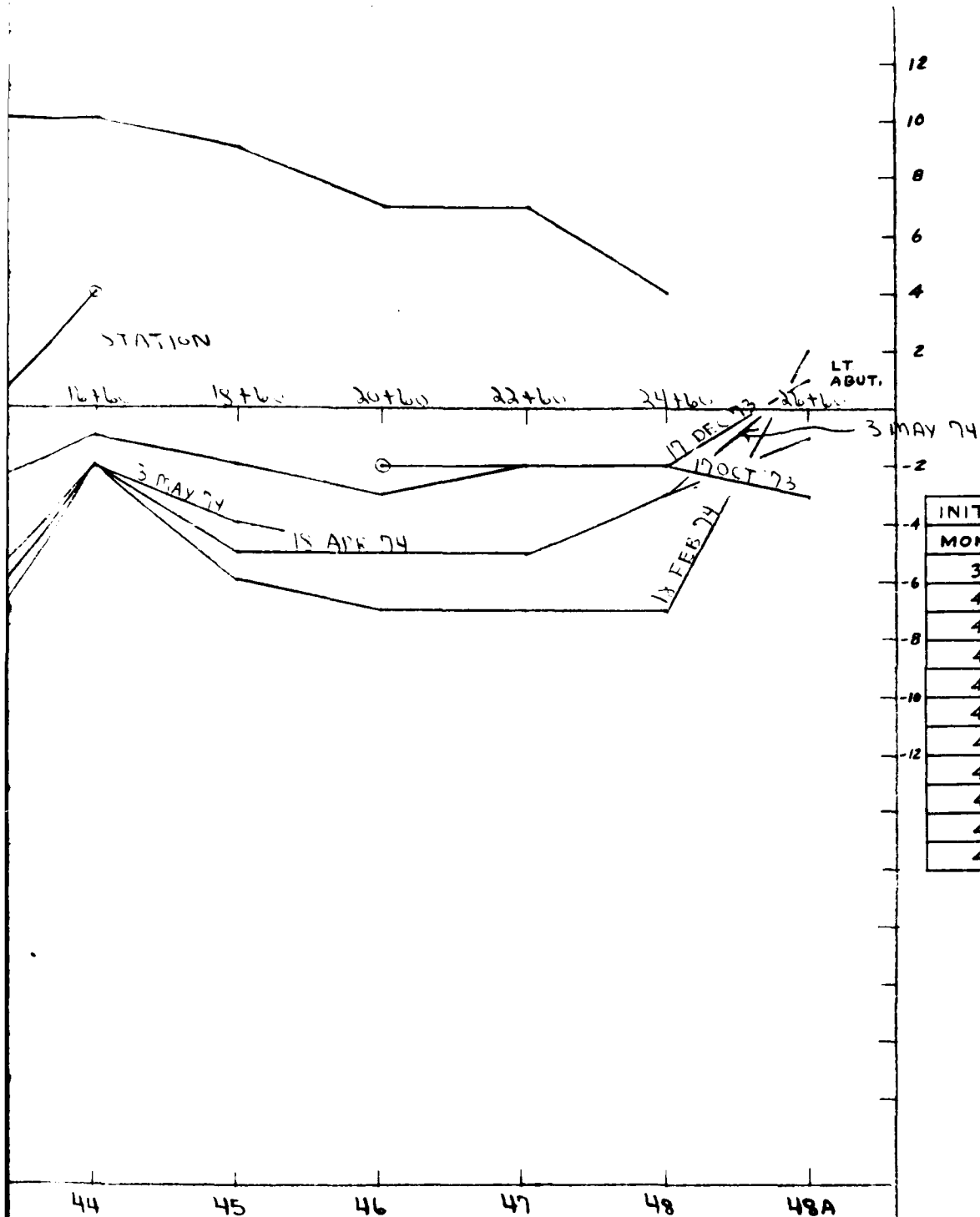
2

CAMP RAIN LAKE
DIAMOND MONUMENTS
KIN 4
HORIZONTAL MOVEMENT

EXHIBIT 69

VERTICAL CUMULATIVE MOVEMENT
(HUNDREDS OF A FOOT)





INITIAL READING	
MON. NO.	ELEV.
39	741.31
40	739.82
41	739.68
42	739.43
43	740.06
44	740.66
45	740.73
46	740.34
47	740.33
48	740.48
48A	743.98

ST NUMBER

CAVE RUN LAKE
MOVEMENT MONUMENTS
150' DOWNSTREAM &
ROW 4
VERTICAL MOVEMENT

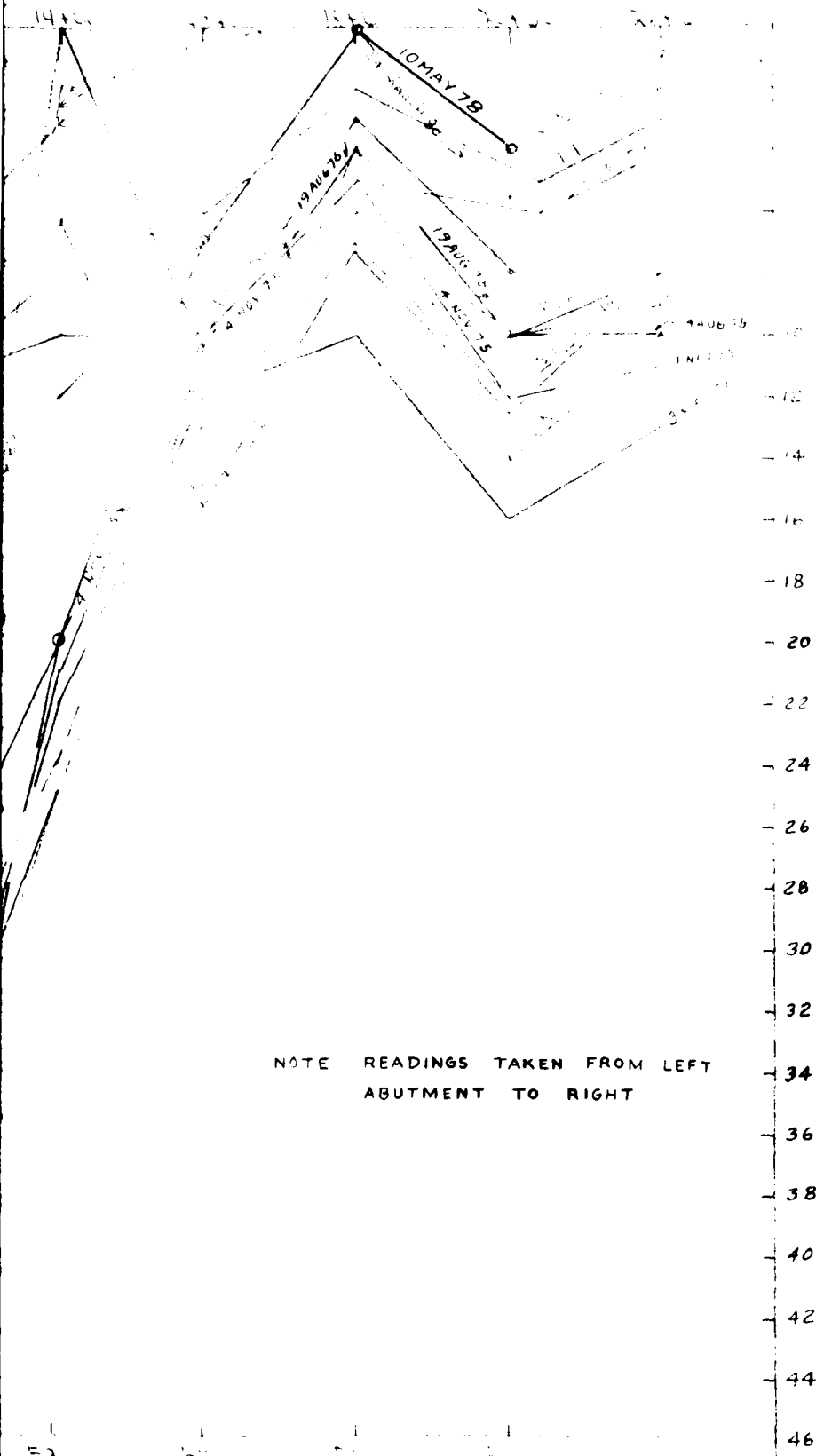
EXHIBIT 70

HORIZONTAL CUMULATIVE MOVEMENT (HUNDREDS OF FEET)



TION

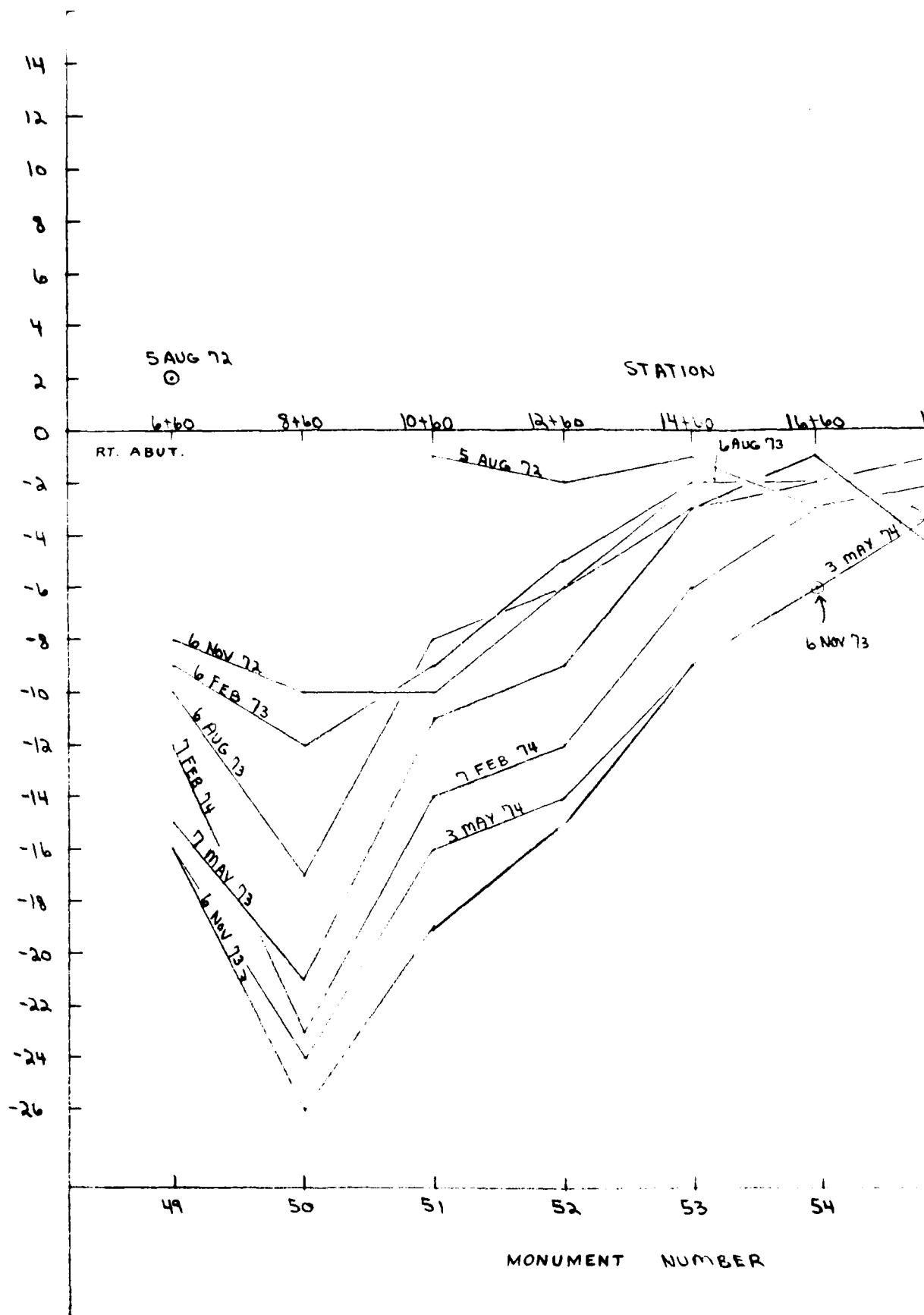
LT. ABUT



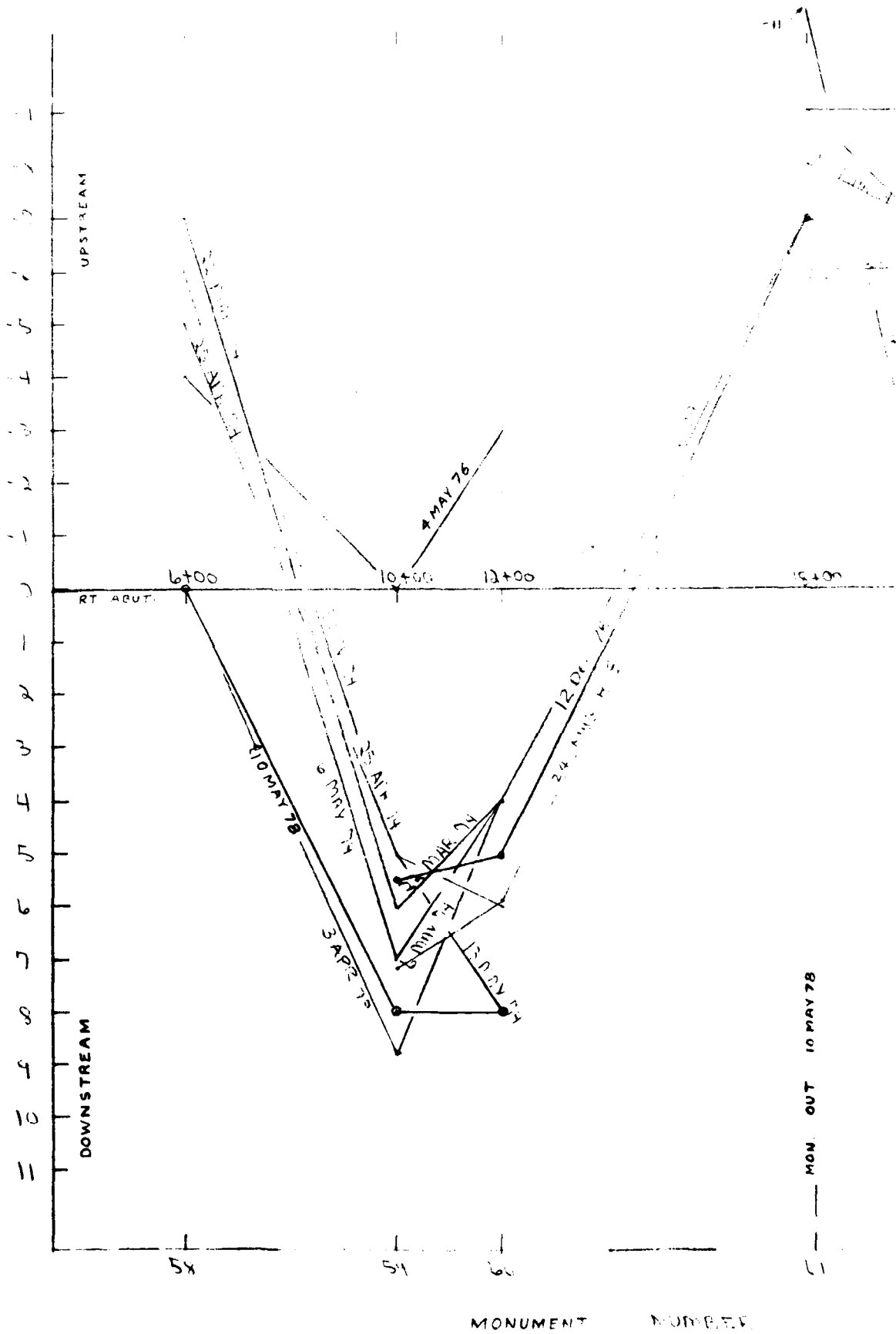
CAVE FROM LEFT
1 OVER 100 MONUMENTS
210' DOWN TOWARD E
ROW 5
HORIZONTAL MOVEMENT

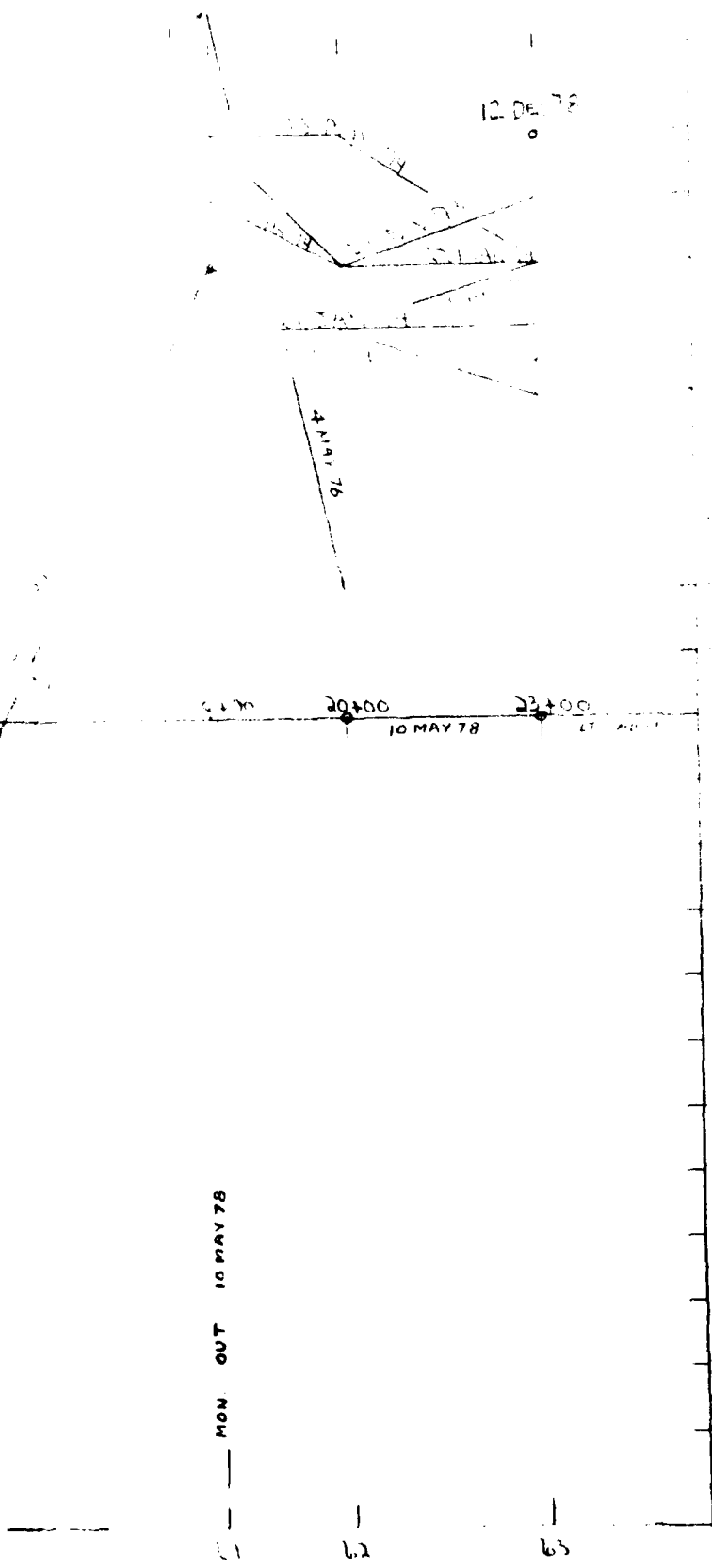
71

VERTICAL CUMULATIVE MOVEMENT
(HUNDREDS OF A FOOT)



HORIZONTAL CUMULATIVE MOVEMENT (HUNDREDS OF FEET)





MONUMENTS TAKEN
TO RIGHT ABUTMENT

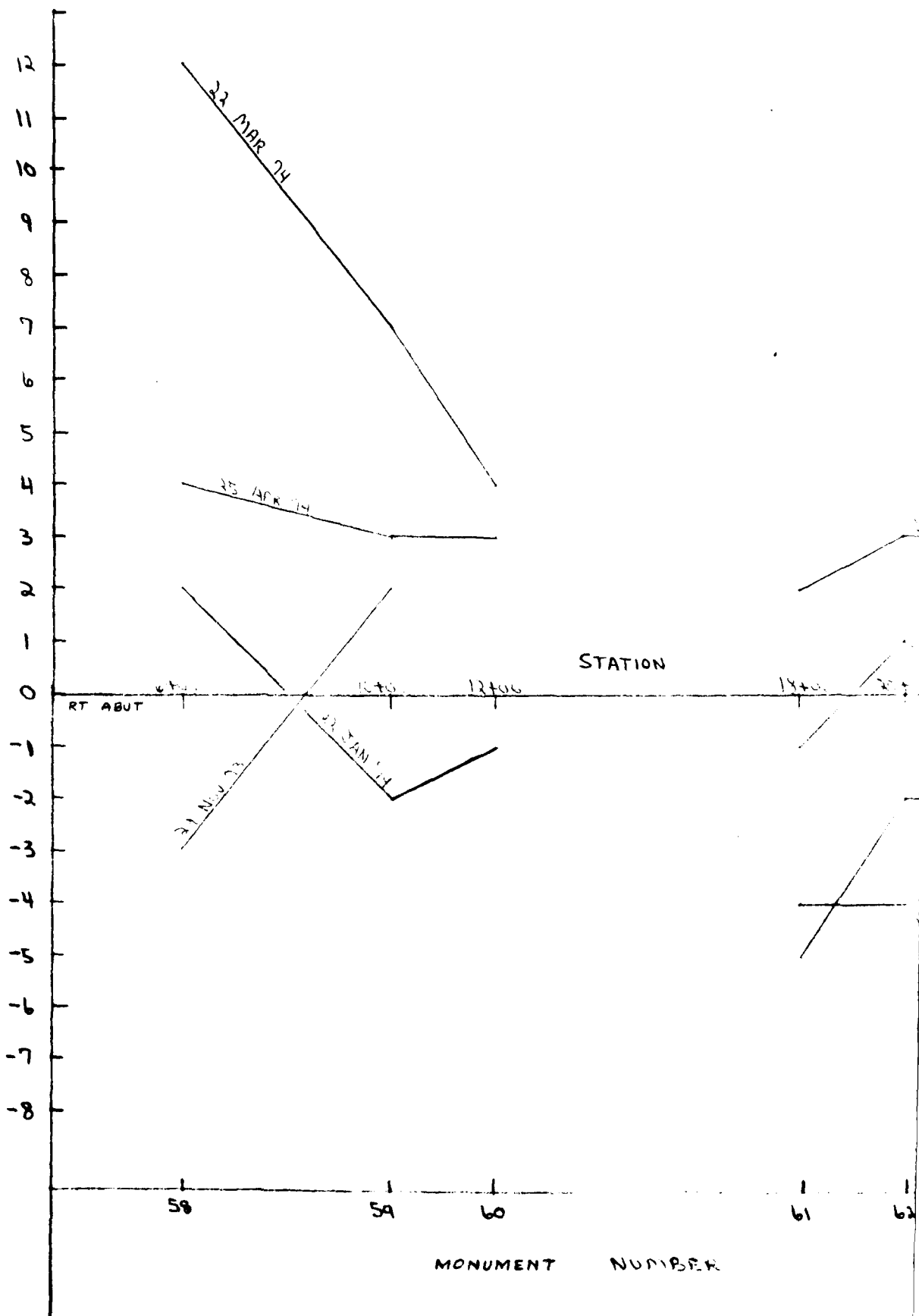
4 MAY 76 READINGS TAKEN RIGHT
TO LEFT ABUTMENT

10 MAY 78 READING TAKEN RIGHT
TO LEFT ABUTMENT STARTING
FROM MONUMENT NO. 63

CHUTE 1.00 L.M.A.
MONUMENTS
340-390 DOWNSTREAM
ROW 6
HORIZONTAL MOVEMENT

11/17/77 73

VERTICAL CUMULATIVE MOVEMENT
(HUNDREDS OF A FOOT)



INITIAL READING	
MON. NO.	ELEV.
58	676.83
59	677.72
60	678.42
61	684.35
62	685.75
63	690.16

CAVE RUN LAKE
 MOVEMENT MONUMENTS
 340' - 390' DOWNSTREAM &
 ROW 6
 VERTICAL MOVEMENT

EXHIBIT 74



READINGS TAKEN FROM LEFT
ABUTMENT TO RIGHT

- 16
- 18
- 20
- 22
- 24
- 26
- 28
- 30
- 32
- 34
- 36

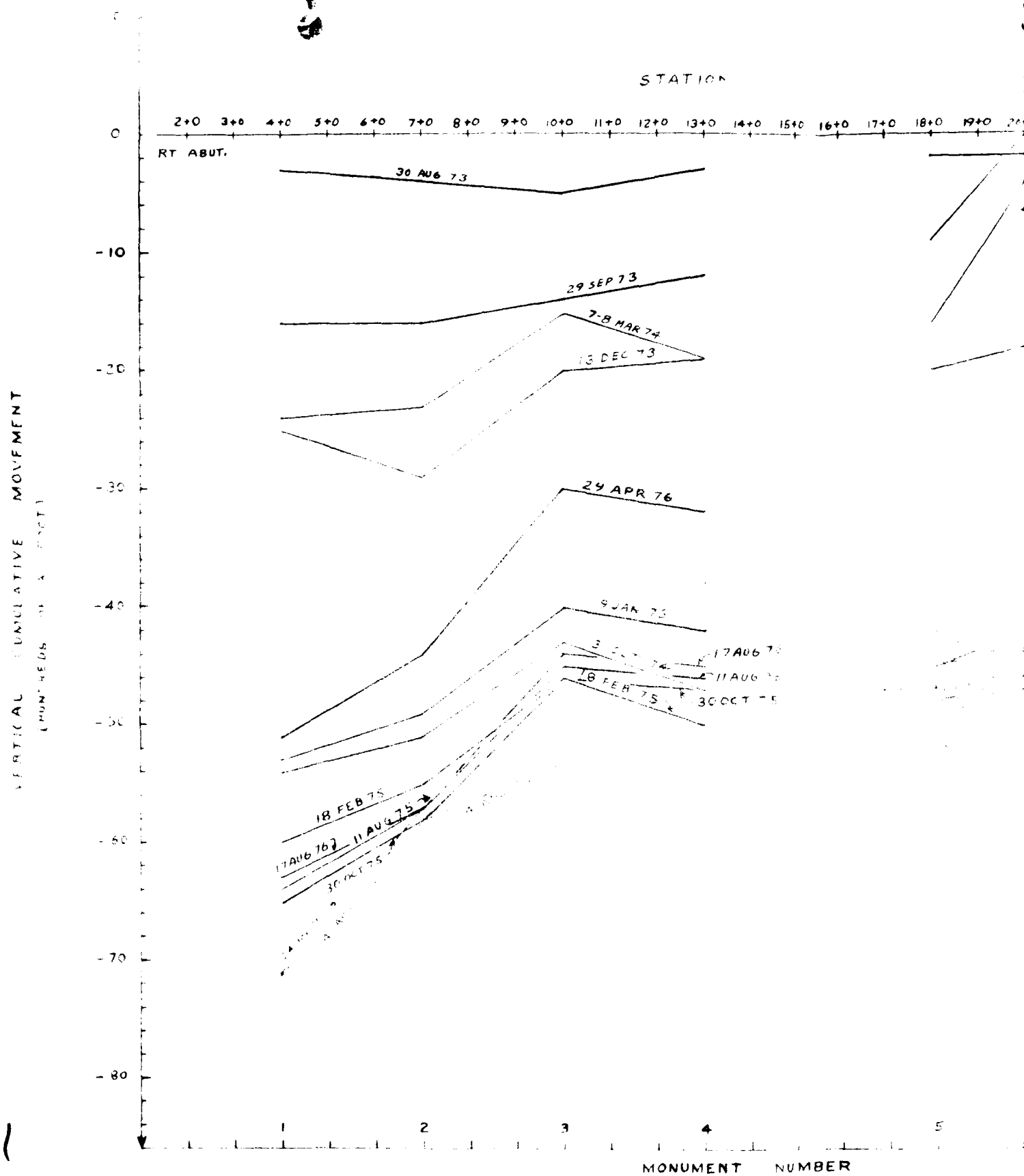
CAVE RUN LAKE
MOVEMENT MONUMENTS
280' UPSTREAM &
ROW 7
HORIZONTAL MOVEMENT

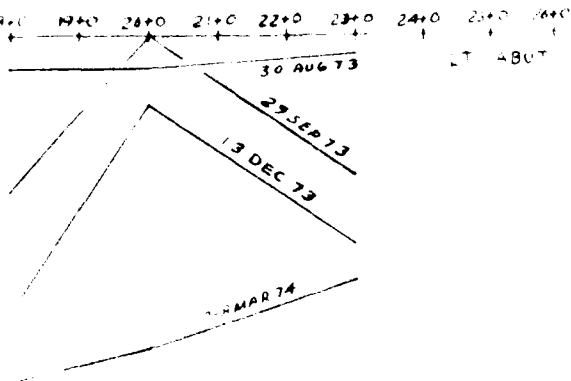
6

7

2

11-11-75

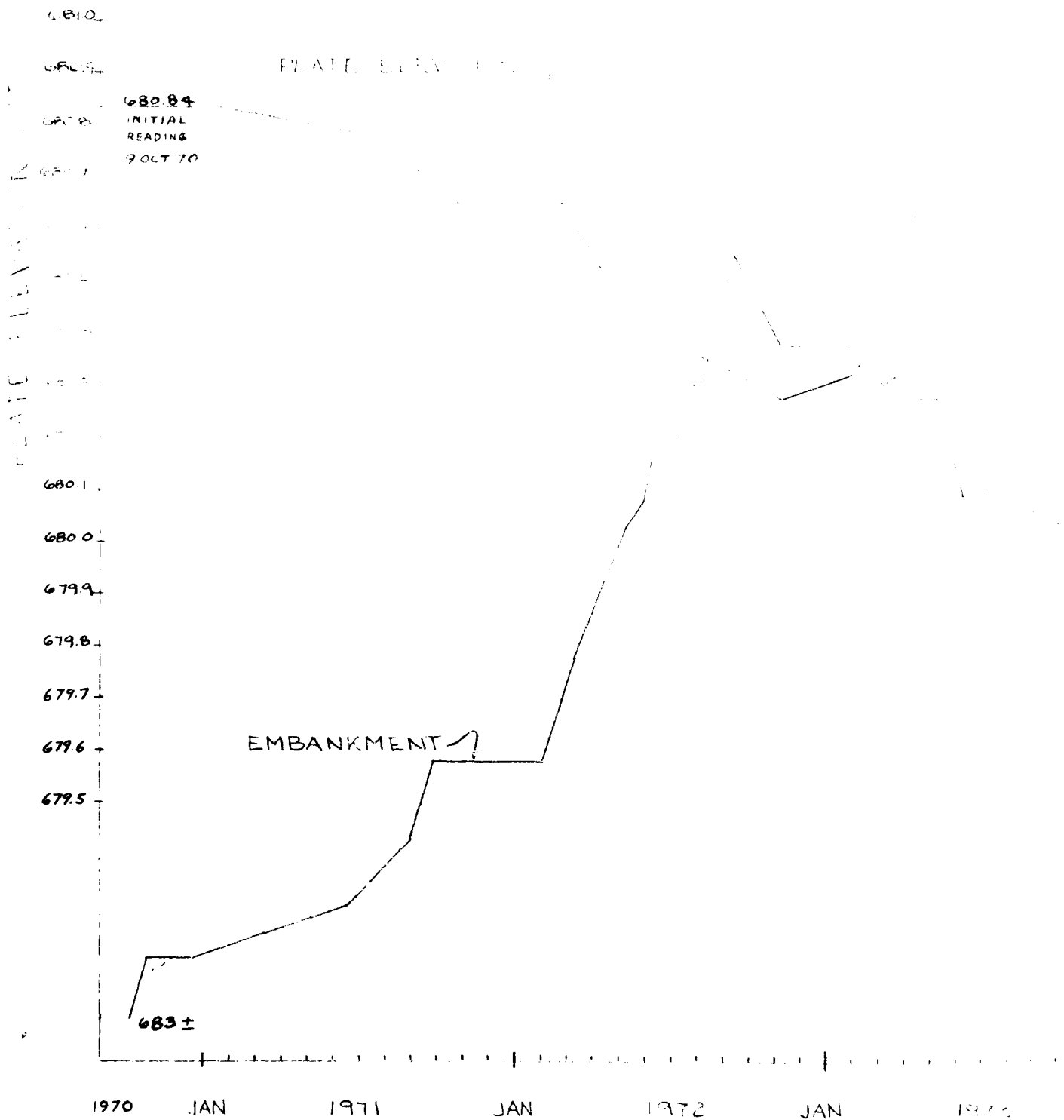




INITIAL READING	
MON. NO.	ELEV.
1	732.68
2	734.40
3	733.67
4	733.18
5	732.64
6	733.75
7	734.02

CAVE RUN LAKE
MOVEMENT MONUMENTS
DOWNSTREAM &
ROW 7
VERTICAL MOVEMENT

PLATE 76



PL 7555

700

75

74

73

72

710

700

690

EL ELEVATION (FT)

11 MAY 79

Rising height - 79.65'

1976

CAVE RUN DAM
SETTLEMENT GAGE #1
100' US STA 11+00

1974

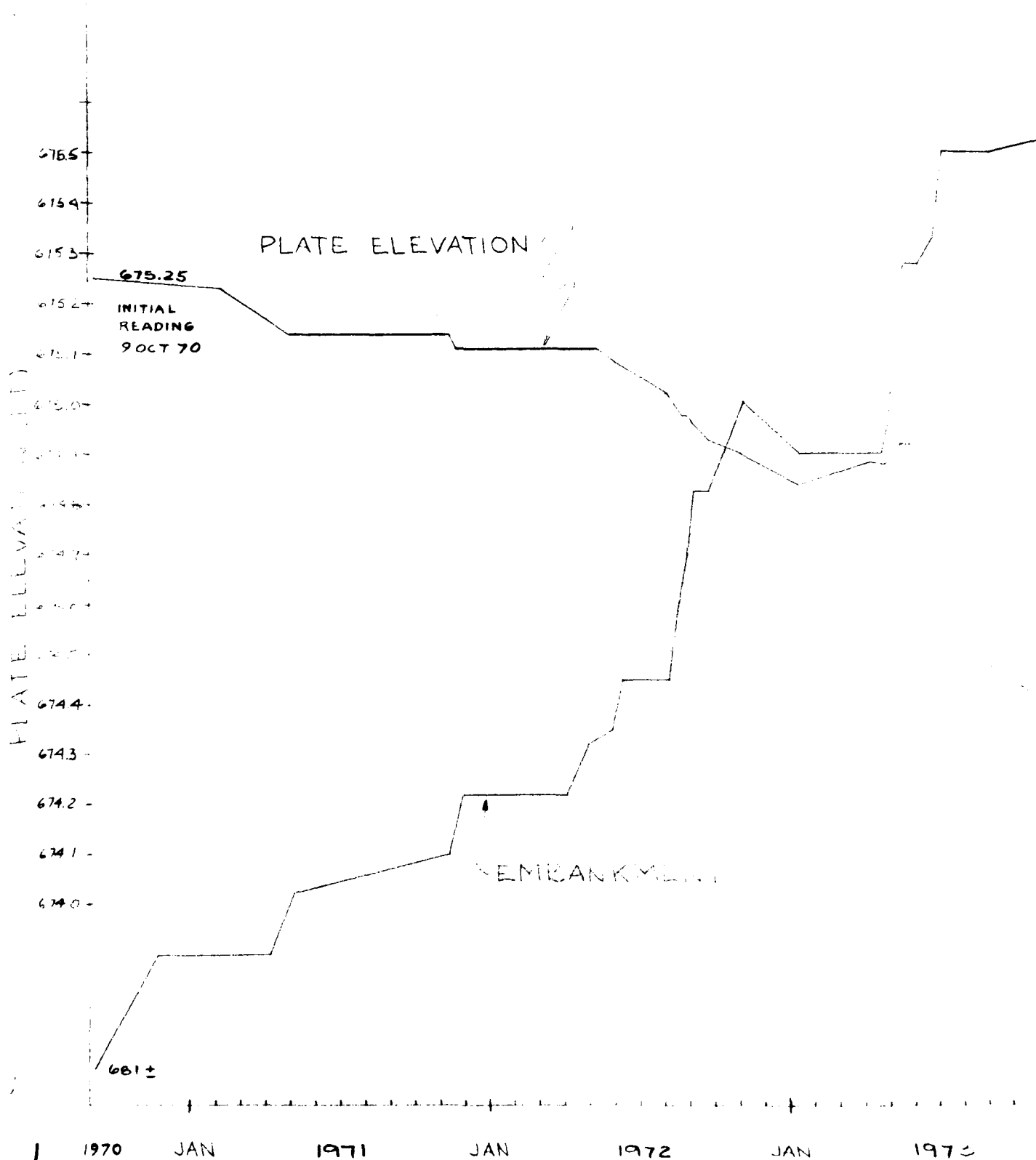
JAN

1975

JAN

2

APPROX PLATE 71



EL. 755.5

+760

+750

+740

+730

+720

+710

+700

+690

+680

MEAN

8.4 MM II

1976

1974

JAN

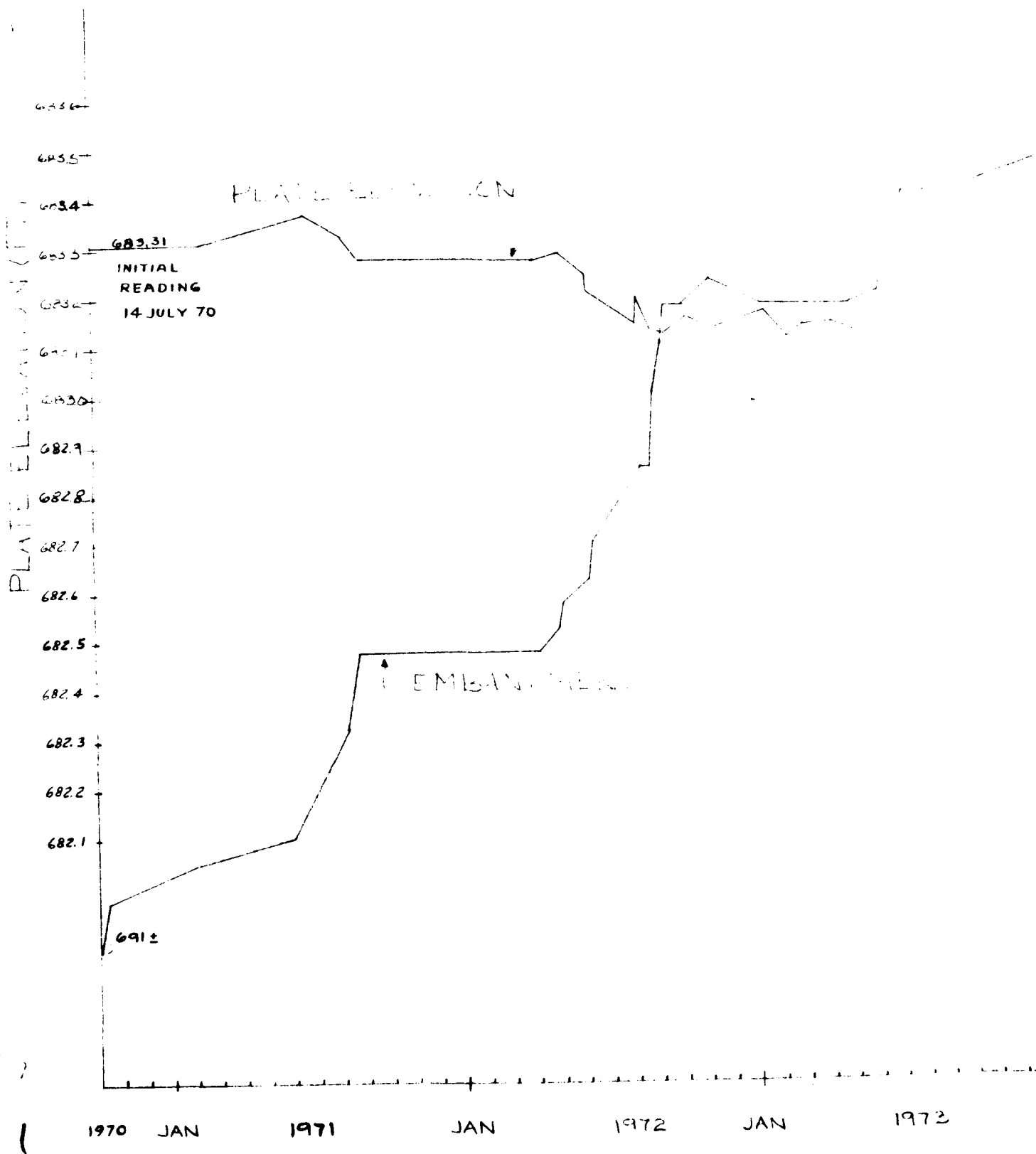
1975

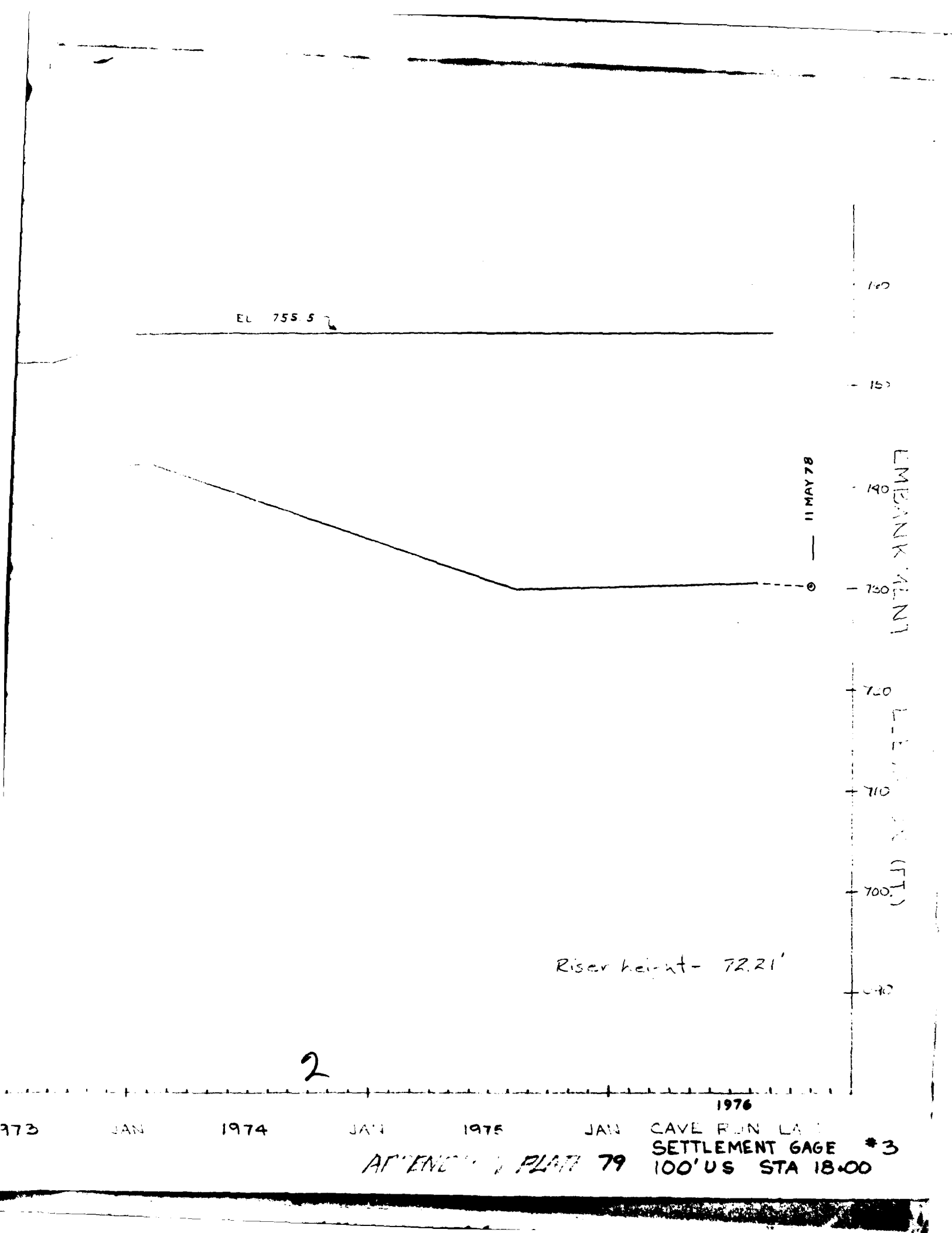
JAN

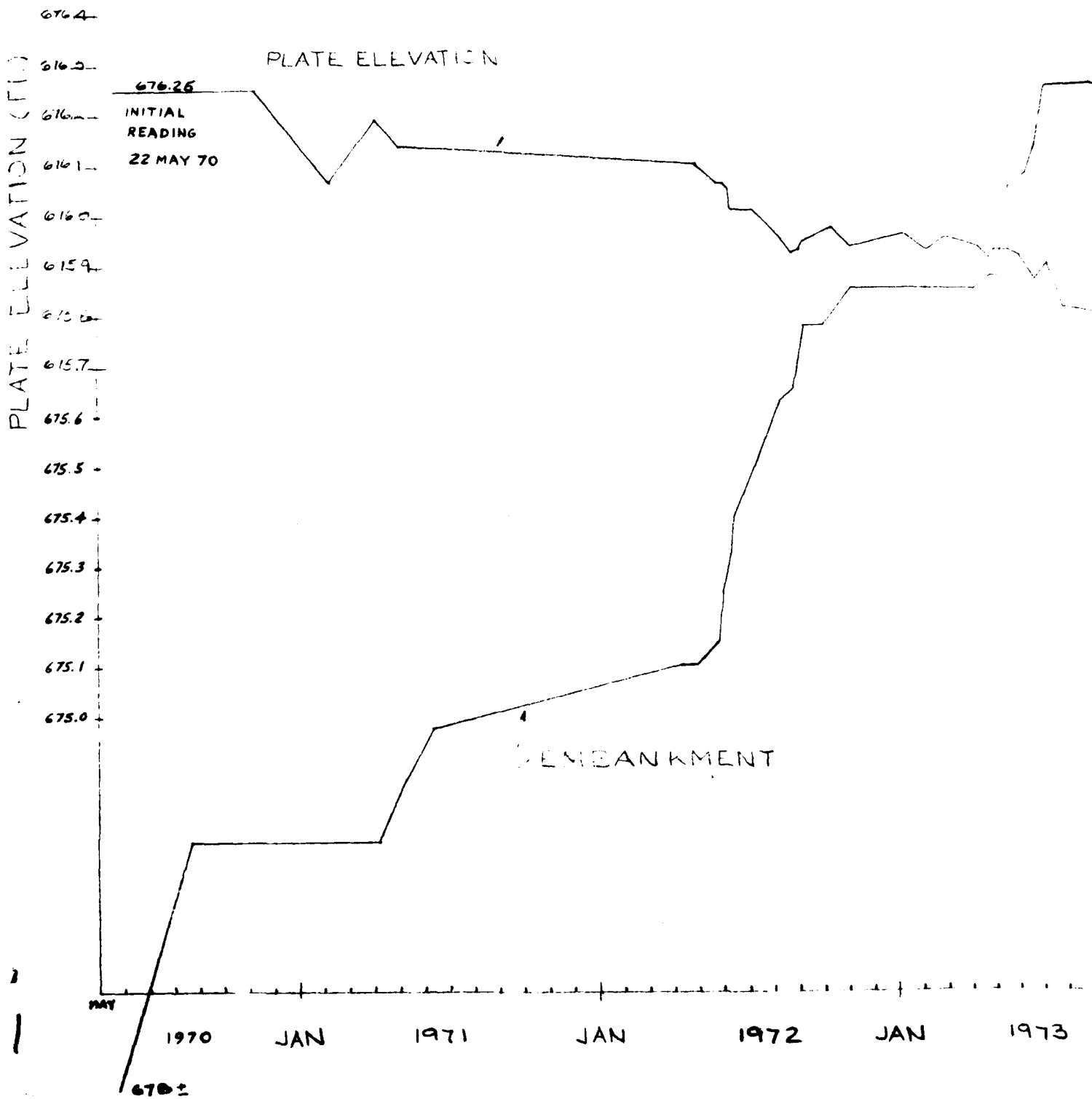
CAVE RUN LAKE
SETTLEMENT GAGE #2
100' D.S. STA 11+00

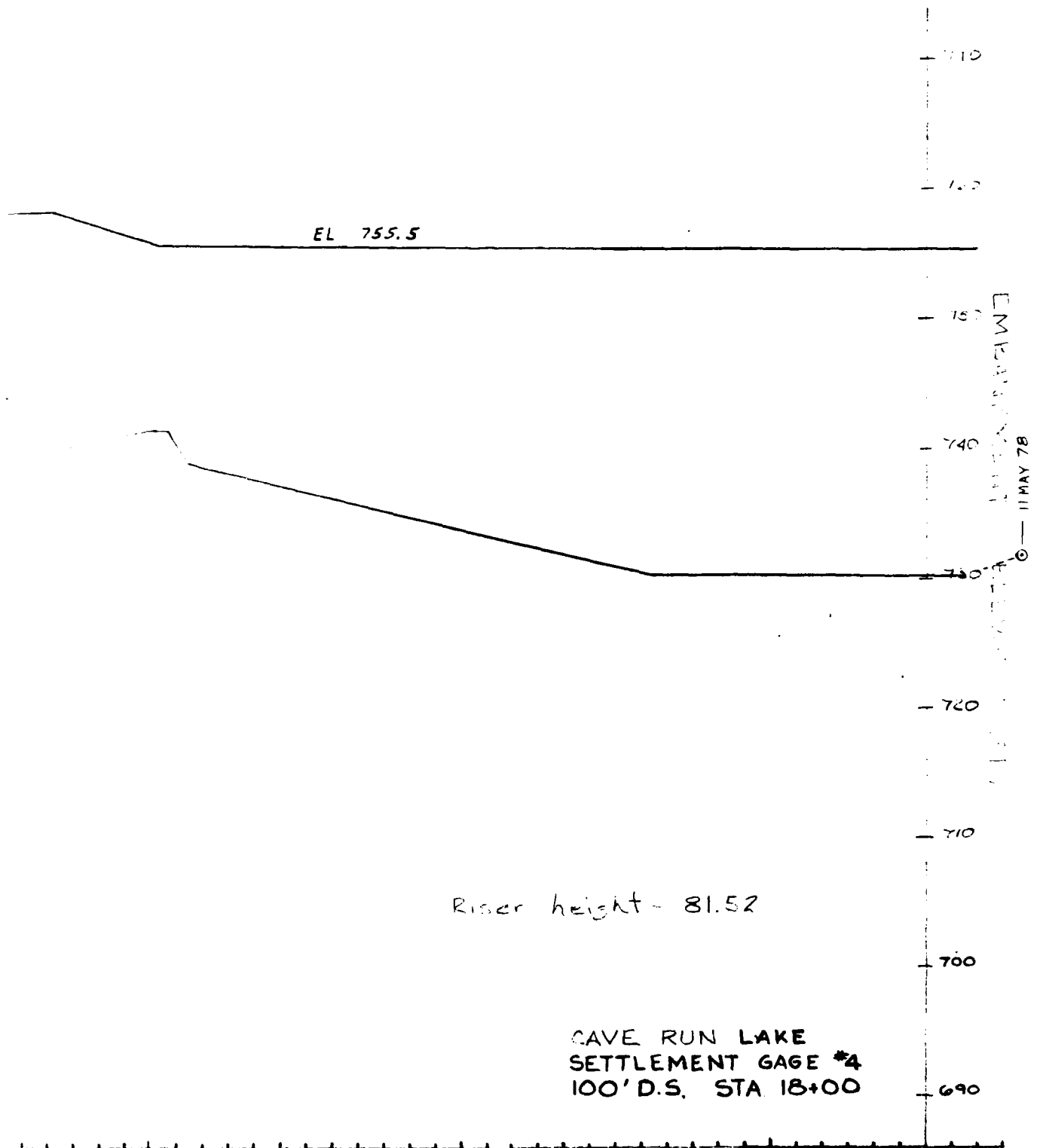
APPENDIX PLATE 78

2









1973

JAN

2

1974

JAN

1975

JAN

1976

APPENDIX V PLATE 80

CAVE RUN LAKE

MATERIALS USAGE CHART
EXCAVATION

<u>Item</u>	<u>Excavated Quantity CY</u>	<u>Total Quantity CY</u>	<u>Disposition</u>	<u>Disposition Quantity CY</u>	<u>Balance Factor</u>	<u>Embankment Quantity CY</u>
<u>Topsoil</u>						
Dam	58,800	67,000	Waste Area	67,000		
Spillway	8,200					
<u>Earth Excavation</u>						
Dam Foundation	205,500					
Spillway Area	27,800	3,677,300	Impervious Fill	1,500,000	0.83	1,245,000
Borrow Areas	3,344,000		Random Fill	2,177,300	0.83	1,807,150
Conduit Storage	100,000					
<u>Rock Excavation</u>						
Spillway Area	132,500	132,500	Random Fill	132,500	1.20	159,000

CAVE RUN LAKE
MATERIALS USAGE CHART
FILL

<u>Item</u>	<u>Quantity</u>	<u>Source</u>	<u>Total</u>
Impervious Fill	1,245,000	Borrow Areas	1,245,000
Random Earth Fill	1,807,150	Borrow Areas	1,807,150
Random Rock Fill	159,000	Spillway	159,000
Graded Aggregate	13,000	Commercial	13,000
Inclined Drain and Horizontal Drain	80,000	Commercial and Borrow Areas	80,000
Stone Protection	54,000	Commercial	54,000
Stability Berm	750,000	Borrow Areas	750,000

FIELD COMPACTION CO

MATERIAL (ZONE)	NUMBER OF TESTS	DRY DENSITY				PERCENT COMPACTION			
		HIGH	LOW	AVERAGE	DESIGN	HIGH	LOW	AVERAGE	DESIR
IMPERVIOUS	795 *	127.8	95.3	110.7	110.0	108.1	84.9	98.8	95.0
RANDOM	893 **	142.6	98.3	113.0	110.0	118.4	86.7	99.7	95.0
PERVIOUS	208 ***	120.8	96.2	111.9	115.0	113.5	36.9	91.6	85.0

* OF THE 795 TESTS RUN ON THE IMPERVIOUS MATERIAL 46 TESTS FAILED BELOW OPTIMUM, 1 TEST INDICATED THE MATERIAL WAS TOO DRY OF OPTIMUM (THE COMPACTION DESIRED AND 8 TESTS INDICATED THE MATERIAL WAS TOO WET (THE COMPACTION DESIRED). ALL OF THE TEST SECTIONS THAT FAILED WERE RETESTED AND ALL THESE TESTS WERE ACCEPTABLE.

** OF THE 893 TESTS RUN ON THE RANDOM MATERIAL 68 TESTS FAILED BELOW OPTIMUM, 2 TESTS INDICATED THE MATERIAL WAS TOO DRY OF OPTIMUM (THE COMPACTION DESIRED AND 18 TESTS INDICATED THE MATERIAL WAS TOO WET (THE COMPACTION DESIRED). ALL OF THE TEST SECTIONS THAT FAILED WERE RETESTED AND ALL THESE TESTS WERE ACCEPTABLE.

*** OF THE 208 TESTS RUN ON THE PERVIOUS MATERIAL 13 TESTS FAILED BELOW THE COMPACTION DESIRED). ALL OF THE TEST SECTIONS THAT FAILED WERE RETESTED AND THE TESTS WERE ACCEPTABLE.

- ① STANDARD PROCTOR TEST USED ON THE IMPERVIOUS AND RANDOM MATERIAL
- ② NOT APPLICABLE - NO MOISTURE CONTROL SPECIFIED
- ③ INDICATE RESULTS OF ALL TESTS FOR HIGH AND LOW VALUES AND INDICATE

CTION CONTROL - PAM

COMPACTION ③		WATER CONTENT ③				DEVIATION FROM OPTIMUM ③			
AGE	DESIRED	HIGH	LOW	AVERAGE	DESIGN	HIGH	LOW	AVERAGE	SPECIFIED
.8	95.0	23.7	10.5	16.4	16.1	+5.6	-3.3	+ .50	-2.0 +2.0
.7	95.0	22.4	5.5	15.2	16.1	+4.1	-3.7	+ .40	-2.0 +2.0
.6	95.0	N/A ③	N/A ③	N/A ③	N/A ③	N/A ③	N/A ③	N/A ③	N/A ③

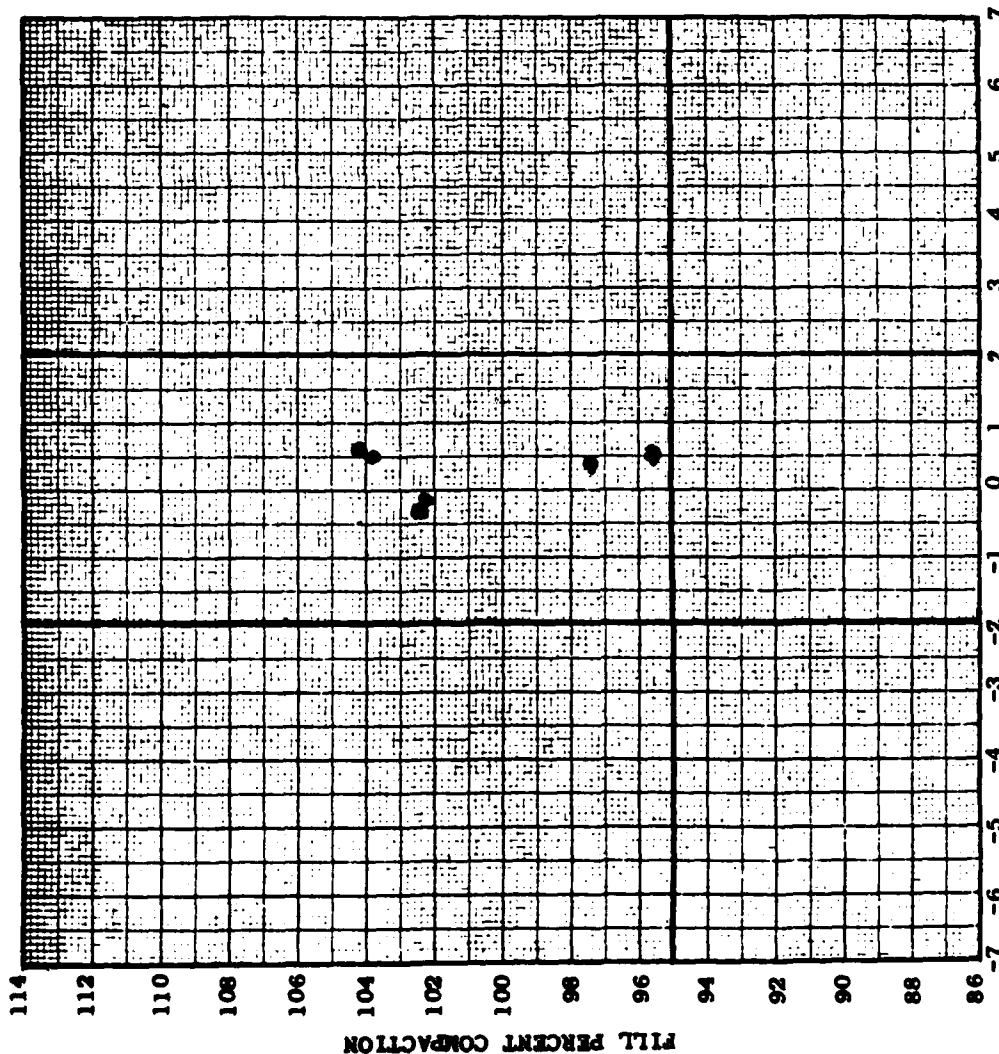
TESTS FAILED (8 TESTS INDICATED THE MATERIAL WAS TOO WET OF
 Y OF OPTIMUM, 29 TESTS INDICATED THE MATERIAL WAS BELOW
 MATERIAL WAS BOTH TOO WET OF OPTIMUM AND BELOW THE
 FILED WERE REWORKED. THERE WERE 25 AREAS THAT WERE

TESTS FAILED (8 TESTS INDICATED THE MATERIAL WAS TOO WET OF
 DRY OF OPTIMUM, 40 TESTS INDICATED THE MATERIAL WAS BELOW
 MATERIAL WAS BOTH TOO WET OF OPTIMUM AND BELOW THE
 FILED WERE REWORKED. THERE WERE 37 AREAS THAT WERE

TESTS FAILED (ALL OF THE TESTS INDICATED THE MATERIAL WAS
 TESTING THAT FAILED WERE REWORKED. ALL AREAS WERE

ROOM MATERIAL, RELATIVE DENSITY TEST USED ON THE PERVIOUS MATERIAL
 INDICATE RESULTS OF ACCEPTABLE TESTS AND RETESTS FOR AVERAGE VALUES

SPECIFIED RANGE OF WATER CONTENT



VARIATION OF FILL w FROM LAB OPTIMUM w,
PERCENTAGE POINTS

ENG Form 4287A
JUN 69

PROJECT: Cave Run Dam & Spillway
DISTRICT: Louisville
REPORT PERIOD: 1 May 70-30 May 70
REPORT NO.: 1
TYPE OF MATERIAL: Compacted Random Earth

	CUMULATIVE	
	TO THIS REPORT	THIS REPORT
TOTAL NO. OF TESTS	6	6
NO. OUTSIDE LIMITS:		
TOTAL	0	0
w	0	0
DENSITY	0	0
w & DENSITY	0	0
NO. REWORKED	0	0
NO. RETESTED AFTER REWORKING	0	0

LEGEND:

- WITHIN ACCEPTABLE LIMITS
- x OUTSIDE ACCEPTABLE LIMITS
- x_n LATER REWORKED ONLY (NO RETEST)
- x₁, x₂ LATER REWORKED AND RETESTED
- ₁, ●₂ RESULT OF RETEST AFTER REWORKING
- Δ₁, Δ₂ INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ₁, Δ₂ CHECK TEST

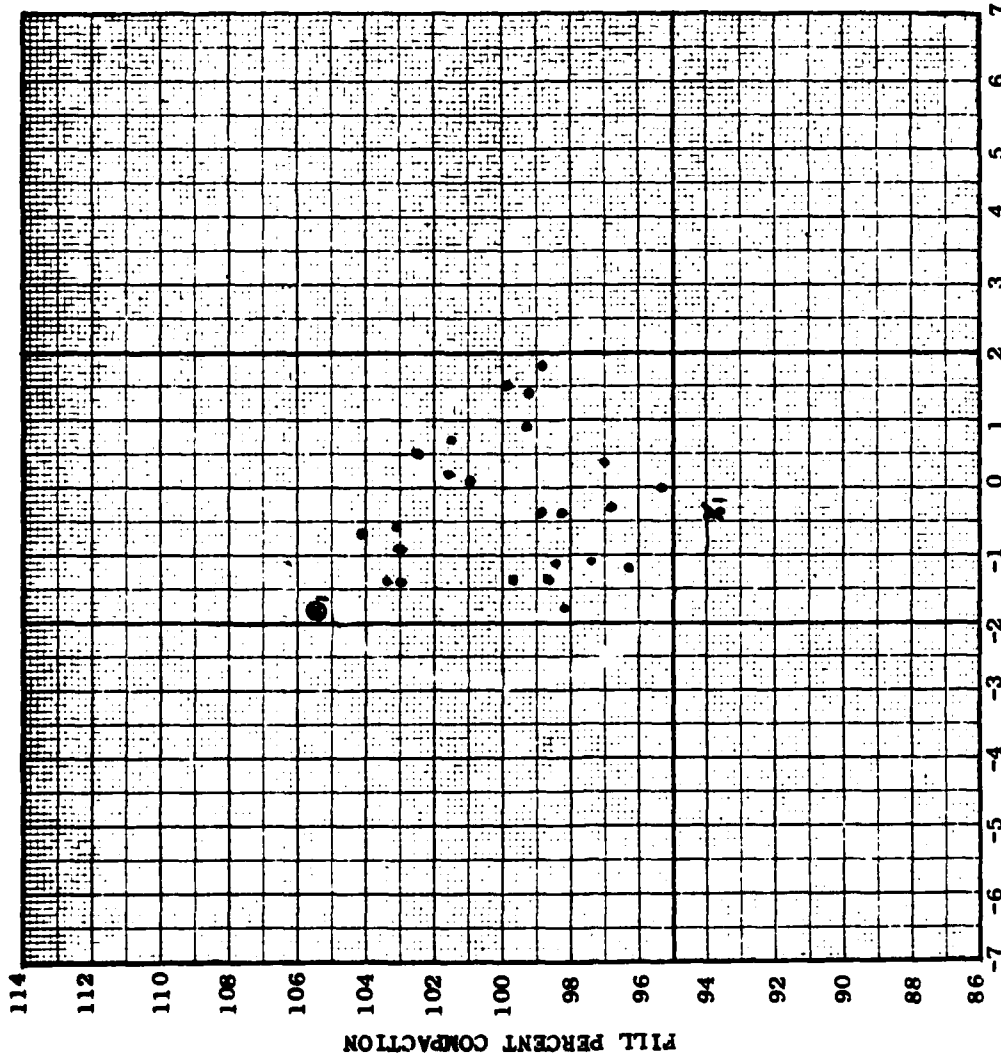
NOTE: USE SAME NUMBER FOR LATER REWORKED AND RETESTED AND RESULT OF RETEST AND FOR INITIAL AND CHECK TEST.

(Specified) (Specified) MIN PERCENT OF MAX STD DRY DEN

Stationing of Areas Tested	16+75 to 22+30
Elevation of Areas Tested	662.5 to 686.5

SPECIFIED RANGE OF WATER CONTENT

Cave Run Reservoir
PROJECT: Const. of Dam & Spillway
DISTRICT: Louisville
REPORT PERIOD: 6/1/70 to 6/30/70
REPORT NO.: 2
TYPE OF
MATERIAL: Impervious Fill



REWORKED (SPECIFIED) MIN PERCENT OF MAX STD DRY DEN

TOTAL NO. OF TESTS	32	CUMULATIVE TO THIS REPORT	THIS REPORT
NO. OUTSIDE LIMITS:			26
TOTAL	1		1
w	0		0
DENSITY	1		1
w & DENSITY	0		0
NO. REWORKED	1		1
NO. RETESTED AFTER REWORKING	1		1

LEGEND:

- WITHIN ACCEPTABLE LIMITS
- x OUTSIDE ACCEPTABLE LIMITS
- x_r LATER REWORKED ONLY (NO RETEST)
- x₁, x₂ LATER REWORKED AND RETESTED
- ₁, ●₂ RESULT OF RETEST AFTER REWORKING
- Δ₁, Δ₂ INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ₁, Δ₂ CHECK TEST

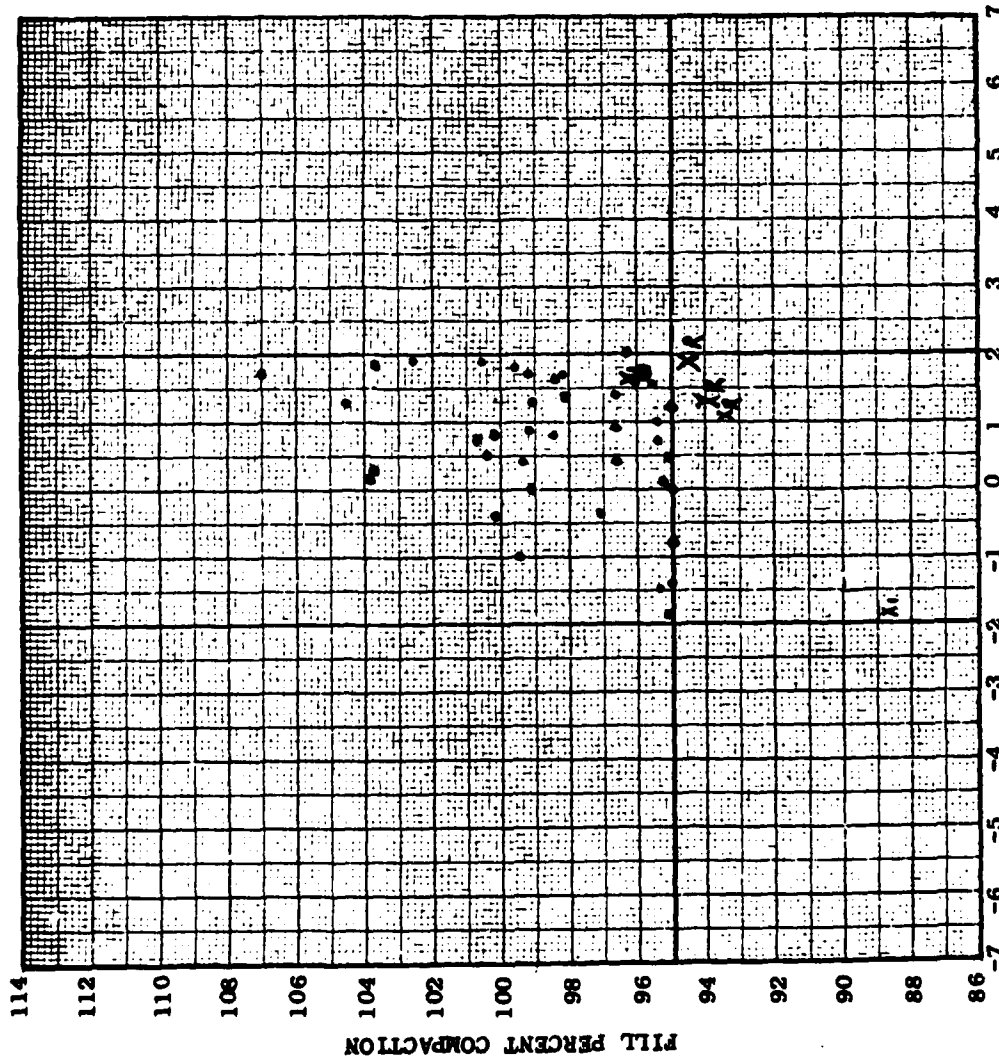
NOTE: USE SAME NUMBER FOR LATER REWORKED AND RETESTED AND RESULT OF RETEST AND FOR INITIAL AND CHECK TEST.

VARIATION OF FILL w FROM LAB OPTIMUM w, PERCENTAGE POINTS

ENG Form 4287A
JUN 69

Stationing of Areas Tested	Sta 11+20 to Sta 23+30 U/S
Elevation of Areas Tested	Sta 12+80 to Sta 14+00 D/S 684.0 to 698.8 U/S & 672.5 to 672.8 D/S

SPECIFIED RANGE OF WATER CONTENT



VARIATION OF FILL % FROM LAB OPTIMUM W,
PERCENTAGE POINTS

ENG Form 4287A
JUN 69

PROJECT: Cave Run Reservoir
DISTRICT: Louisville
REPORT PERIOD: 7-1-70 thru 7-31-70
REPORT NO.: 3
TYPE OF MATERIAL: Impervious - Random Earth

	CUMULATIVE TO THIS REPORT	THIS REPORT
TOTAL NO. OF TESTS	75	43
NO. OUTSIDE LIMITS:		
TOTAL	5	4
w	0	0
DENSITY	5	4
w & DENSITY	0	0
NO. REWORKED	5	4
NO. RETESTED AFTER REWORKING	2	1

(SPECIFIED) MIN PERCENT OF MAX STD DRY DEN

- LEGEND:
- WITHIN ACCEPTABLE LIMITS
 - x OUTSIDE ACCEPTABLE LIMITS
 - x_R LATER REWORKED ONLY (NO RETEST)
 - x₁, x₂ LATER REWORKED AND RETESTED
 - ₁, ●₂ RESULT OF RETEST AFTER REWORKING
 - Δ₁, Δ₂ INITIAL TEST (USE ONLY w/CHECK TEST)
 - Δ₁, Δ₂ CHECK TEST

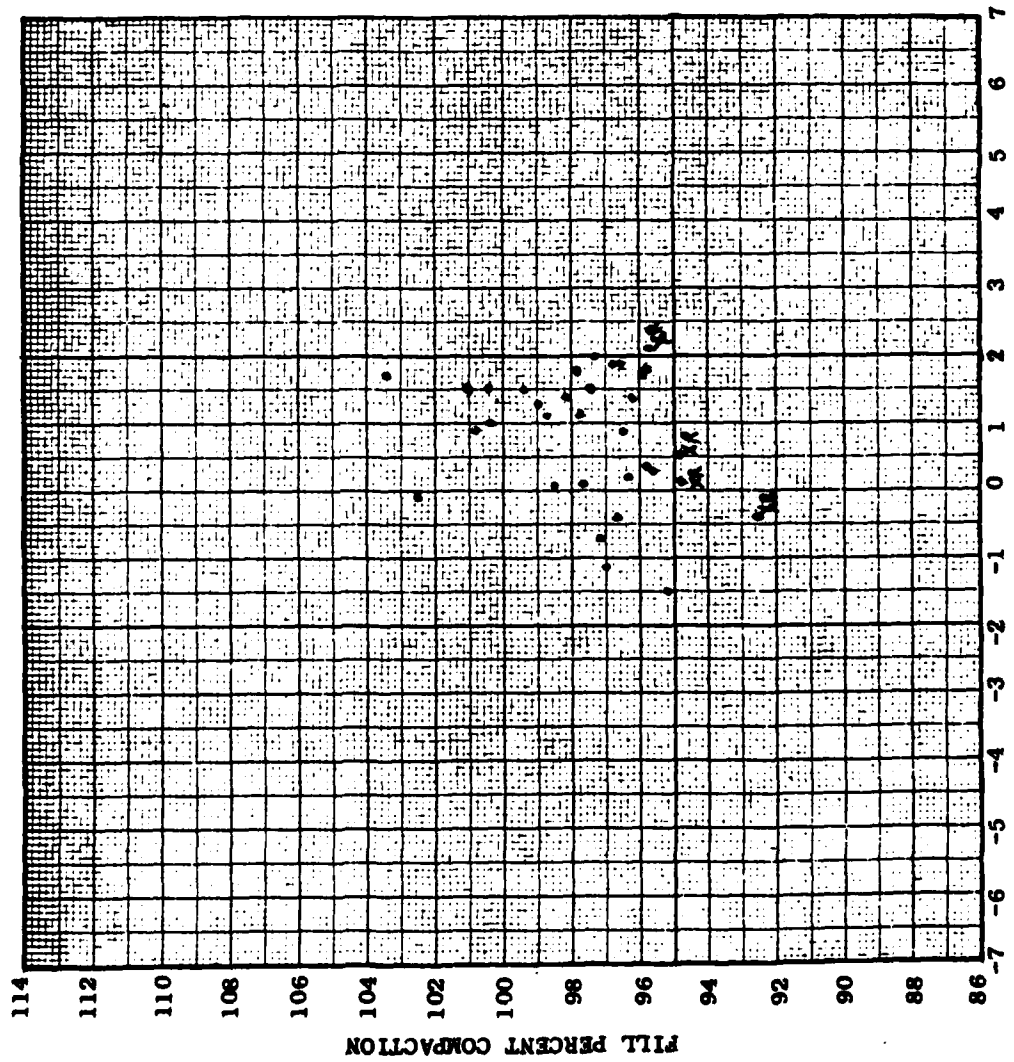
NOTE: USE SAME NUMBER FOR LATER REWORKED AND RETESTED AND RESULT OF RETEST AND FOR INITIAL AND CHECK TEST.

Stationing of Areas Tested	11+00 to 24+75
Elevation of Areas Tested	662.0 to 697.4

100-100



SPECIFIED RANGE OF WATER CONTENT



PROJECT: Cave Run Reservoir
DISTRICT: Louisville
REPORT PERIOD: 8-1-70 thru 8-31-70
REPORT NO.: 4
TYPE OF MATERIAL: Impervious

	CUMULATIVE TO THIS REPORT	THIS REPORT
TOTAL NO. OF TESTS	108	33
NO. OUTSIDE LIMITS:		
TOTAL	9	4
w	1	1
DENSITY	8	3
w & DENSITY	0	0
NO. REWORKED	9	4
NO. RETESTED AFTER REWORKING	2	0

(SPECIFIED) MIN PERCENT OF MAX STD DRY DEN

- LEGEND:
- WITHIN ACCEPTABLE LIMITS
 - x OUTSIDE ACCEPTABLE LIMITS
 - x₁ LATER REWORKED ONLY (NO RETEST)
 - x₁, x₂ LATER REWORKED AND RETESTED
 - ₁, ●₂ RESULT OF RETEST AFTER REWORKING
 - Δ₁, Δ₂ INITIAL TEST (USE ONLY w/CHECK TEST)
 - Δ₁, Δ₂ CHECK TEST

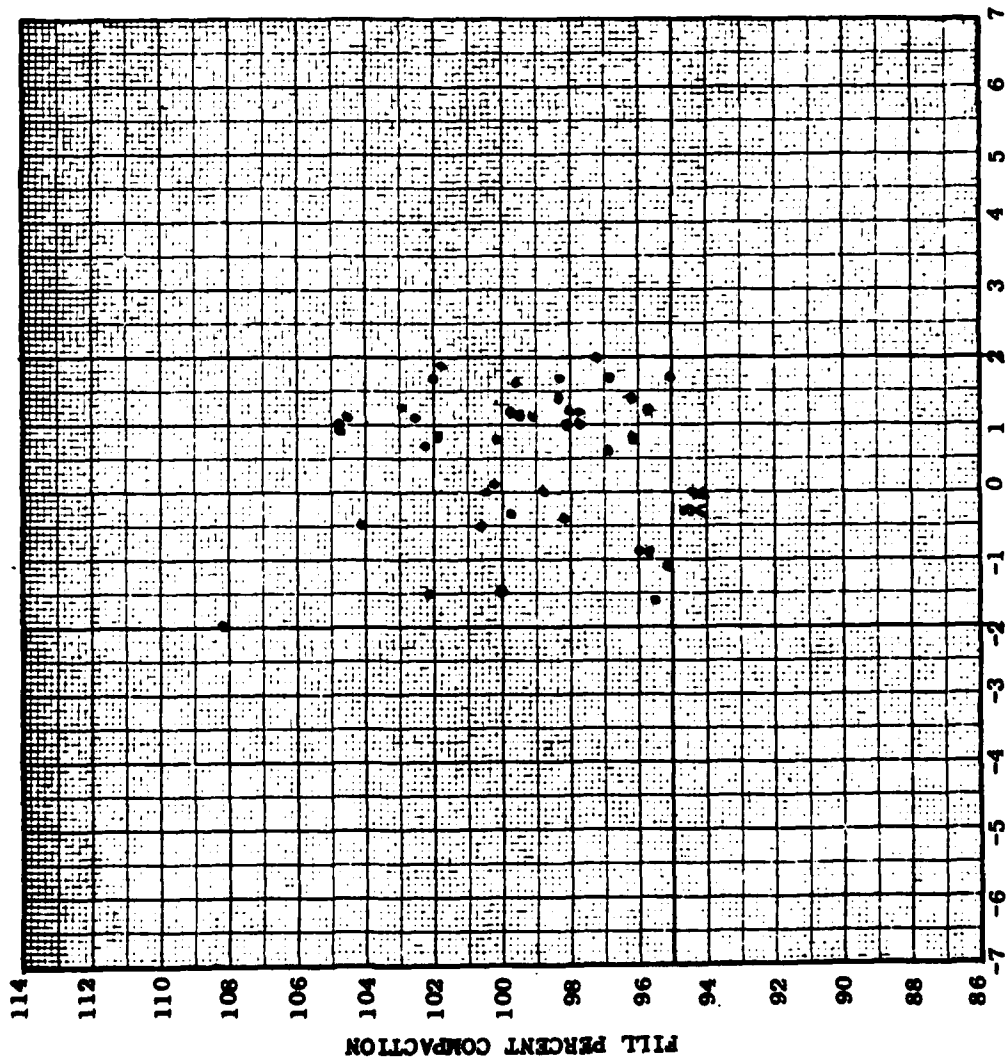
NOTE: USE SAME NUMBER FOR LATER REWORKED AND RETESTED AND RESULT OF RETEST AND FOR INITIAL AND CHECK TEST.

Stationing of Areas Tested	15+00 to 24+70
Elevation of Areas Tested	666.0 to 709.0

VARIATION OF FILL w FROM LAB OPTIMUM w, PERCENTAGE POINTS

ENG Form 4287A
JUN 69

SPECIFIED RANGE OF WATER CONTENT



VARIATION OF FILL W FROM LAB OPTIMUM W.
PERCENTAGE POINTS

ENG Form 4287A
JUN 69

Cave Run Lake
PROJECT: Construction of Dam and Spillway
DISTRICT: Louisville
REPORT PERIOD: 9-1-70 thru 9-30-70
REPORT NO.: 5
TYPE OF MATERIAL: Impervious

	CUMULATIVE TO THIS REPORT	THIS REPORT
TOTAL NO. OF TESTS	150	42
NO. OUTSIDE LIMITS:		
TOTAL	10	1
w	1	0
DENSITY	9	1
w & DENSITY	2	0
NO. REWORKED	10	1
NO. RETESTED AFTER REWORKING	2	0

LEGEND:

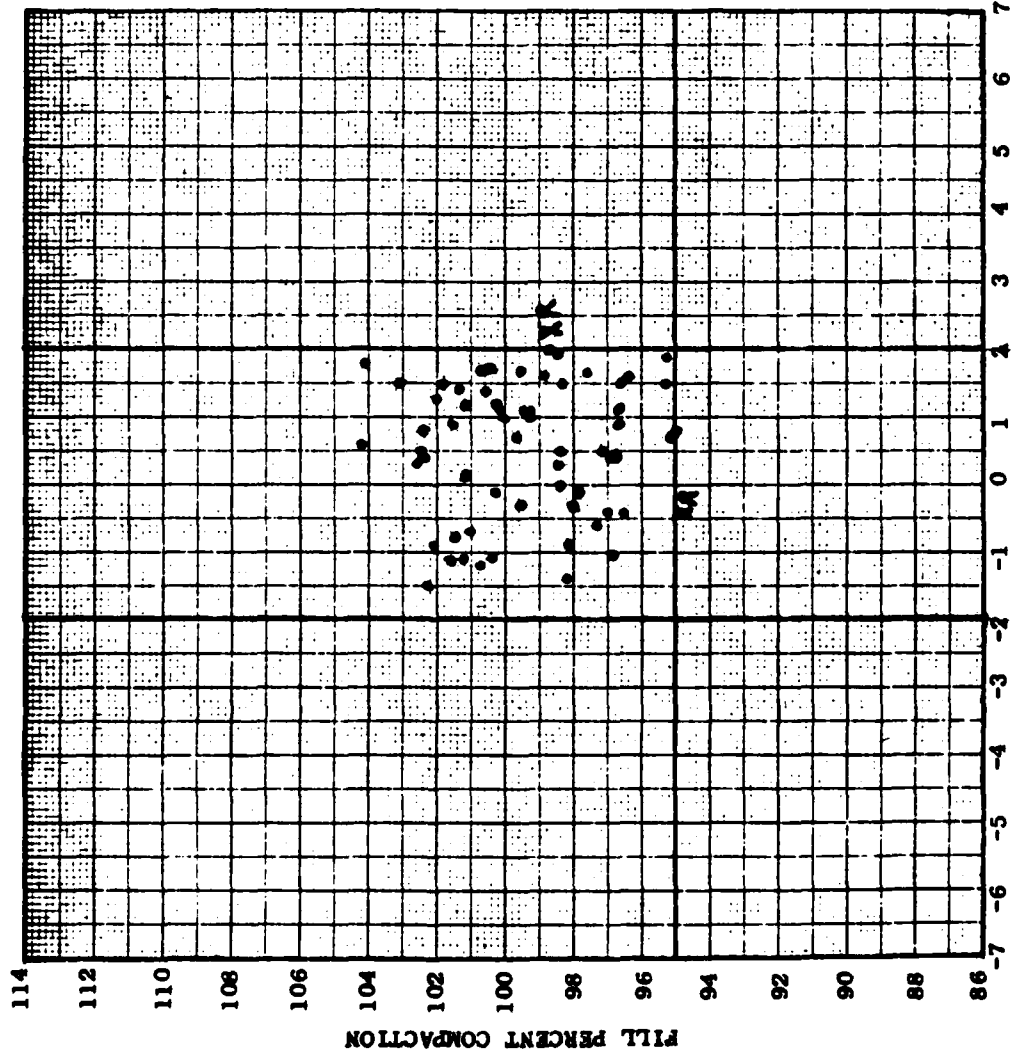
- WITHIN ACCEPTABLE LIMITS
- x OUTSIDE ACCEPTABLE LIMITS
- x_r LATER REWORKED ONLY (NO RETEST)
- x₁, x₂ LATER REWORKED AND RETESTED
- _p, ●₂ RESULT OF RETEST AFTER REWORKING
- Δ₁, Δ₂ INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ₁, Δ₂ CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

Stationing of Areas Tested	9+65 to 26+00
Elevation of Areas Tested	546.0 to 713.0

(REWORKED) (SPECIFIED) MIN PERCENT OF MAX STD DRY DEN

SPECIFIED RANGE OF WATER CONTENT



VARIATION OF FILL % FROM LAB OPTIMUM w,
PERCENTAGE POINTS

ENC Form 4287A
JUN 69

Cave Run Lake
PROJECT: Construction of Dam and Spillway
DISTRICT: Louisville
REPORT PERIOD: 10 Oct., 70 thru 31 Oct., 70
REPORT NO.: 6
TYPE OF MATERIAL: Impervious

	CUMULATIVE TO THIS REPORT	THIS REPORT
TOTAL NO. OF TESTS	213	63
NO. OUTSIDE LIMITS:		
TOTAL	12	2
w	2	1
DENSITY	10	1
w & DENSITY	0	0
NO. REWORKED	12	2
NO. RETESTED AFTER REWORKING	2	0

LEGEND:

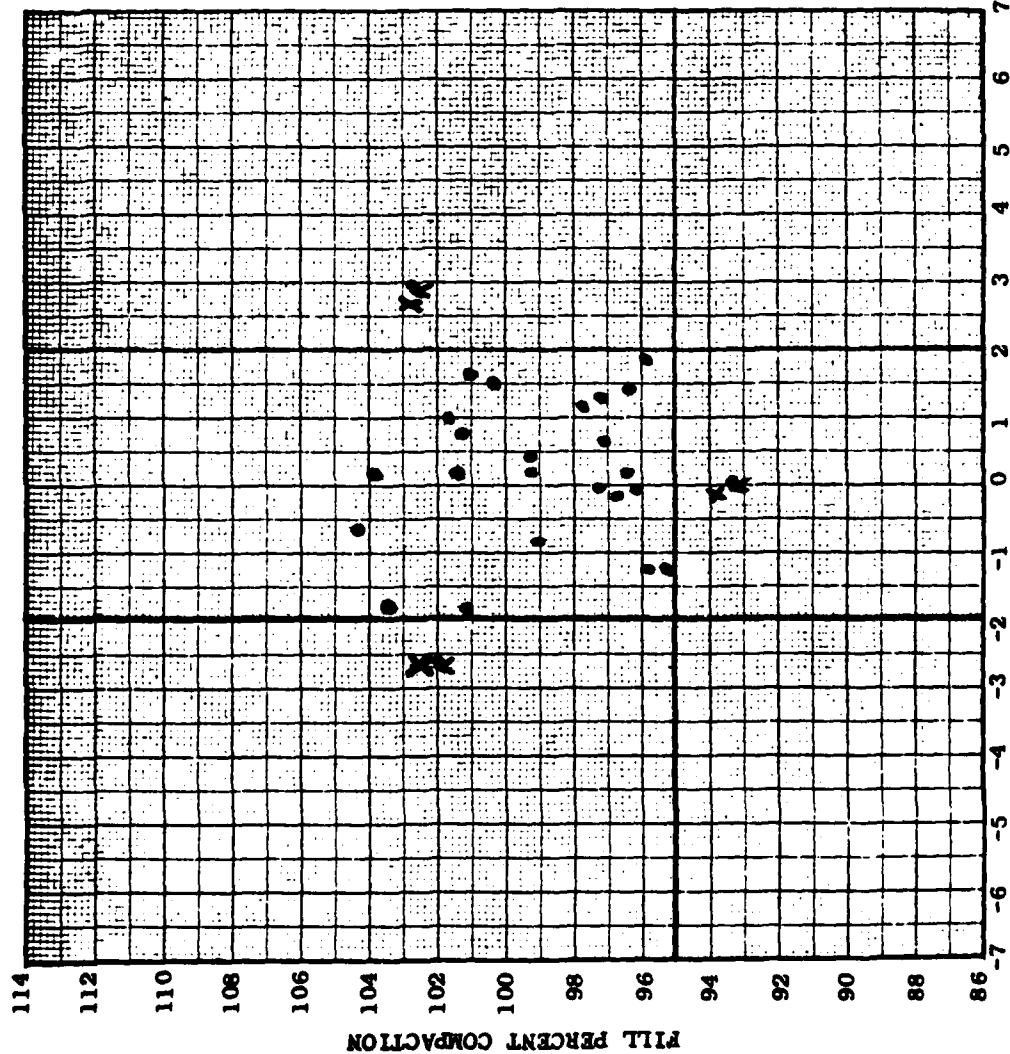
- WITHIN ACCEPTABLE LIMITS
- x OUTSIDE ACCEPTABLE LIMITS
- x_r LATER REWORKED ONLY (NO RETEST)
- x₁, x₂ LATER REWORKED AND RETESTED
- _p, ●₂ RESULT OF RETEST AFTER REWORKING
- Δ₁, Δ₂ INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ₁, Δ₂ CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

Stationing of Areas Tested	9+20 to 24+50
Elevation of Areas Tested	670.0 to 703.0

(REMOVED) (SPECIFIED) MIN PERCENT OF MAX STD DRY DEN

SPECIFIED RANGE OF WATER CONTENT



VARIATION OF FILL w FROM LAB OPTIMUM w ,
PERCENTAGE POINTS

ENG Form 4287A
JUN 69

PROJECT: CAVE RUN LAKE
DISTRICT: LOUISVILLE
REPORT PERIOD: 9 MAY TO 30 MAY 1970
REPORT NO.: 7
TYPE OF MATERIAL: JAMP

	CUMULATIVE TO THIS REPORT	THIS REPORT
TOTAL NO. OF TESTS	239	26
NO. OUTSIDE LIMITS:		
TOTAL	15	3
w	4	2
DENSITY	11	1
w & DENSITY		
NO. REWORKED	15	3
NO. RETESTED AFTER REWORKING	2	0

LEGEND:

- WITHIN ACCEPTABLE LIMITS
- x OUTSIDE ACCEPTABLE LIMITS
- x_R LATER REWORKED ONLY (NO RETEST)
- x_1, x_2 LATER REWORKED AND RETESTED
- $\odot_1, \odot_2$ RESULT OF RETEST AFTER REWORKING
- Δ_1, Δ_2 INITIAL TEST (USE ONLY w /CHECK TEST)
- Δ_1, Δ_2 CHECK TEST

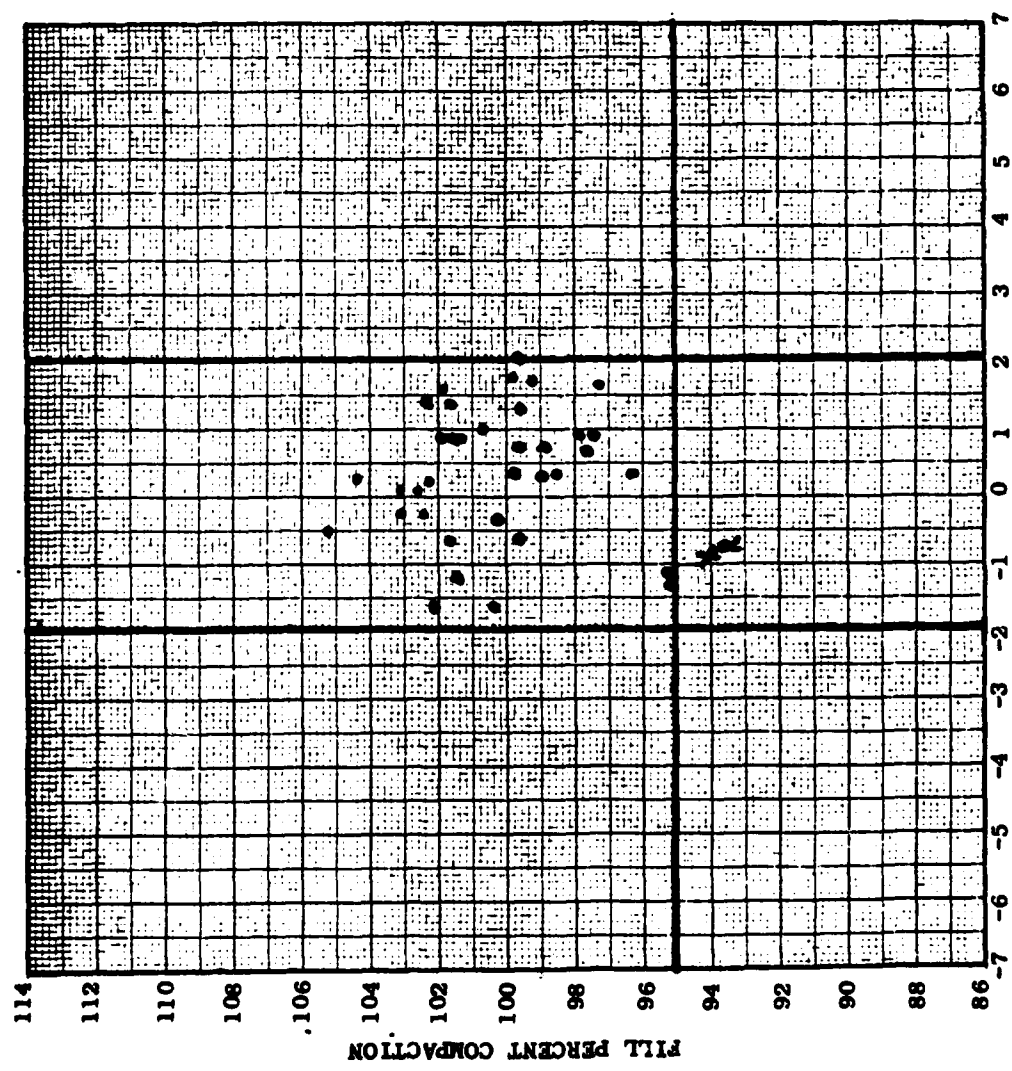
NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

Stationing of Areas Tested	11+00 to 23+00
Elevation of Areas Tested	681.0 to 701.5

(PRINTED) (SPECIFIED) MIN PERCENT OF MAX STD DRY DEN

SPECIFIED RANGE OF WATER CONTENT

Cave Run Lake
PROJECT: Construction of Dam and Spillway
DISTRICT: Louisville
REPORT PERIOD: 1 Dec 70 to 31 Dec 70
REPORT NO.: 9
TYPE OF MATERIAL: Impervious



(TESTED) (SPECIFIED) MIN PERCENT OF MAX STD DRY DEN

TOTAL NO. OF TESTS	CUMULATIVE TO THIS REPORT	
	REPORT	THIS
37	276	37
NO. OUTSIDE LIMITS:		
TOTAL	15	1
w	4	0
DENSITY	12	1
w & DENSITY	0	0
NO. REWORKED	16	1
NO. RETESTED AFTER REWORKING	2	0

LEGEND:

- WITHIN ACCEPTABLE LIMITS
- x OUTSIDE ACCEPTABLE LIMITS
- x₁ LATER REWORKED ONLY (NO RETEST)
- x₁, x₂ LATER REWORKED AND RETESTED
- ₁, ●₂ RESULT OF RETEST AFTER REWORKING
- Δ₁, Δ₂ INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ₁, Δ₂ CHECK TEST

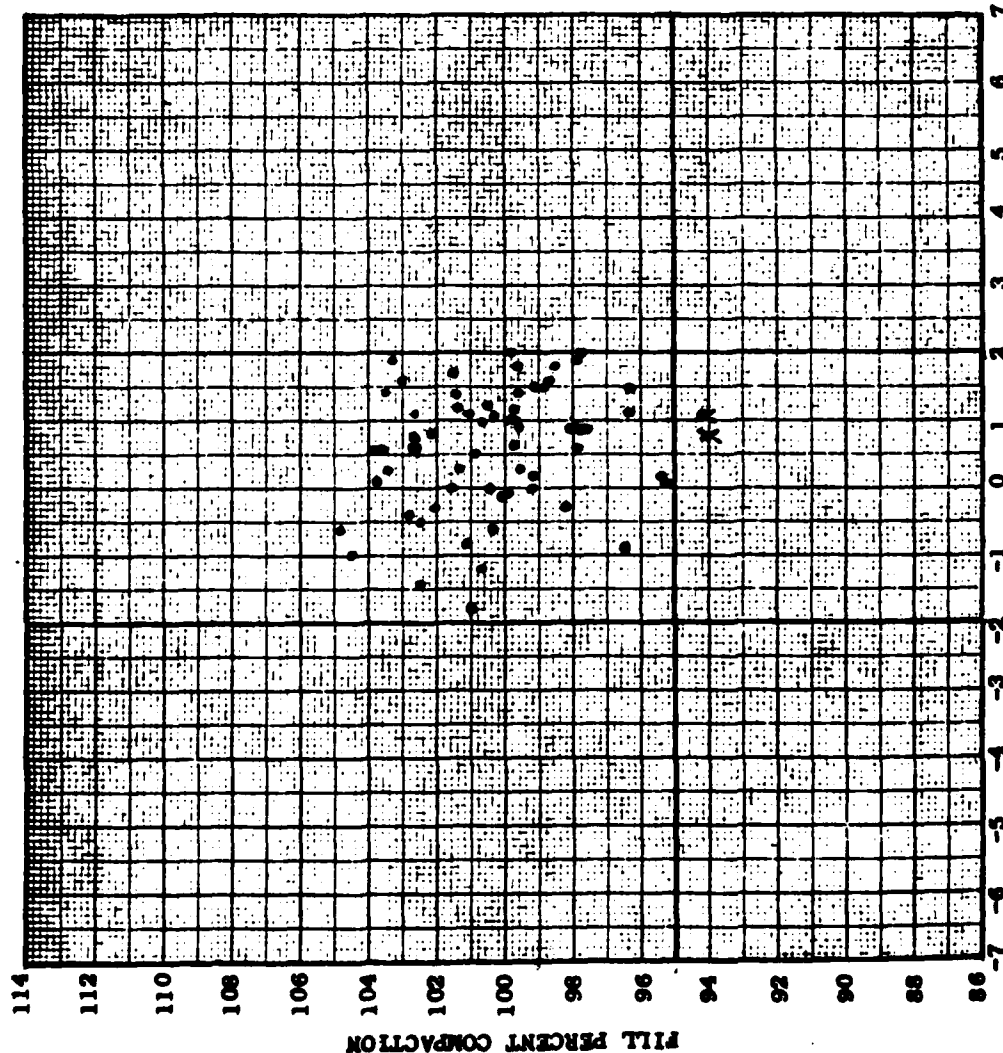
NOTE: USE SAME NUMBER FOR LATER REWORKED AND RETESTED AND RESULT OF RETEST AND FOR INITIAL AND CHECK TEST.

Stationing of Areas Tested	11+00 to 24+20
Elevation of Areas Tested	681.0 to 706.0

VARIATION OF FILL w FROM LAB OPTIMUM w, PERCENTAGE POINTS

ENG. Form 4287A
JUN 69

SPECIFIED RANGE OF WATER CONTENT



VARIATION OF FILL % FROM LAB OPTIMUM w,
PERCENTAGE POINTS

EMC Form 4287A
JUN 69

PROJECT: CAVE RUN LAKE
DISTRICT: LEWISVILLE
REPORT PERIOD: 4-1-71 To 4-30-71
REPORT NO.: 9
TYPE OF
MATERIAL: IMP. & RANDOM

CUMULATIVE
TO THIS
REPORT
THIS
REPORT
63

TOTAL 16
v 4
DENSITY 13
v & DENSITY 0
NO. REWORKED 17
NO. RETESTED
AFTER REWORKING 2

LEGEND:

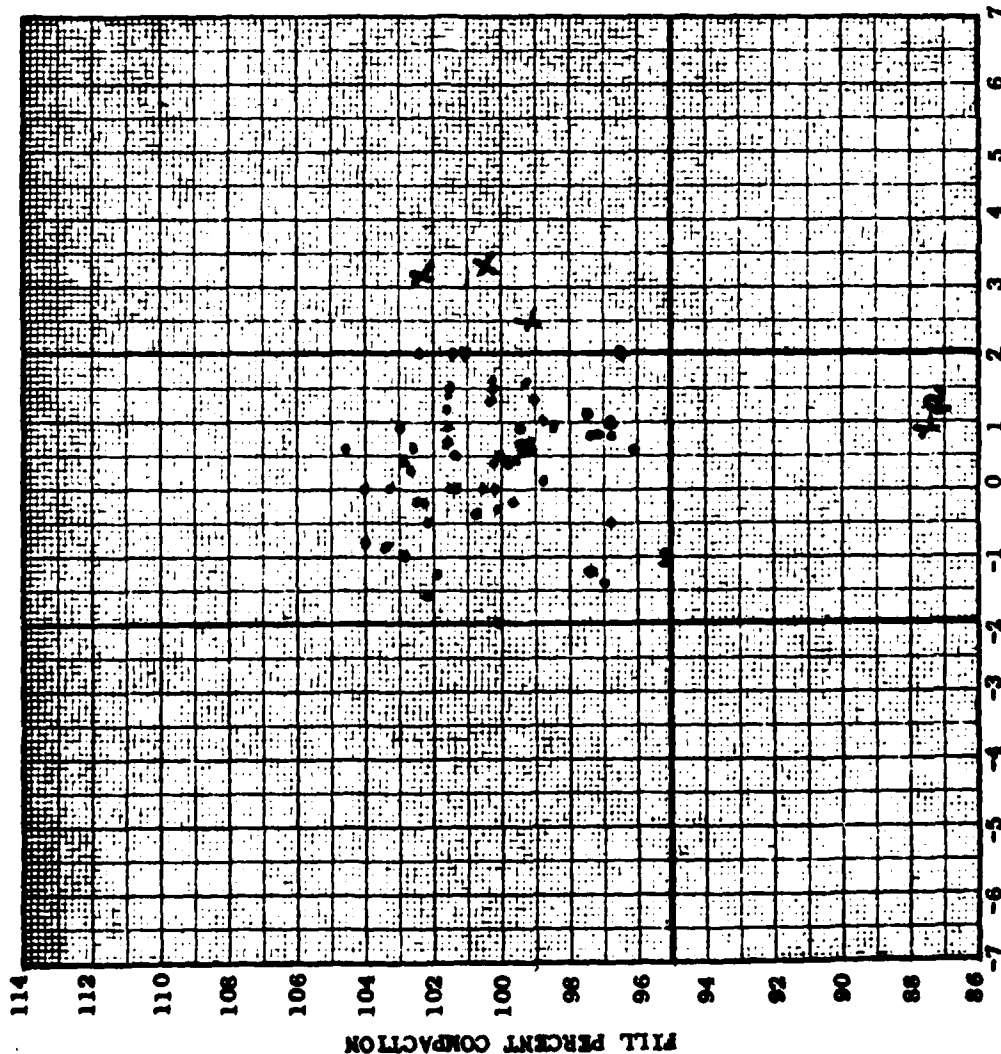
- o WITHIN ACCEPTABLE LIMITS
- x OUTSIDE ACCEPTABLE LIMITS
- x_r LATER REWORKED ONLY (NO RETEST)
- x₁, x₂ LATER REWORKED AND RETESTED
- o_p, o₂ RESULT OF RETEST AFTER REWORKING
- A₁, A₂ INITIAL TEST (USE ONLY w/CHECK TEST)
- A₁, A₂ CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

Stationing of Areas Tested	10+00 to 25+20
Elevation of Areas Tested	679.0 to 715.5

(BROKEN) (SPECIFIED) MIN PERCENT OF MAX STD DRY DEN

SPECIFIED RANGE OF WATER CONTENT



VARIATION OF FILL w FROM LAB OPTIMUM w,
PERCENTAGE POINTS

ENC Form 4287A

7-69

PROJECT: Cave Run Lake
DISTRICT: LEWISVILLE
REPORT PERIOD: May 71 - May 71
REPORT NO.: 16
TYPE OF
MATERIAL: Impervious Random Earth

	CUMULATIVE TO THIS REPORT	THIS REPORT
TOTAL NO. OF TESTS	<u>402</u>	<u>64</u>
NO. OUTSIDE LIMITS:		
TOTAL	<u>20</u>	<u>4</u>
w	<u>7</u>	<u>3</u>
DENSITY	<u>14</u>	<u>1</u>
w & DENSITY	<u>0</u>	<u>0</u>
NO. REWORKED	<u>18</u>	<u>1</u>
NO. RETESTED AFTER REWORKING	<u>2</u>	<u>0</u>

LEGEND:

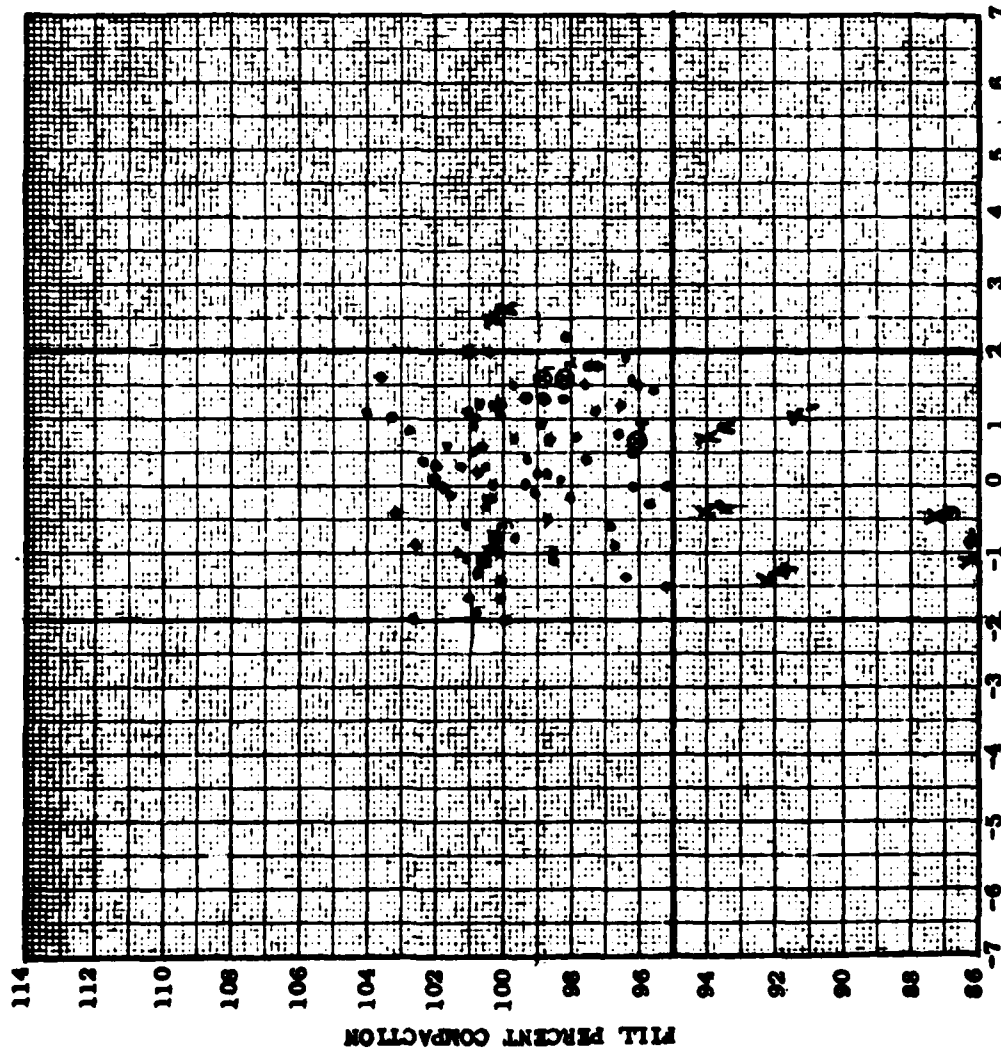
- WITHIN ACCEPTABLE LIMITS
- x OUTSIDE ACCEPTABLE LIMITS
- x₁ LATER REWORKED ONLY (NO RETEST)
- x₂ LATER REWORKED AND RETESTED
- ₁ ●₂ RESULT OF RETEST AFTER REWORKING
- Δ₁ Δ₂ INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ₁ Δ₂ CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

Stationing of Areas Tested	<u>11+00 To 26+00</u>
Elevation of Areas Tested	<u>691.0 To 721.8</u>

(REWORKED) (SPECIFIED) MIN PERCENT OF MAX STD DRY DEN

SPECIFIED RANGE OF WATER CONTENT



VARIATION OF FILL % FROM LAB OPTIMUM %
PERCENTAGE POINTS

ENG Form 4237A
JUN 59

PROJECT: Cave Run Lake
DISTRICT: LOUISVILLE
REPORT PERIOD: 1 June - 30 June 1971
REPORT NO.: 11
TYPE OF MATERIAL: Impervious & Random Earth

	CUMULATIVE TO THIS REPORT	THIS REPORT
TOTAL NO. OF TESTS	494	92
NO. OUTSIDE LIMITS:		
TOTAL	28	8
γ	9	2
DENSITY	20	6
γ & DENSITY	0	0
NO. REWORKED	25	7
NO. RETESTED AFTER REWORKING	6	4

LEGEND:

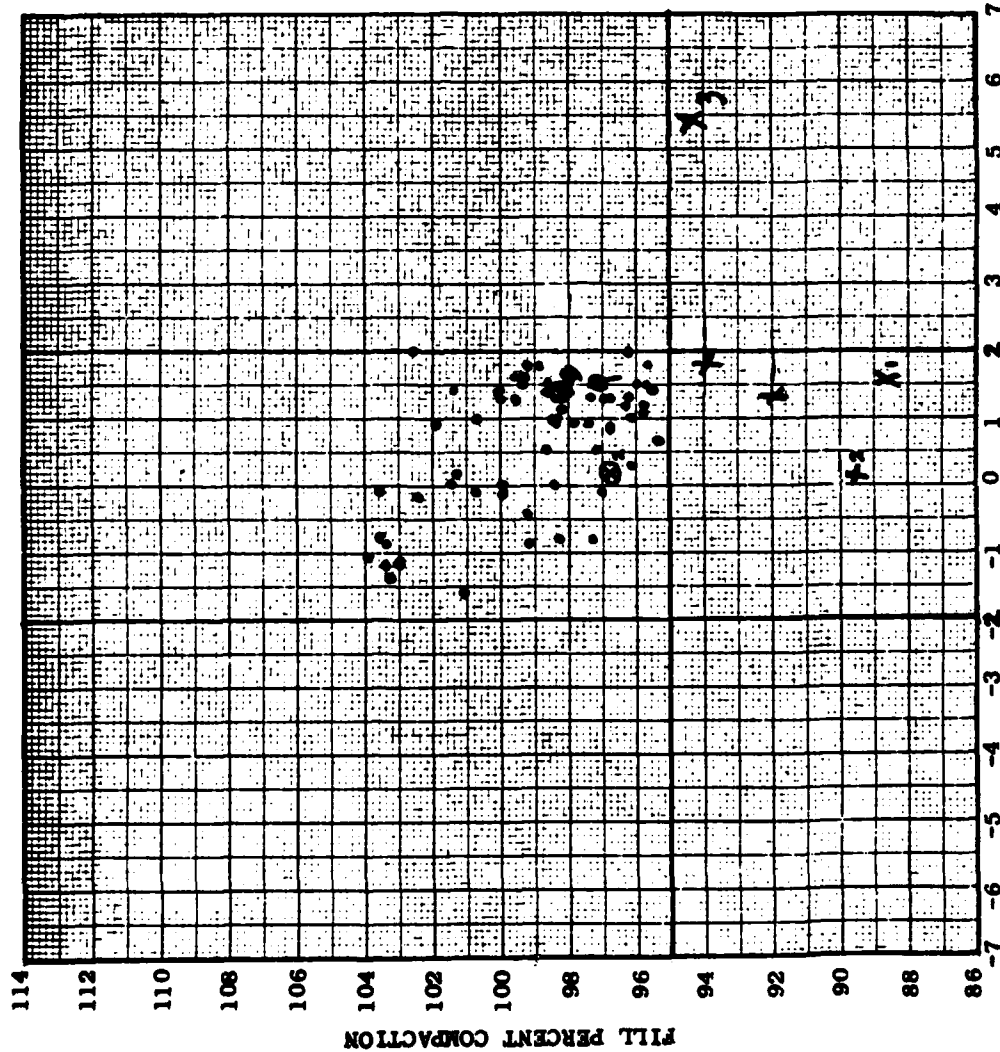
- WITHIN ACCEPTABLE LIMITS
- x OUTSIDE ACCEPTABLE LIMITS
- x_R LATER REWORKED ONLY (NO RETEST)
- x_1, x_2 LATER REWORKED AND RETESTED
- ϕ, ϕ_2 RESULT OF RETEST AFTER REWORKING
- Δ, Δ_2 INITIAL TEST (USE ONLY γ /CHECK TEST)
- Δ_1, Δ_2 CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

Stationing of Areas Tested	2+85 to 25+55
Elevation of Areas Tested	648.0 to 720.0

(SPECIFIED) MIN PERCENT OF MAX STD DRY DEN

SPECIFIED RANGE OF WATER CONTENT



VARIATION OF FILL w FROM LAB OPTIMUM w,
PERCENTAGE POINTS

ENG Form 4287A
JUN 69

PROJECT: Cave Run Lake
DISTRICT: LOUISVILLE
REPORT PERIOD: 7-1-71 to 7-31-71
REPORT NO.: 12
TYPE OF MATERIAL: Impervious - Random Earth

	CUMULATIVE TO THIS REPORT	THIS REPORT
TOTAL NO. OF TESTS	556	62
NO. OUTSIDE LIMITS:		
TOTAL	33	5
w	10	1
DENSITY	24	4
w & DENSITY	0	0
NO. REWORKED	28	3
NO. RETESTED AFTER REWORKING	9	3

LEGEND:

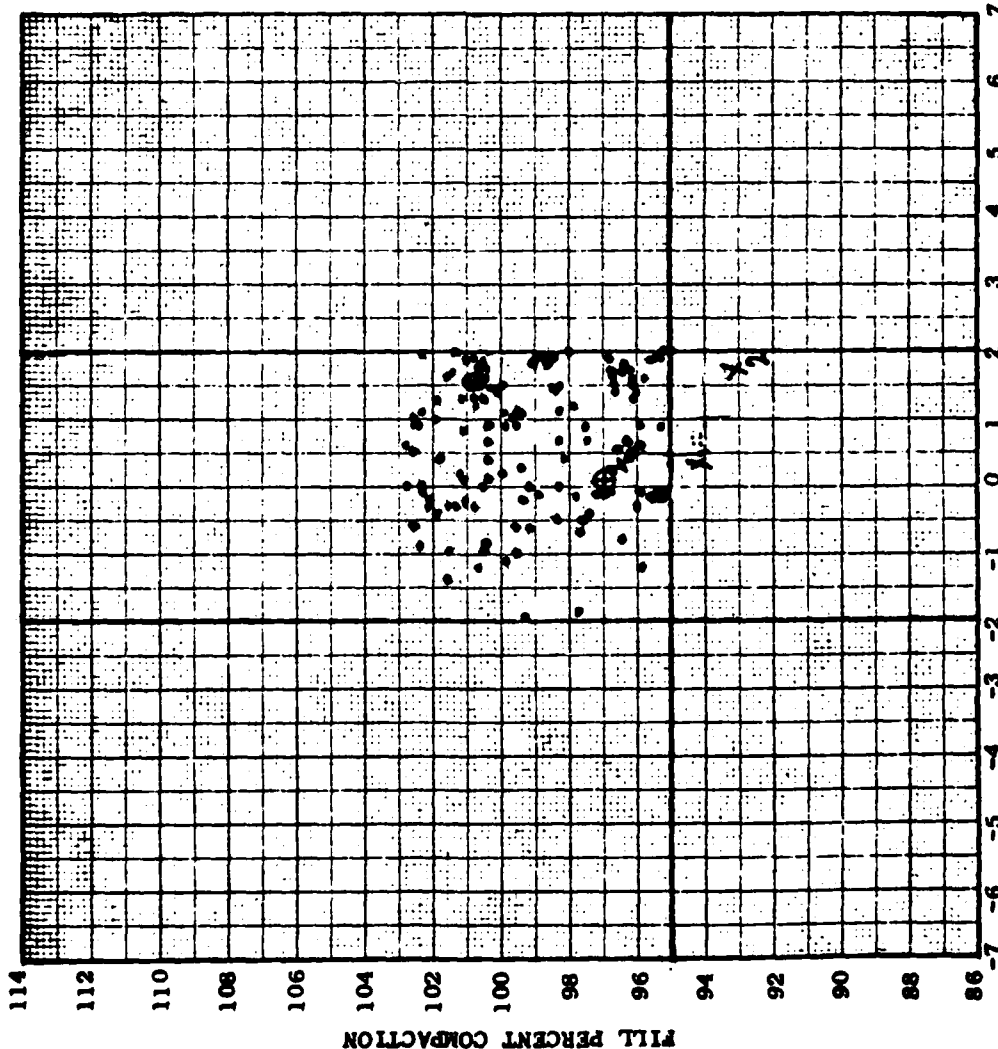
- WITHIN ACCEPTABLE LIMITS
- x OUTSIDE ACCEPTABLE LIMITS
- x₁ LATER REWORKED ONLY (NO RETEST)
- x₁, x₂ LATER REWORKED AND RETESTED
- ₁, ●₂ RESULT OF RETEST AFTER REWORKING
- Δ₁, Δ₂ INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ₁, Δ₂ CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

(Specified) MIN PERCENT OF MAX STD DRY DEN

Stationing of Areas Tested	2+90 to 24+50
Elevation of Areas Tested	654.0 to 720.0

SPECIFIED RANGE OF WATER CONTENT



VARIATION OF FILL w FROM LAB OPTIMUM w ,
PERCENTAGE POINTS

EMC Form 4287A
JUN 69

PROJECT: Cave Run Lake
DISTRICT: Louisville
REPORT PERIOD: 8/17/71 to 8/31/71
REPORT NO.: 13
TYPE OF MATERIAL: Impervious & Random Earth

	CUMULATIVE TO THIS REPORT	THIS REPORT
TOTAL NO. OF TESTS	683	127
NO. OUTSIDE LIMITS:		
TOTAL	34	2
w	10	0
DENSITY	26	2
w & DENSITY	0	0
NO. REWORKED	32	2
NO. RETESTED AFTER REWORKING	13	2

LEGEND:

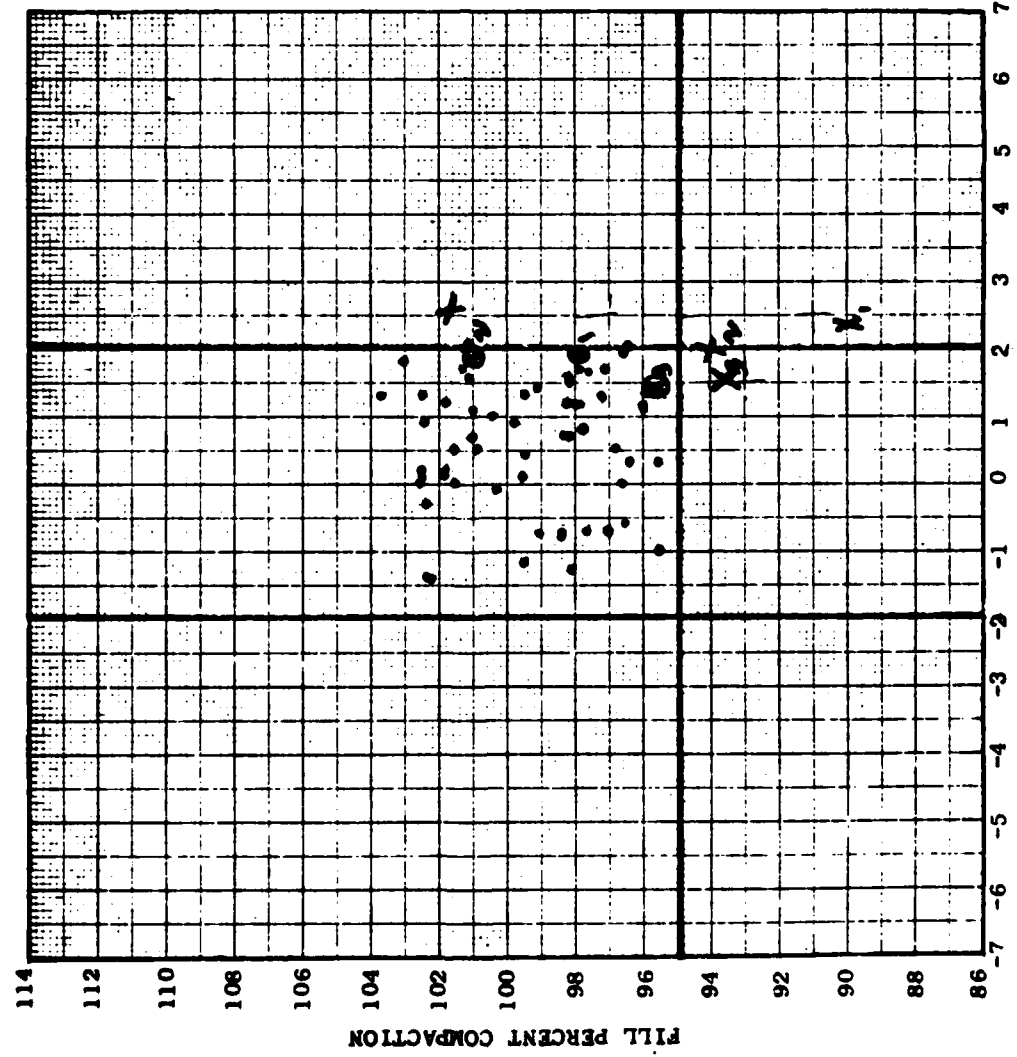
- WITHIN ACCEPTABLE LIMITS
- x OUTSIDE ACCEPTABLE LIMITS
- x_R LATER REWORKED ONLY (NO RETEST)
- x_1, x_2 LATER REWORKED AND RETESTED
- ₁, ●₂ RESULT OF RETEST AFTER REWORKING
- Δ₁, Δ₂ INITIAL TEST (USE ONLY w /CHECK TEST)
- Δ₁, Δ₂ CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

Stationing of Areas Tested	3+25 to 26+50
Elevation of Areas Tested	645.0 to 724.5

(DESIGNED) (SPECIFIED) MIN PERCENT OF MAX STD DRY DEN

SPECIFIED RANGE OF WATER CONTENT



ENG Form 4287A
JUN 69
VARIATION OF FILL w FROM LAB OPTIMUM w,
PERCENTAGE POINTS

PROJECT: Cave run Lake
DISTRICT: LOUISVILLE
REPORT PERIOD: 9-1-71 thru 9-30-71
REPORT NO.: 14
TYPE OF MATERIAL: Impervious & Random Earth

	CUMULATIVE TO THIS REPORT	THIS REPORT
TOTAL NO. OF TESTS	745	62
NO. OUTSIDE LIMITS:		
TOTAL	38	4
w	11	1
DENSITY	28	2
w & DENSITY	1	1
NO. REWORKED	35	3
NO. RETESTED AFTER REWORKING	16	3

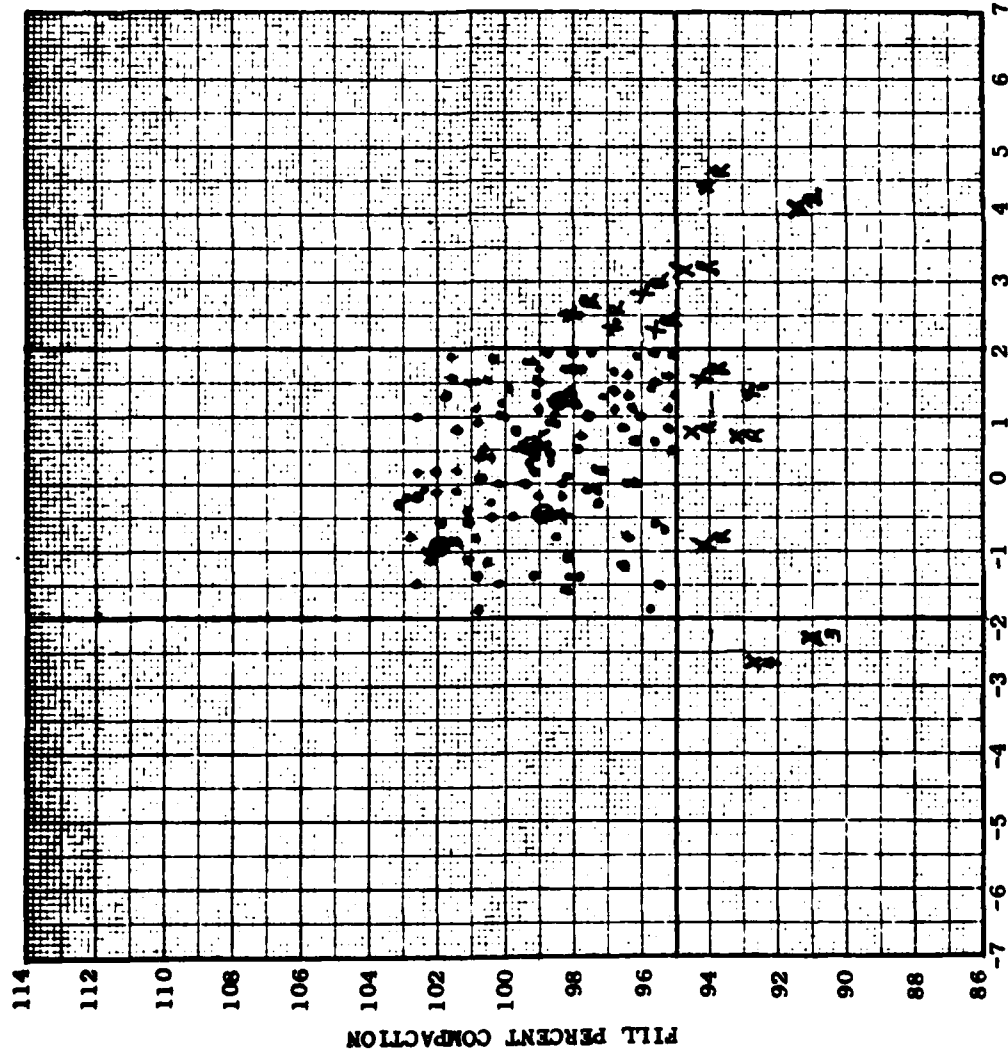
- LEGEND:
- WITHIN ACCEPTABLE LIMITS
 - x OUTSIDE ACCEPTABLE LIMITS
 - x_n LATER REWORKED ONLY (NO RETEST)
 - x₁, x₂ LATER REWORKED AND RETESTED
 - ₁, ●₂ RESULT OF RETEST AFTER REWORKING
 - Δ₁, Δ₂ INITIAL TEST (USE ONLY w/CHECK TEST)
 - Δ₁, Δ₂ CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

Stationing of Areas Tested	3+00 to 24+00
Elevation of Areas Tested	644.0 to 720.0

(DESIGNED) (SPECIFIED) MIN PERCENT OF MAX STD DRY DEN

SPECIFIED RANGE OF WATER CONTENT



VARIATION OF FILL w FROM LAB OPTIMUM w ,
PERCENTAGE POINTS

ENG. Form 4287A
JUN 69

PROJECT: Cave Run Lake
DISTRICT: Louisville
REPORT PERIOD: 1 Oct. to 31 Oct 1971
REPORT NO.: 15
TYPE OF MATERIAL: Impervious & Random Earth

TOTAL NO. OF TESTS	NO. OUTSIDE LIMITS:	CUMULATIVE TO THIS REPORT	
		885	140
TOTAL		60	22
w		20	9
DENSITY		37	9
w & DENSITY		5	4
NO. REWORKED		57	22
NO. RETESTED AFTER REWORKING		20	4

LEGEND:

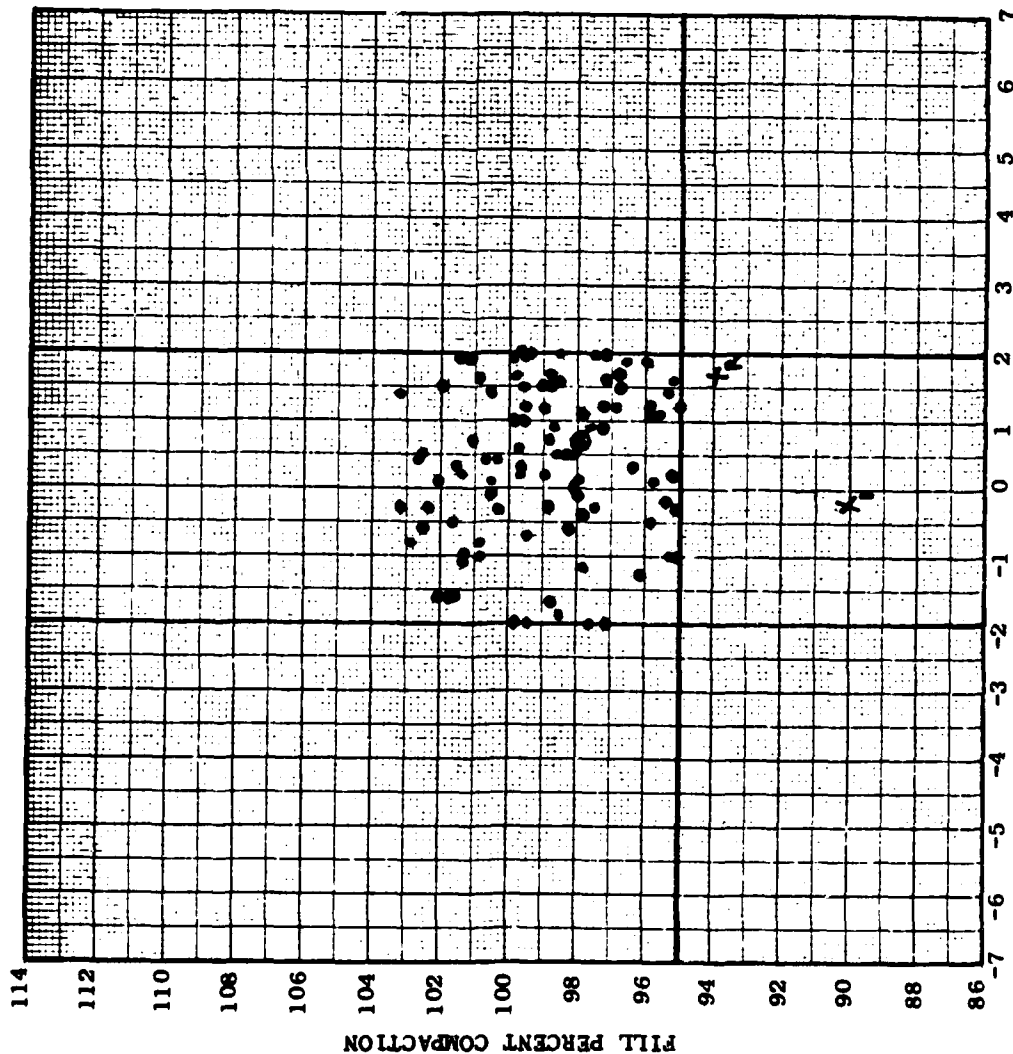
- WITHIN ACCEPTABLE LIMITS
- x OUTSIDE ACCEPTABLE LIMITS
- x_R LATER REWORKED ONLY (NO RETEST)
- x_1, x_2 LATER REWORKED AND RETESTED
- , ●₂ RESULT OF RETEST AFTER REWORKING
- Δ_1, Δ_2 INITIAL TEST (USE ONLY w /CHECK TEST)
- Δ_1, Δ_2 CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED AND RETESTED AND RESULT OF RETEST AND FOR INITIAL AND CHECK TEST.

Stationing of Areas Tested	2+65 to 19+95
Elevation of Areas Tested	643.0 to 719.0

(B801HB) (SPECIFIED) MIN PERCENT OF MAX STD DRY DEN

SPECIFIED RANGE OF WATER CONTENT



VARIATION OF FILL w FROM LAB OPTIMUM w ,
PERCENTAGE POINTS

ENG Form 4287A
JUN 69

PROJECT: Cave Run Lake
DISTRICT: Louisville
REPORT PERIOD: Nov. 1971 to 30 Nov 1971
REPORT NO.: 16
TYPE OF
MATERIAL: Impervious & Random Earth

	CUMULATIVE TO THIS REPORT	THIS REPORT
TOTAL NO. OF TESTS	984	99

NO. OUTSIDE LIMITS:

TOTAL	62	2
w	20	0
DENSITY	39	2
w & DENSITY	5	0
NO. REWORKED	58	1
NO. RETESTED AFTER REWORKING	21	1

LEGEND:

- WITHIN ACCEPTABLE LIMITS
- x OUTSIDE ACCEPTABLE LIMITS
- x_R LATER REWORKED ONLY (NO RETEST)
- x_1, x_2 LATER REWORKED AND RETESTED
- $\odot_1, \odot_2$ RESULT OF RETEST AFTER REWORKING
- Δ_1, Δ_2 INITIAL TEST (USE ONLY w /CHECK TEST)
- Δ_1, Δ_2 CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

Stationing of Areas Tested	4+00 to 11+00
Elevation of Areas Tested	669.0 to 704.5

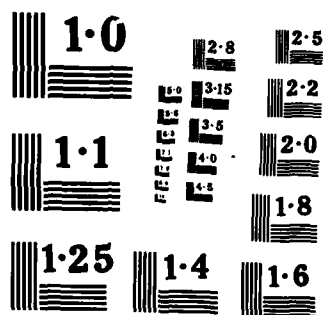
(Revised) (SPECIFIED) MIN PERCENT OF MAX STD DRY DEN

313

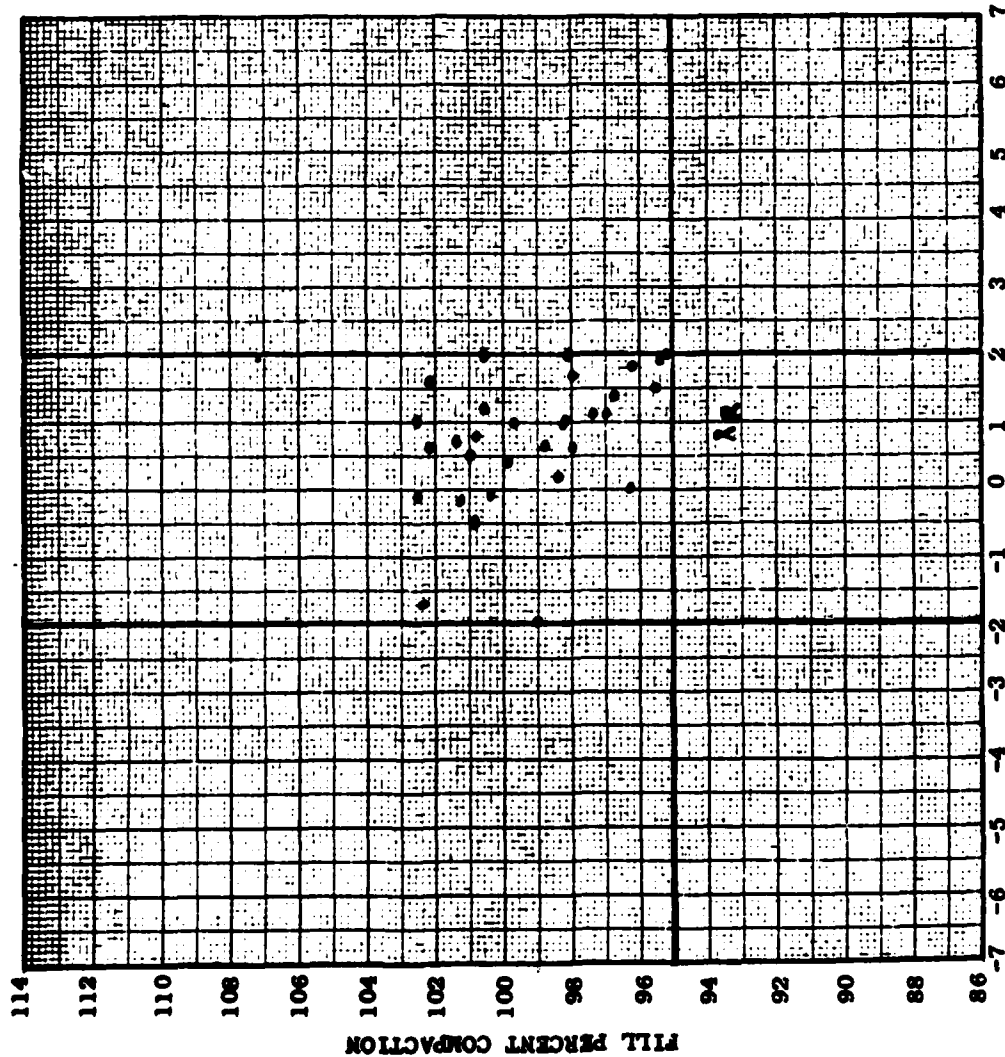
NL

F/G 13/2

END
DATE
FILMED
5-86
C11



SPECIFIED RANGE OF WATER CONTENT



VARIATION OF FILL % FROM LAB OPTIMUM %
PERCENTAGE POINTS

ENG Form 4287A
JUN 69

PROJECT: Cave Run Lake
DISTRICT: Louisville
REPORT PERIOD: 4/1/72 to 4/29/72
REPORT NO.: 17
TYPE OF

MATERIAL: Impervious & Random

	CUMULATIVE TO THIS REPORT	THIS REPORT
TOTAL NO. OF TESTS	1016	32

NO. OUTSIDE LIMITS:

TOTAL	63	1
w	20	0
DENSITY	40	1
w & DENSITY	5	0
NO. REWORKED	59	1
NO. RETESTED AFTER REWORKING	21	0

LEGEND:

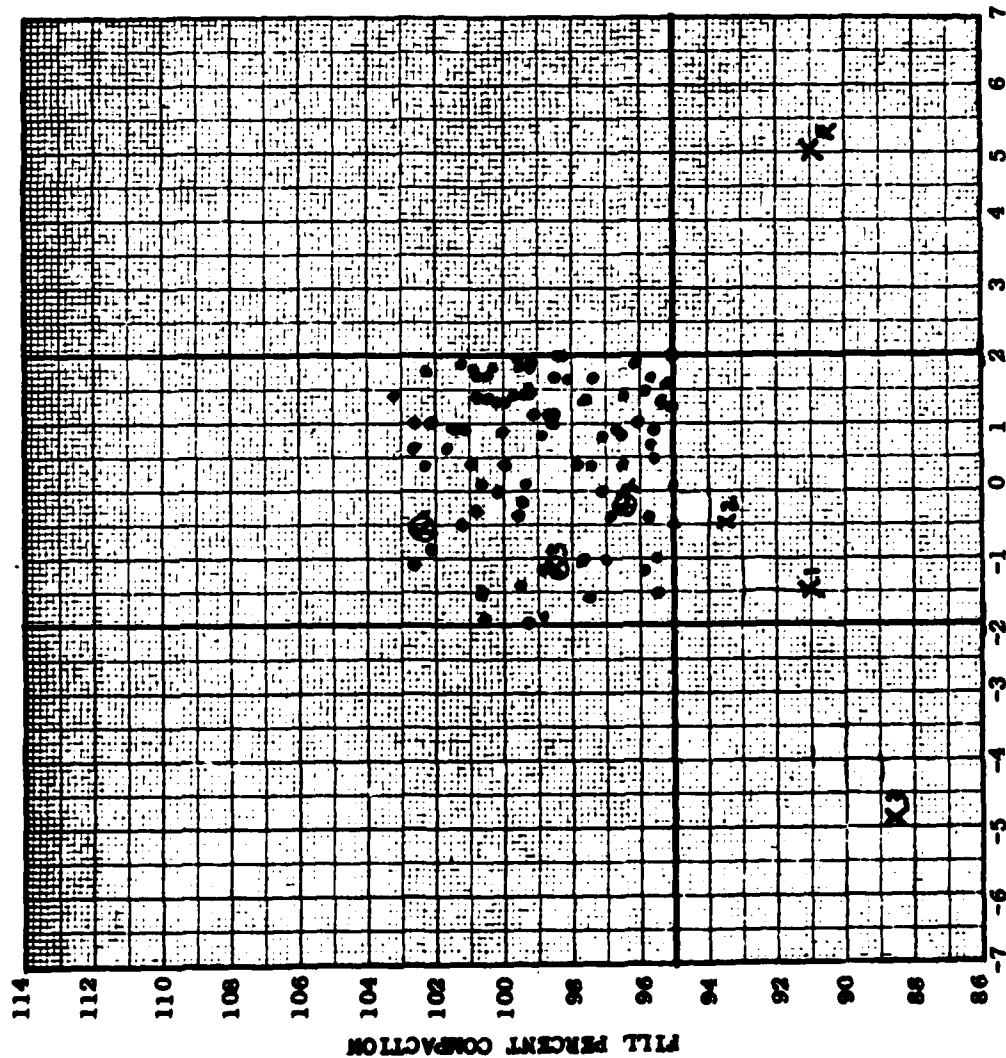
- WITHIN ACCEPTABLE LIMITS
- x OUTSIDE ACCEPTABLE LIMITS
- x_R LATER REWORKED ONLY (NO RETEST)
- x₁, x₂ LATER REWORKED AND RETESTED
- ₁, ●₂ RESULT OF RETEST AFTER REWORKING
- Δ₁, Δ₂ INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ₁, Δ₂ CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

Stationing of Areas Tested	3+90 to 26+50
Elevation of Areas Tested	701.5 to 728.5

(SPECIFIED) MIN PERCENT OF MAX STD DRY DEN

SPECIFIED RANGE OF WATER CONTENT



VARIATION OF FILL w FROM LAB OPTIMUM w ,
PERCENTAGE POINTS

ENC Form 4287A
JUN 69

PLATE 101

PROJECT: Cave Run Lake
DISTRICT: Louisville
REPORT PERIOD: 5-1 thru 5-31-72
REPORT NO.: 18
TYPE OF MATERIAL: Impervious & Random Earth

	CUMULATIVE TO THIS REPORT	THIS REPORT
TOTAL NO. OF TESTS	1113	97
NO. OUTSIDE LIMITS:		
TOTAL	67	4
w	22	2
DENSITY	42	2
w & DENSITY	6	1
NO. REWORKED	63	4
NO. RETESTED AFTER REWORKING	24	3

LEGEND:

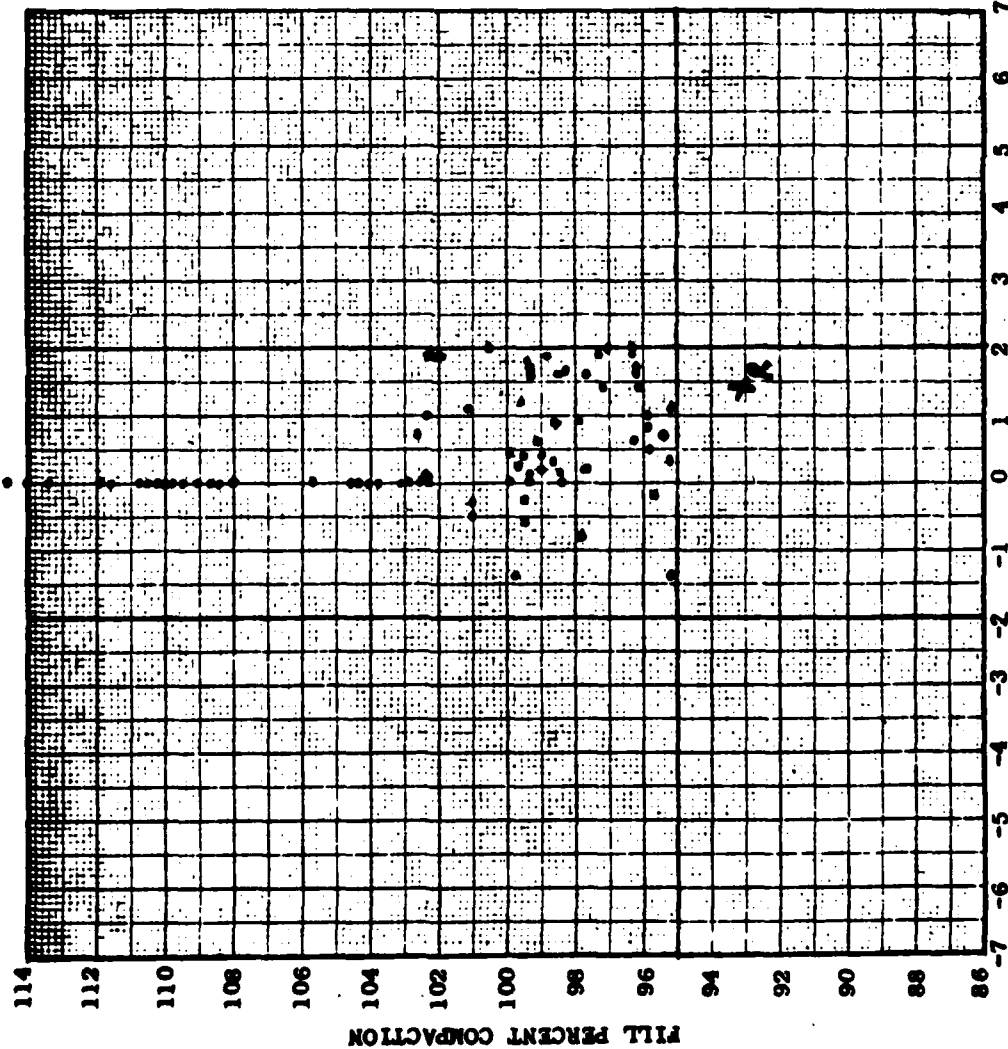
- WITHIN ACCEPTABLE LIMITS
- x OUTSIDE ACCEPTABLE LIMITS
- x_n LATER REWORKED ONLY (NO RETEST)
- x_1, x_2 LATER REWORKED AND RETESTED
- $\odot_2$ RESULT OF RETEST AFTER REWORKING
- Δ_1, Δ_2 INITIAL TEST (USE ONLY w /CHECK TEST)
- Δ_1, Δ_2 CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

Stationing of Areas Tested	3+25 to 27+15
Elevation of Areas Tested	700.0 to 728.5

(SPECIFIED) MIN PERCENT OF MAX STD DRY DEN

SPECIFIED RANGE OF WATER CONTENT



VARIATION OF FILL w FROM LAB OPTIMUM w,
PERCENTAGE POINTS

ENG Form 4287A
JUN 69

PROJECT: Cave Run Lake
DISTRICT: Louisville
REPORT PERIOD: 6/1/72 to 6/30/72
REPORT NO.: 19
TYPE OF: Impervious, Random Earth,
MATERIAL: Sandy Random, Residual Shale

	CUMULATIVE TO THIS REPORT	THIS REPORT
TOTAL NO. OF TESTS	1200	87
NO. OUTSIDE LIMITS:		
TOTAL	68	1
w	22	0
DENSITY	43	1
w & DENSITY	6	0
NO. REWORKED	64	1
NO. RETESTED AFTER REWORKING	24	0

LEGEND:

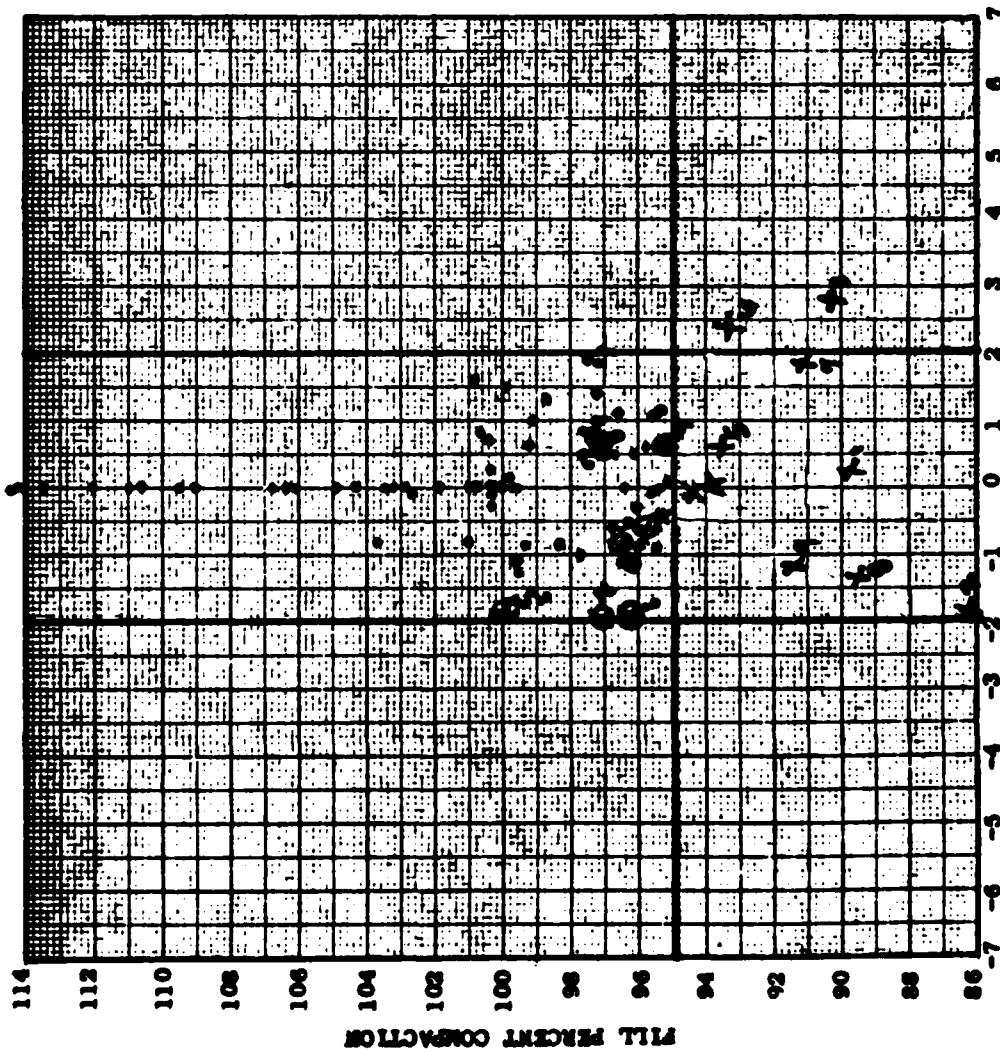
- WITHIN ACCEPTABLE LIMITS
- x OUTSIDE ACCEPTABLE LIMITS
- x_n LATER REWORKED ONLY (NO RETEST)
- x₁, x₂ LATER REWORKED AND RETESTED
- ₁, ●₂ RESULT OF RETEST AFTER REWORKING
- Δ₁, Δ₂ INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ₁, Δ₂ CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

Stationing of Areas Tested	3+45 to 27+25
Elevation of Areas Tested	713.0 to 735.0

(ASSURED)(SPECIFIED) MIN PERCENT OF MAX STD DRY DEN

SPECIFIED RANGE OF WATER CONTENT



VARIATION OF FILL w FROM LAB OPTIMUM w ,
PERCENTAGE POINTS

ESC Form 4287A
JUN 69

PROJECT: Cave Run Lake
DISTRICT: Louisville
REPORT PERIOD: 1 July - 31 July 1972
REPORT NO.: 20
TYPE OF: Sandy Random
MATERIAL: Impervious, Random Earth

	CUMULATIVE	
	TO THIS REPORT	THIS REPORT
TOTAL NO. OF TESTS	1296	96

NO. OUTSIDE LIMITS:	
TOTAL	77
w	24
DENSITY	51
w & DENSITY	8
NO. REWORKED	72
NO. RETESTED AFTER REWORKING	32

LEGEND:

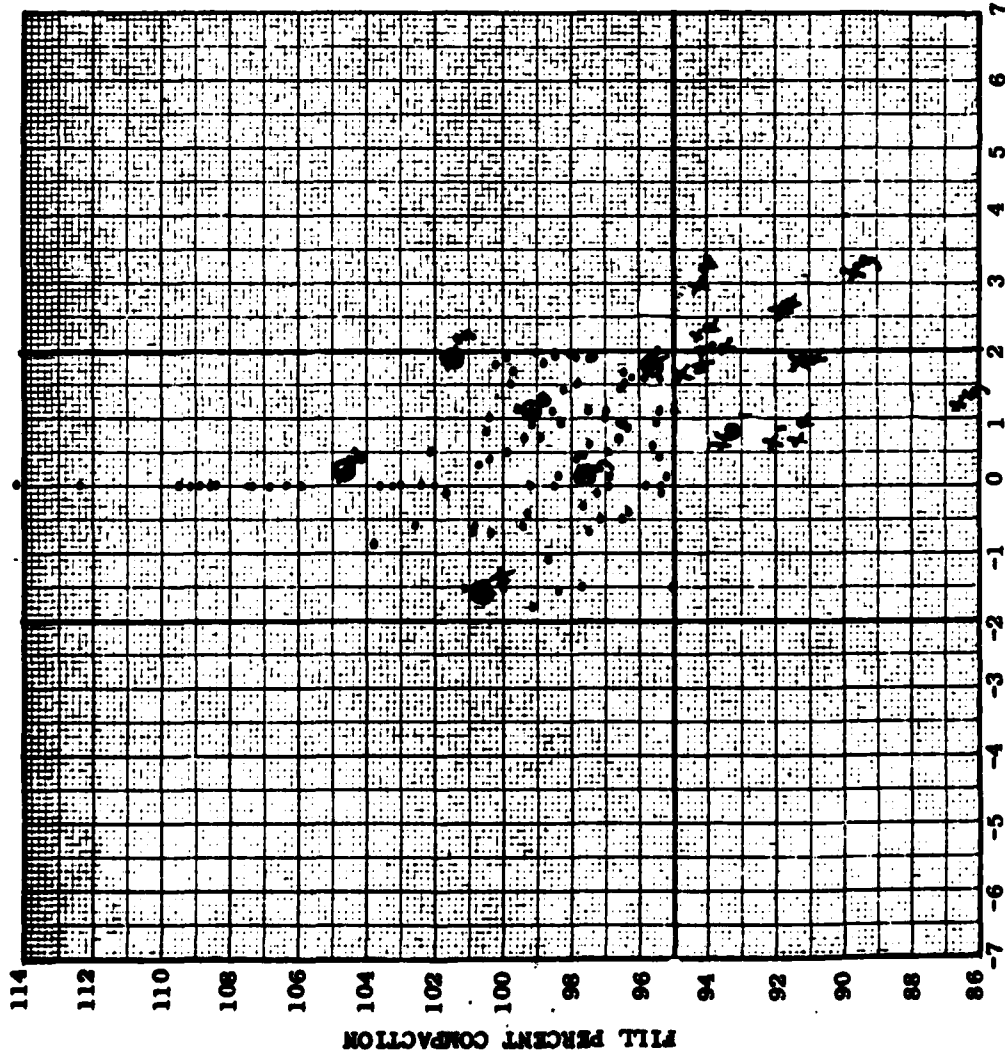
- WITHIN ACCEPTABLE LIMITS
- x OUTSIDE ACCEPTABLE LIMITS
- x_n LATER REWORKED ONLY (NO RETEST)
- x_n, x_2 LATER REWORKED AND RETESTED
- ϕ_1, ϕ_2 RESULT OF RETEST AFTER REWORKING
- Δ_1, Δ_2 INITIAL TEST (USE ONLY w /CHECK TEST)
- Δ_1, Δ_2 CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

Stationing of Areas Tested	5+00 to 26+95
Elevation of Areas Tested	715.5 to 744.5

(SPECIFIED) MIN PERCENT OF MAX STD DRY DEN

SPECIFIED RANGE OF WATER CONTENT



ENG Form 4287A
JUN 69
VARIATION OF FILL w FROM LAB OPTIMUM w ,
PERCENTAGE POINTS

PROJECT: Cave Run Lake
DISTRICT: Louisville
REPORT PERIOD: 8-1-72 to 8-1-72
REPORT NO.: 21
TYPE OF MATERIAL: Sandy Random
Impervious, Random Earth

	CUMULATIVE TO THIS REPORT	THIS REPORT
TOTAL NO. OF TESTS	1418	122
NO. OUTSIDE LIMITS:		
TOTAL	99	22
w	29	5
DENSITY	63	12
w & DENSITY	13	5
NO. REWORKED	89	17
NO. RETESTED AFTER REWORKING	38	6

LEGEND:

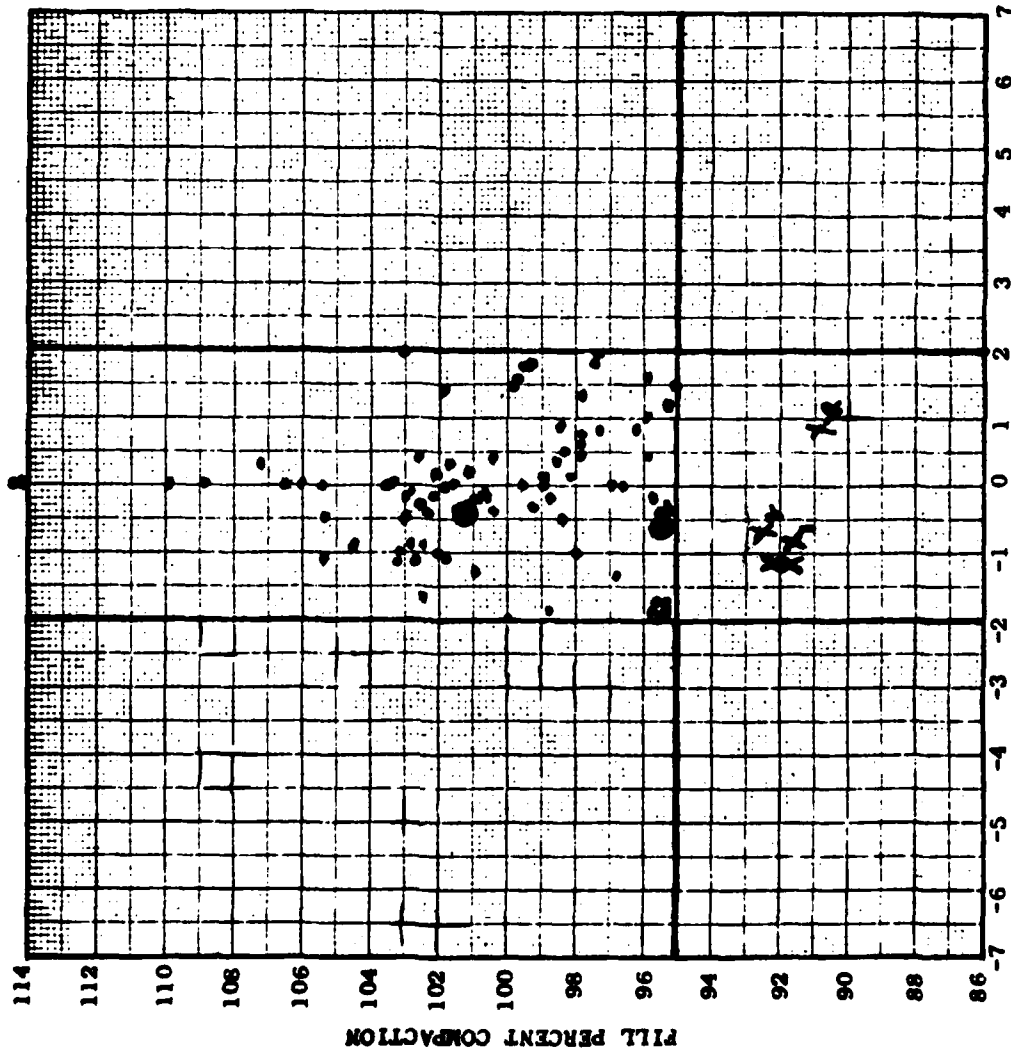
- WITHIN ACCEPTABLE LIMITS
- x OUTSIDE ACCEPTABLE LIMITS
- x_R LATER REWORKED ONLY (NO RETEST)
- x_1, x_2 LATER REWORKED AND RETESTED
- ϕ_1, ϕ_2 RESULT OF RETEST AFTER REWORKING
- Δ_1, Δ_2 INITIAL TEST (USE ONLY w /CHECK TEST)
- Δ_1, Δ_2 CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

Stationing of Areas Tested	3+25 to 27+20
Elevation of Areas Tested	717.0 to 752.4

(REMOVED) (SPECIFIED) MIN PERCENT OF MAX STD DRY DEN

SPECIFIED RANGE OF WATER CONTENT



VARIATION OF FILL w FROM LAB OPTIMUM w,
PERCENTAGE POINTS

ENG Form 4287A
JUN 69

PROJECT: Cave Run Lake
DISTRICT: LOUISVILLE
REPORT PERIOD: 1 - 30 Sept 72
REPORT NO.: 22
TYPE OF: Sandy random
MATERIAL: Impervious, random earth

	CUMULATIVE TO THIS REPORT	THIS REPORT
TOTAL NO. OF TESTS	1511	93
NO. OUTSIDE LIMITS:		
TOTAL	103	4
w	29	0
DENSITY	67	4
w & DENSITY	13	0
NO. REWORKED	93	4
NO. RETESTED AFTER REWORKING	40	2

LEGEND:

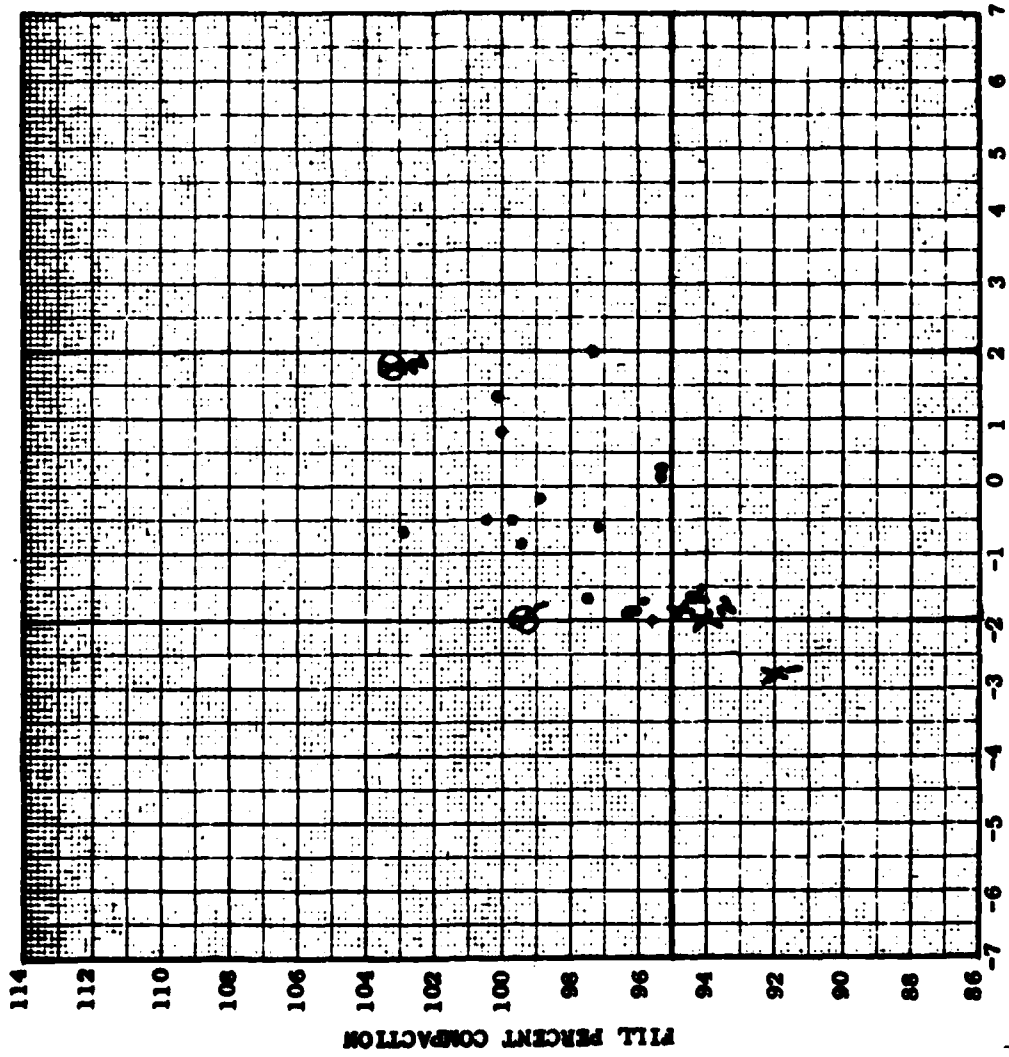
- WITHIN ACCEPTABLE LIMITS
- x OUTSIDE ACCEPTABLE LIMITS
- x_n LATER REWORKED ONLY (NO RETEST)
- x₁, x₂ LATER REWORKED AND RETESTED
- ₁, ●₂ RESULT OF RETEST AFTER REWORKING
- Δ₁, Δ₂ INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ₁, Δ₂ CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

Stationing of Areas Tested	4+05 to 26+10
Elevation of Areas Tested	722.5 to 751.0

(DESIGNED) (SPECIFIED) MIN PERCENT OF MAX STD DRY DEN

SPECIFIED RANGE OF WATER CONTENT



VARIATION OF FILL % FROM LAB OPTIMUM w,
PERCENTAGE POINTS

ENC FORM 4287A
JUN 69

PROJECT: Cave Run Lake
DISTRICT: LOUISVILLE
REPORT PERIOD: 1 Oct - 31 Oct 72
REPORT NO.: 23
TYPE OF MATERIAL: Impervious, Random Earth

	CUMULATIVE TO THIS REPORT	THIS REPORT
TOTAL NO. OF TESTS	1533	22
NO. OUTSIDE LIMITS:		
TOTAL	106	3
w	30	1
DENSITY	70	3
w & DENSITY	14	1
NO. REWORKED	96	3
NO. RETESTED AFTER RWORKING	42	2

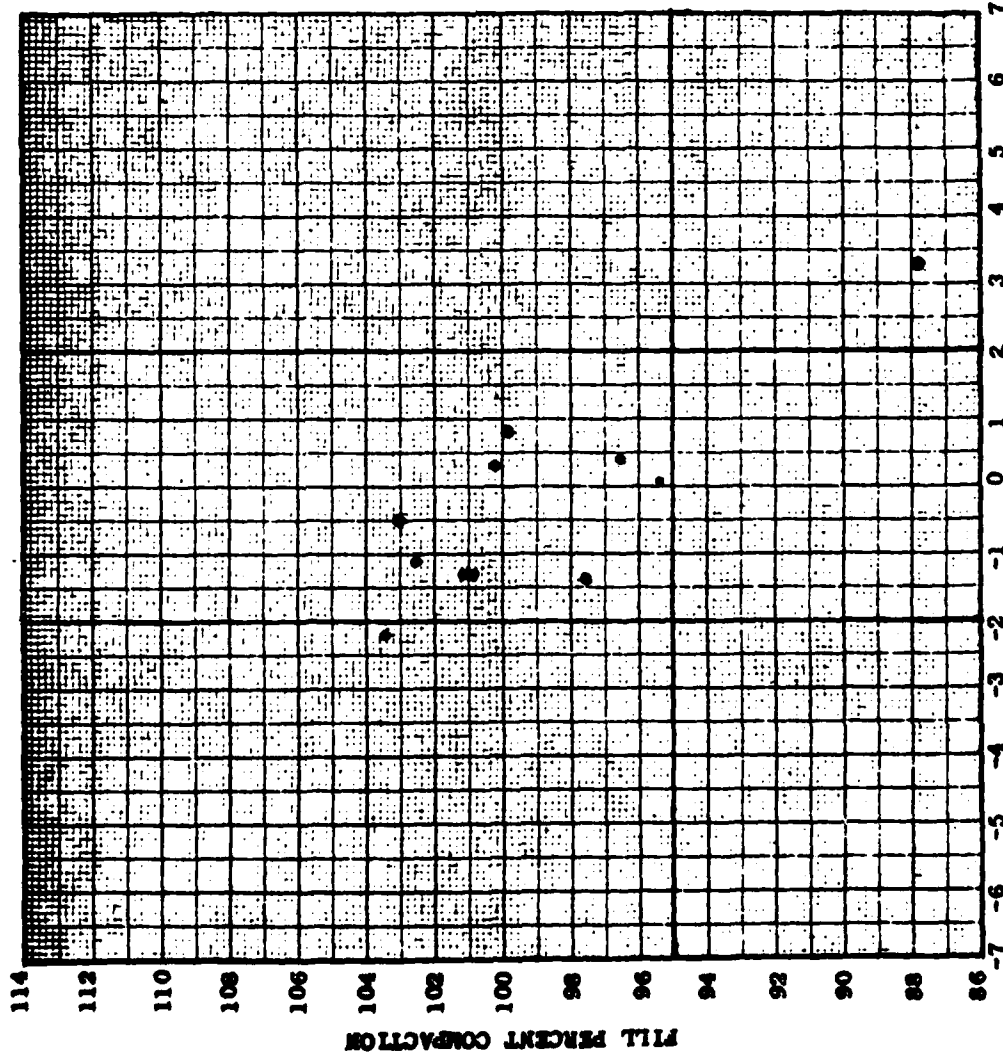
- LEGEND:
- o WITHIN ACCEPTABLE LIMITS
 - x OUTSIDE ACCEPTABLE LIMITS
 - A₁ LATER REWORKED ONLY (NO RETEST)
 - A₂ A₁ LATER REWORKED AND RETESTED
 - o₂ o₁ RESULT OF RETEST AFTER RWORKING
 - A₁ A₂ INITIAL TEST (USE ONLY w/CHECK TEST)
 - A₁ A₂ CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED AND RETESTED AND RESULT OF RETEST AND FOR INITIAL AND CHECK TEST.

Stationing of Areas Tested	6+10 to 25+00
Elevation of Areas Tested	726.5 to 752.5

(SPECIFIED) MIN PERCENT OF MAX STD DRY DEN

SPECIFIED RANGE OF WATER CONTENT



VARIAION OF FILL w FROM LAB OPTIMUM w ,
PERCENTAGE POINTS

ENG Form 4287A
JUN 69

PROJECT: Cave Run Lake
DISTRICT: Louisville
REPORT PERIOD: 3-1 thru 3-21-73
REPORT NO.: 24
TYPE OF MATERIAL: Random Earth

	CUMULATIVE TO THIS REPORT	THIS REPORT
TOTAL NO. OF TESTS	1544	11
NO. OUTSIDE LIMITS:		
TOTAL	108	2
w	32	2
DENSITY	71	1
w & DENSITY	15	1
NO. REWORKED	96	0
NO. RETESTED AFTER REWORKING	42	0

LEGEND:

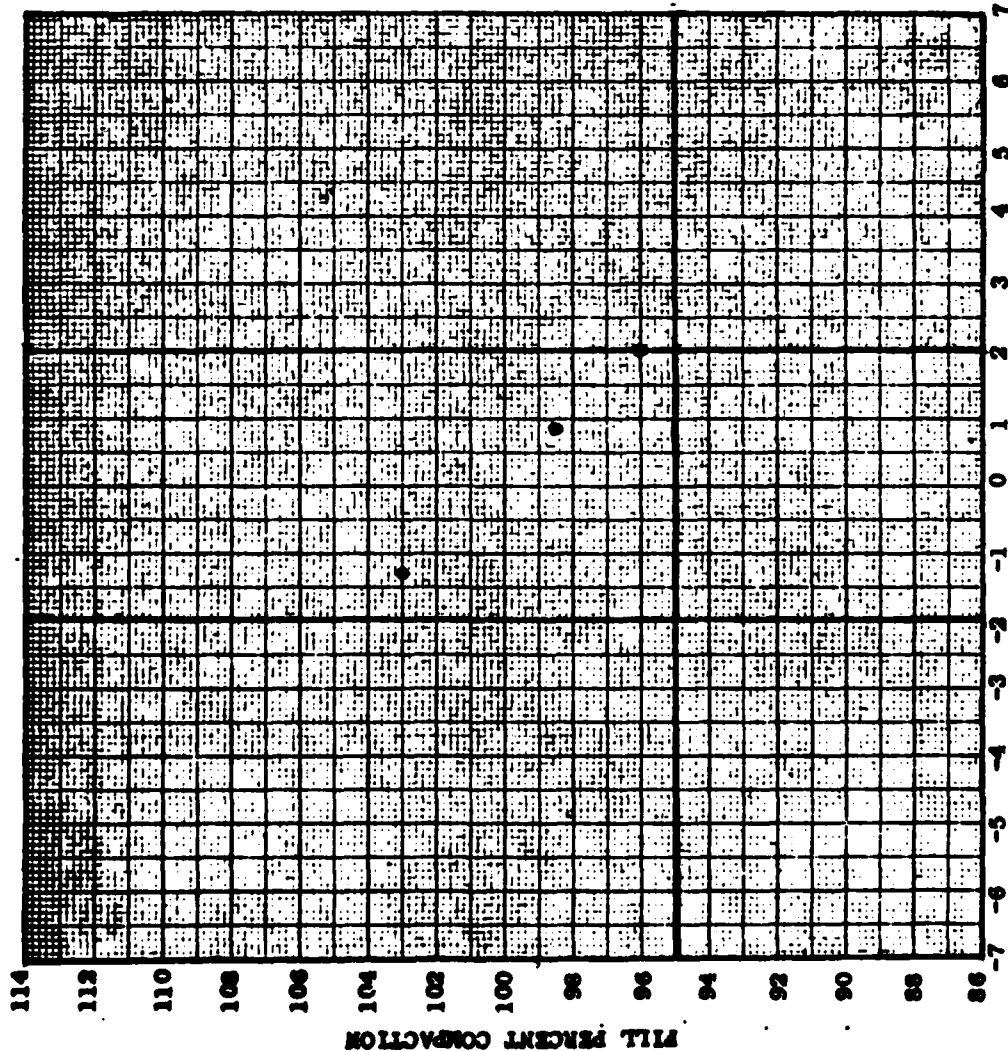
- WITHIN ACCEPTABLE LIMITS
- x OUTSIDE ACCEPTABLE LIMITS
- x_R LATER REWORKED ONLY (NO RETEST)
- x_1, x_2 LATER REWORKED AND RETESTED
- $\odot_1, \odot_2$ RESULT OF RETEST AFTER REWORKING
- Δ_1, Δ_2 INITIAL TEST (USE ONLY w /CHECK TEST)
- Δ_1, Δ_2 CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

Stationing of Areas Tested	4+80 to 14+35
Elevation of Areas Tested	733.5 to 739.5

(RETESTED) (SPECIFIED) MIN PERCENT OF MAX STD DRY DEN

SPECIFIED RANGE OF WATER CONTENT



VARIATION OF FILL w FROM LAB OPTIMUM w ,
PERCENTAGE POINTS

ENC Form 4287A
JUN 69

PROJECT: Cave Run Lake
DISTRICT: Louisville
REPORT PERIOD: 4-1-73 thru 4-30-73
REPORT NO.: 25
TYPE OF MATERIAL: Random

	CUMULATIVE TO THIS REPORT	THIS REPORT
TOTAL NO. OF TESTS	1547	3
NO. OUTSIDE LIMITS:		
TOTAL	108	0
w	32	0
DENSITY	71	0
w & DENSITY	15	0
NO. REWORKED	96	0
NO. RETESTED AFTER REWORKING	42	0

LEGEND:

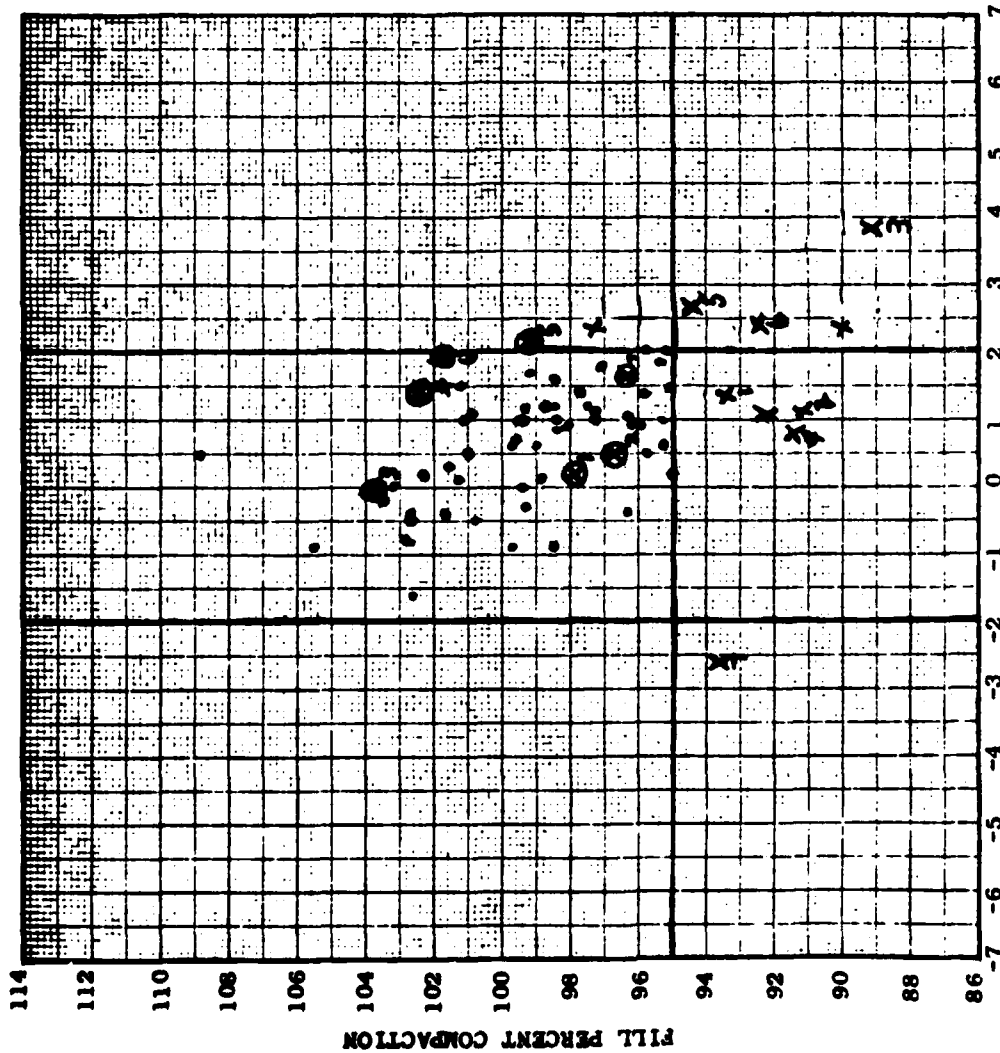
- WITHIN ACCEPTABLE LIMITS
- x OUTSIDE ACCEPTABLE LIMITS
- x_R LATER REWORKED ONLY (NO RETEST)
- x_1, x_2 LATER REWORKED AND RETESTED
- ϕ_1, ϕ_2 RESULT OF RETEST AFTER REWORKING
- Δ_1, Δ_2 INITIAL TEST (USE ONLY w /CHECK TEST)
- Δ_1, Δ_2 CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

Stationing of Areas Tested	4+75 to 14+90
Elevation of Areas Tested	729.0 to 736.1

(SPECIFIED) MIN PERCENT OF MAX STD DRY DEN

SPECIFIED RANGE OF WATER CONTENT



VARIATION OF FILL w FROM LAB OPTIMUM w,
PERCENTAGE POINTS

ENG Form 4287A
JUN 69

PROJECT: Cave Run Lake
DISTRICT: Louisville
REPORT PERIOD: 1 May, 73 to 31 May 73
REPORT NO.: 26
TYPE OF Impervious
MATERIAL: Sandy Random & Random Earth

CUMULATIVE	
TO THIS	THIS
REPORT	REPORT
TOTAL NO. OF TESTS	1630
NO. OUTSIDE LIMITS:	83

TOTAL	121	13
w	41	9
DENSITY	83	12
w & DENSITY	22	7
NO. REWORKED	103	7
NO. RETESTED AFTER REWORKING	49	7

LEGEND:

- WITHIN ACCEPTABLE LIMITS
- x OUTSIDE ACCEPTABLE LIMITS
- x_R LATER REWORKED ONLY (NO RETEST)
- x₁, x₂ LATER REWORKED AND RETESTED
- ₁, ●₂ RESULT OF RETEST AFTER REWORKING
- Δ₁, Δ₂ INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ₁, Δ₂ CHECK TEST

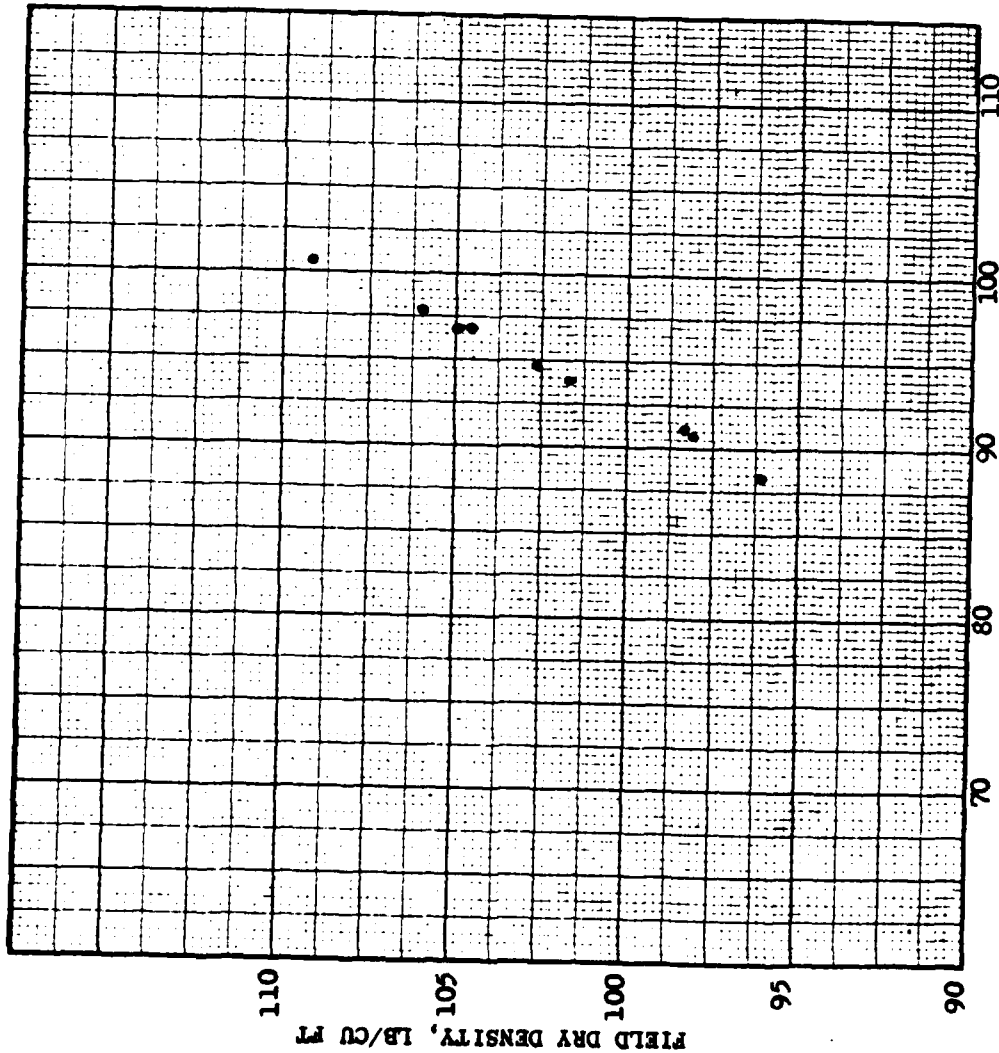
NOTE: USE SAME NUMBER FOR LATER REWORKED AND RETESTED AND RESULT OF RETEST AND FOR INITIAL AND CHECK TEST.

Stationing of Areas Tested	2+93 to 25+65
Elevation of Areas Tested	731.0 to 755.0

(SPECIFIED) MIN PERCENT OF MAX STD DRY DEN

(DESIGNED) (SPECIFIED) MIN PERCENT MAX STD DRY DEN

(DESIGNED) (SPECIFIED) MIN REL DEN



PROJECT: Cave Run Reservoir
DISTRICT: Louisville
REPORT PERIOD: 7-1-70 thru 7-31-70
REPORT NO. 1
TYPE OF
MATERIAL: Filter Sand

	CUMULATIVE TO THIS REPORT	THIS REPORT
TOTAL NO. OF TESTS	9	9
NO. BELOW MINIMUM	0	0
NO. REWORKED	0	0
NO. RETESTED AFTER REWORKING	0	0

LEGEND:

- ABOVE ACCEPTABLE MIN
- x BELOW ACCEPTABLE MIN
- x_R LATER REWORKED ONLY (NO RETEST)
- x_1, x_2 LATER REWORKED & RETESTED
- , ●₂ RESULT OF RETEST AFTER REWORKING
- Δ_1, Δ_2 INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ_1, Δ_2 CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED AND RETESTED AND RESULT OF RETEST AND FOR INITIAL AND CHECK TEST.

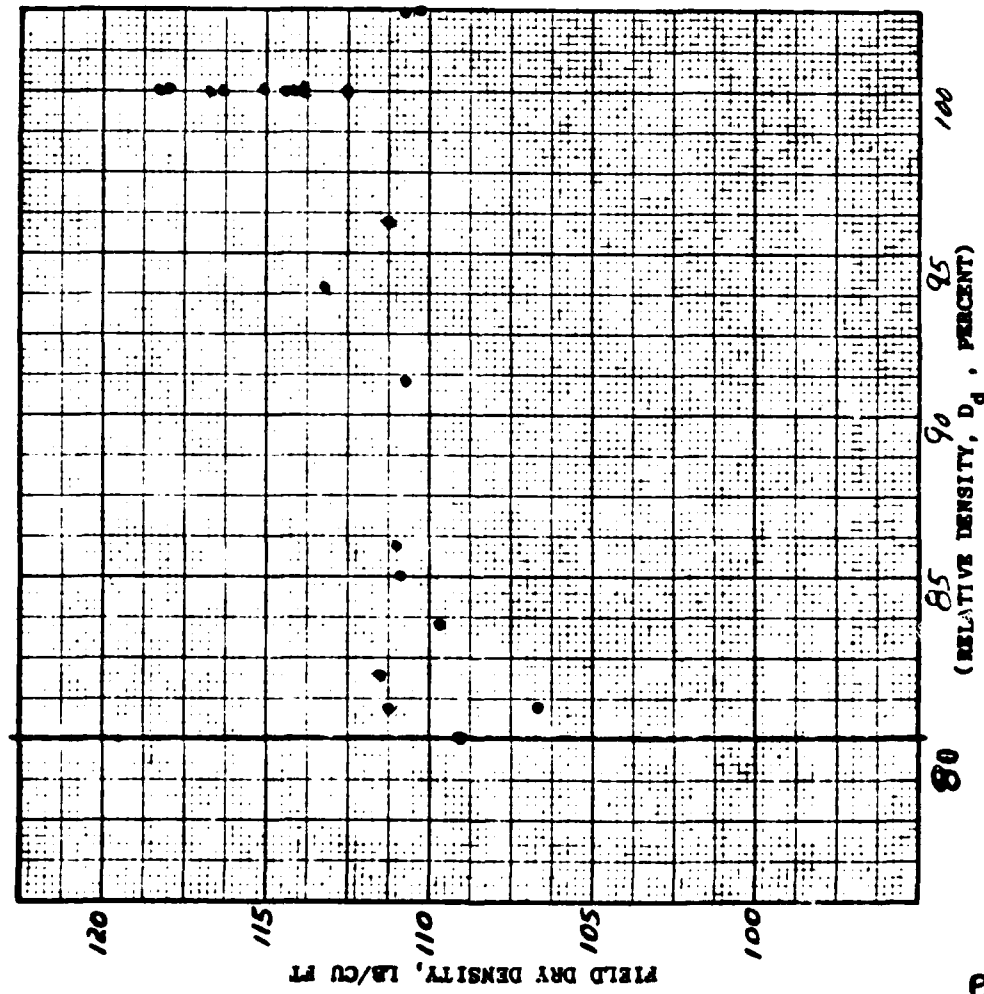
(PERCENT OF MAX (STD) DRY DEN)

Stationing of Areas Tested	19+85 to 23+80
Elevation of Areas Tested	686.0 to 687.5

ENG Form 4287B
JUN 69

(SPECIFIED) MIN REL DEN

(SPECIFIED) MIN REL DEN



PROJECT: CAVE RUN DAM
DISTRICT: LOUISVILLE
REPORT PERIOD: 1 AUG. '70 TO 31 MAR. '70
REPORT NO. 2
TYPE OF
MATERIAL: FILTER SAND

	CUMULATIVE TO THIS REPORT	THIS REPORT
TOTAL NO. OF TESTS	30	2
NO. BELOW MINIMUM	1	0
NO. REWORKED	0	0
NO. RETESTED AFTER REWORKING	0	0

LEGEND:

- ABOVE ACCEPTABLE MIN
- x BELOW ACCEPTABLE MIN
- x_n LATER REWORKED ONLY (NO RETEST)
- x₁, x₂ LATER REWORKED & RETESTED
- , ●₂ RESULT OF RETEST AFTER REWORKING
- Δ₁, Δ₂ INITIAL TEST (USE ONLY Δ/CHECK TEST)
- Δ₁, Δ₂ CHECK TEST

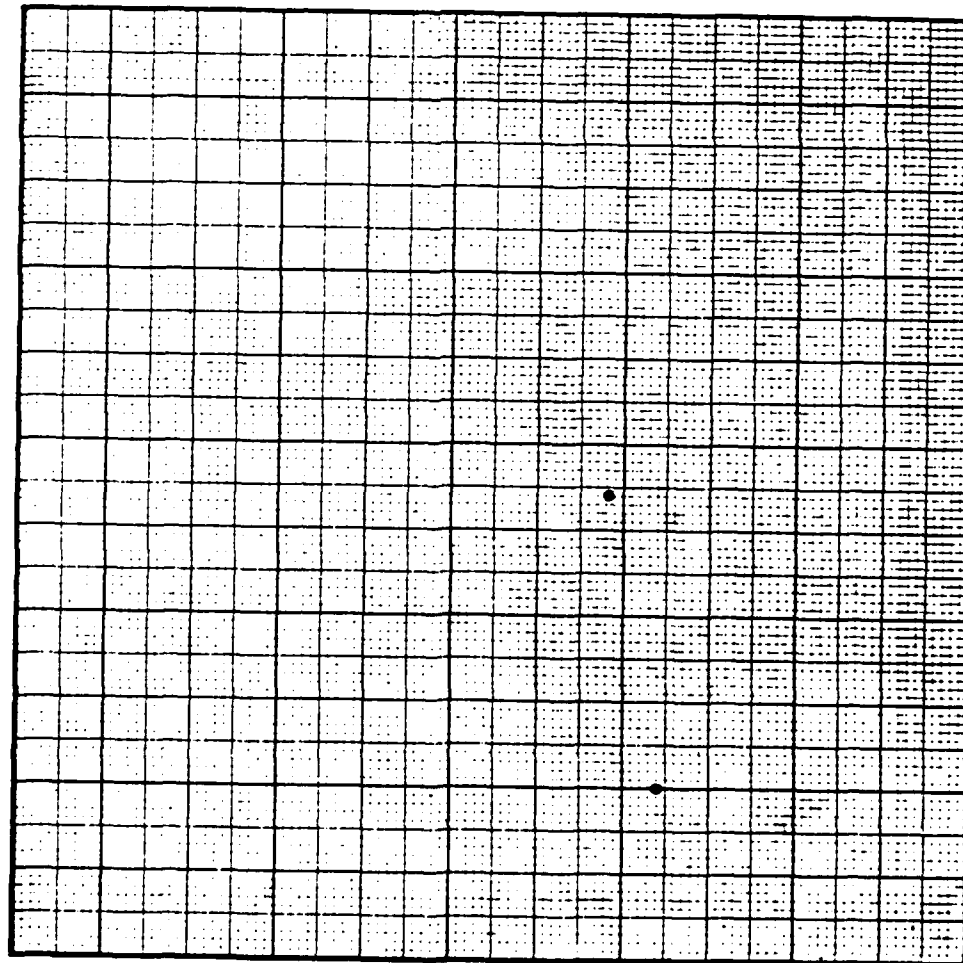
NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

Stationing of Areas Tested	15+70 to 24+85
Elevation of Areas Tested	682.0 to 706.0

ENC Form 4287B
JUN 69

(RECORDED) (SPECIFIED) MIN PERCENT MIN STD DRY DEN

(RECORDED) (SPECIFIED) MIN REL DEN



FIELD DRY DENSITY, LB/CU FT

110

115

120

85

90

95

(RELATIVE DENSITY, D_d , PERCENT)

(PERCENT OF MIN (STD) DRY DEN)

ENG Form 4287B

JUN 69

PLATE 112

PROJECT: CAVE RUN DAM
DISTRICT: LOUISVILLE
REPORT PERIOD: 1 Sept - 30 Sept 70
REPORT NO. 3
TYPE OF

MATERIAL: FILTER SAND

	CUMULATIVE TO THIS REPORT	THIS REPORT
TOTAL NO. OF TESTS	32	2
NO. BELOW MINIMUM	0	0
NO. REWORKED	0	0
NO. RETESTED AFTER REWORKING	0	0

LEGEND:

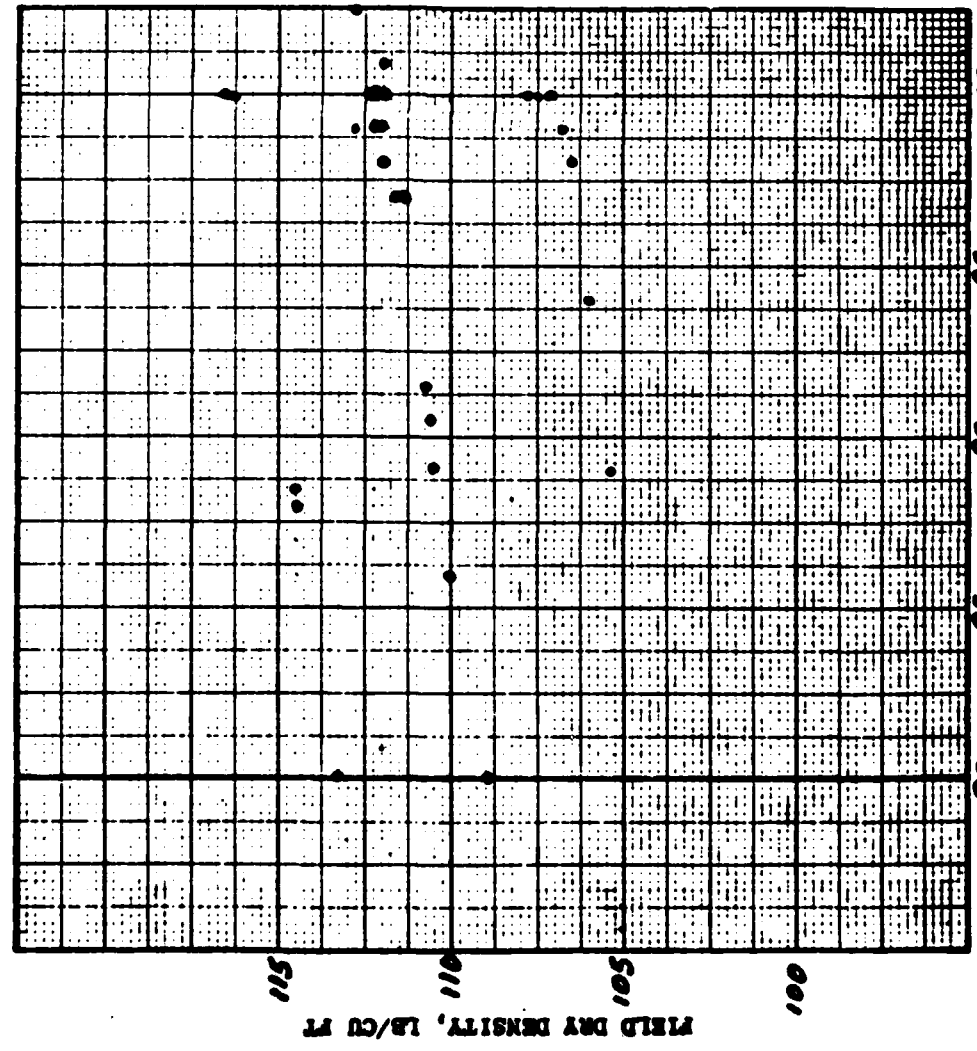
- ABOVE ACCEPTABLE MIN
- x BELOW ACCEPTABLE MIN
- x_R LATER REWORKED ONLY (NO RETEST)
- x_1, x_2 LATER REWORKED & RETESTED
- ₁ ●₂ RESULT OF RETEST AFTER REWORKING
- Δ_1, Δ_2 INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ_1, Δ_2 CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

Stationing of Areas Tested	21+80 to 23+80
Elevation of Areas Tested	690.0 to 701.0

(SPECIFIED) MIN REL DEN

(SPECIFIED) MIN REL DEN



(RELATIVE DENSITY, D_d , PERCENT)

(PERCENT OF MAX (STD) DRY DEN)

Cave Run Lake
PROJECT: Construction of Dam and Spillway
DISTRICT: Louisville
REPORT PERIOD: 1 Oct. thru 31 Oct. 1970
REPORT NO. 4
TYPE OF
MATERIAL: Filter Sand

	CUMULATIVE TO THIS REPORT	THIS REPORT
TOTAL NO. OF TESTS	60	28
NO. BELOW MINIMUM	0	0
NO. REWORKED	0	0
NO. RETESTED AFTER REWORKING	0	0

LEGEND:

- ABOVE ACCEPTABLE MIN
- x BELOW ACCEPTABLE MIN
- X_n LATER REWORKED ONLY (NO RETEST)
- X_p, X_2 LATER REWORKED & RETESTED
- $\odot, \odot_2$ RESULT OF RETEST AFTER REWORKING
- Δ, Δ_2 INITIAL TEST (USE ONLY ∇ /CHECK TEST)
- Δ, Δ_2 CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

Stationing of Areas Tested	10+30 to 23+00
Elevation of Areas Tested	676.0 to 701.5

(SPECIFIED) MIN PERCENT MAX OTD DRY DEN

(SPECIFIED) MIN REL DEN

Cave Run Lake
PROJECT: Construction of Dam & Spillway
DISTRICT: Louisville

REPORT PERIOD: Nov to 30 Nov 1970
REPORT NO. 5

TYPE OF

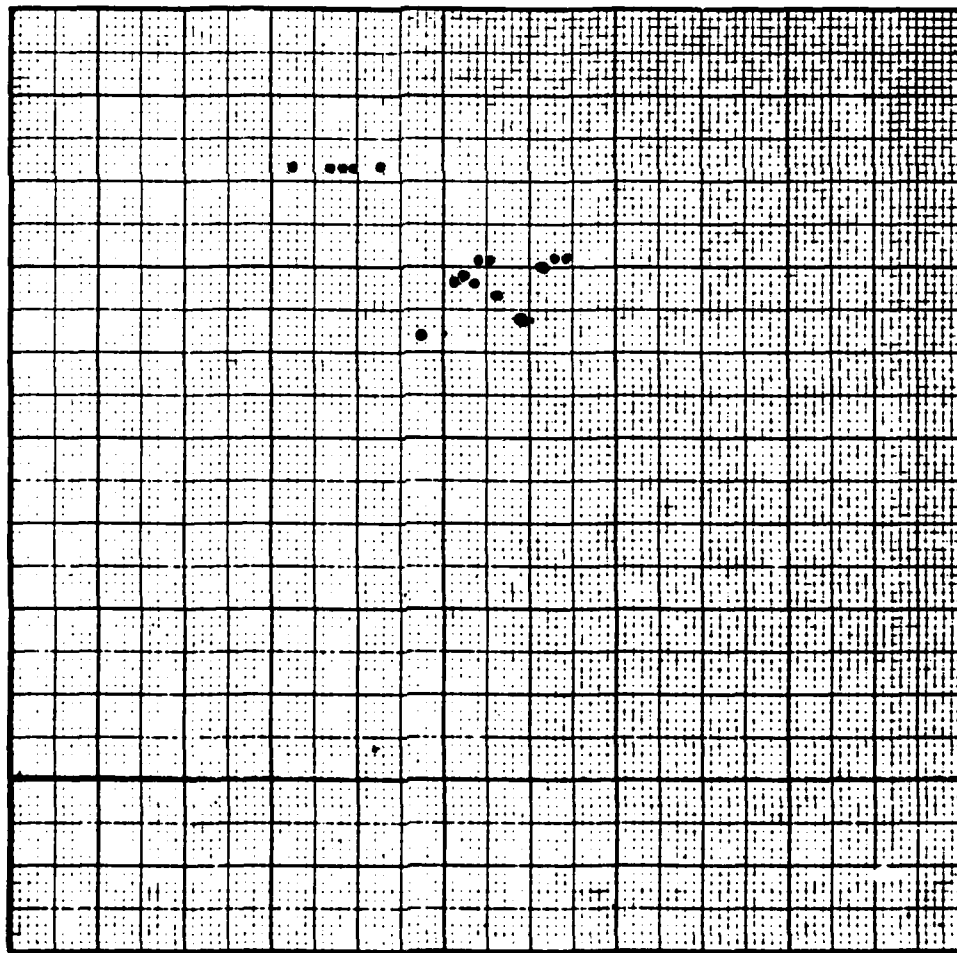
MATERIAL: Filter Sand

TOTAL NO. OF TESTS	CUMULATIVE TO THIS	
	REPORT	REPORT
76	0	16
NO. BELOW MINIMUM	0	0
NO. REWORKED	0	0
NO. RETESTED AFTER REWORKING	0	0

LEGEND:

- ABOVE ACCEPTABLE MIN
- x BELOW ACCEPTABLE MIN
- X_R LATER REWORKED ONLY (NO RETEST)
- X_1, X_2 LATER REWORKED & RETESTED
- $\odot, \odot_2$ RESULT OF RETEST AFTER REWORKING
- Δ, Δ_1 INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ, Δ_2 CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.



80 85 90 95 100
(RELATIVE DENSITY, D_r , PERCENT)

(PERCENT OF MAX (STD) DRY DEN)

Stationing of Areas Tested	Sta 22+00 to 11+30
Elevation of Areas Tested	699.0 to 677.0

Cave Run Lake
 PROJECT: Construction of Dam and Spillway
 DISTRICT: Louisville
 REPORT PERIOD: 1 Dec. 70 to 31 Dec 70
 REPORT NO. 6

TYPE OF

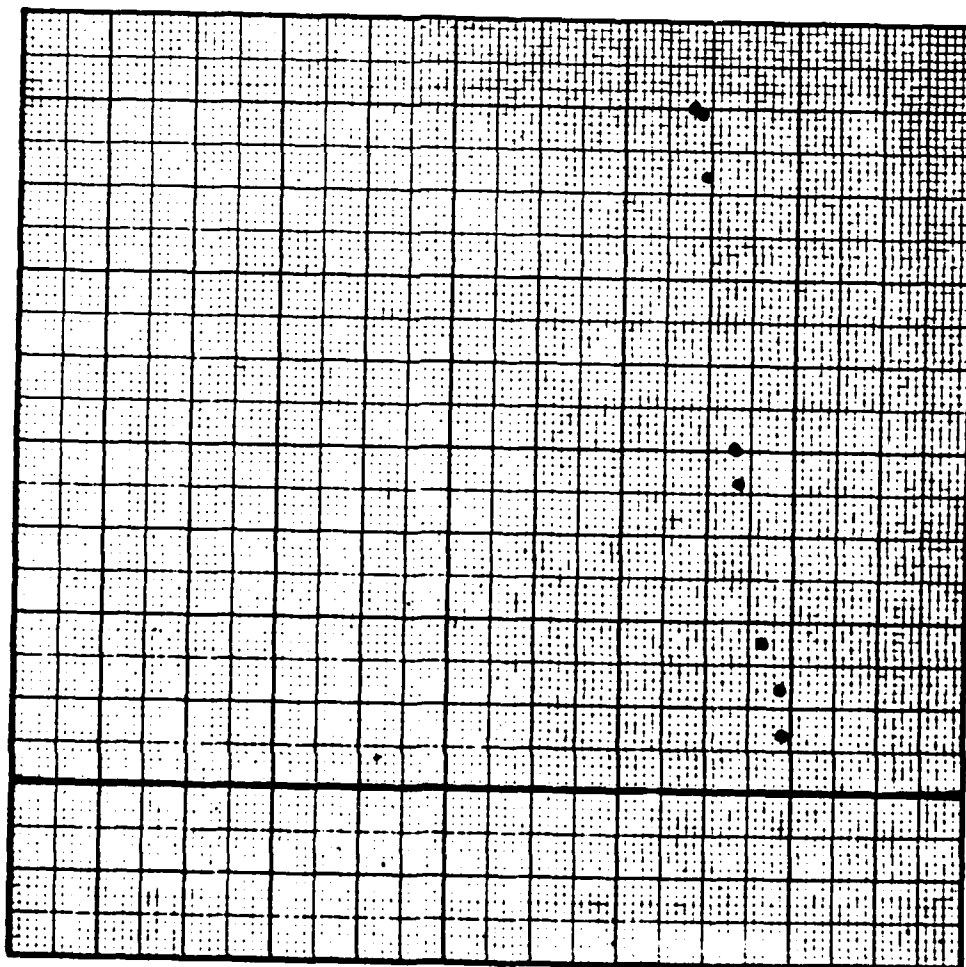
MATERIAL: Filter Sand

TOTAL NO. OF TESTS	CUMULATIVE	
	TO THIS	THIS
	REPORT	REPORT
NO. BELOW MINIMUM	0	0
NO. REWORKED	0	0
NO. RETESTED	0	0
AFTER REWORKING		

LEGEND:

- ABOVE ACCEPTABLE MIN
- X BELOW ACCEPTABLE MIN
- X₁ LATER REWORKED ONLY (NO RETEST)
- X₁, X₂ LATER REWORKED & RETESTED
- ₁ ●₂ RESULT OF RETEST AFTER REWORKING
- A₁, A₂ INITIAL TEST (USE ONLY w/CHECK TEST)
- A₁, A₂ CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED AND RETESTED AND RESULT OF RETEST AND FOR INITIAL AND CHECK TEST.



80 85 90 95 100
 (RELATIVE DENSITY, D_r , PERCENT)

(REMARKS - OF THIS - (4000) - 1000 - 1000)

ENG FORM 4287B
 JUN 69

Stationing of Areas Tested	14+00 to 23+80
Elevation of Areas Tested	682.0 to 703.0

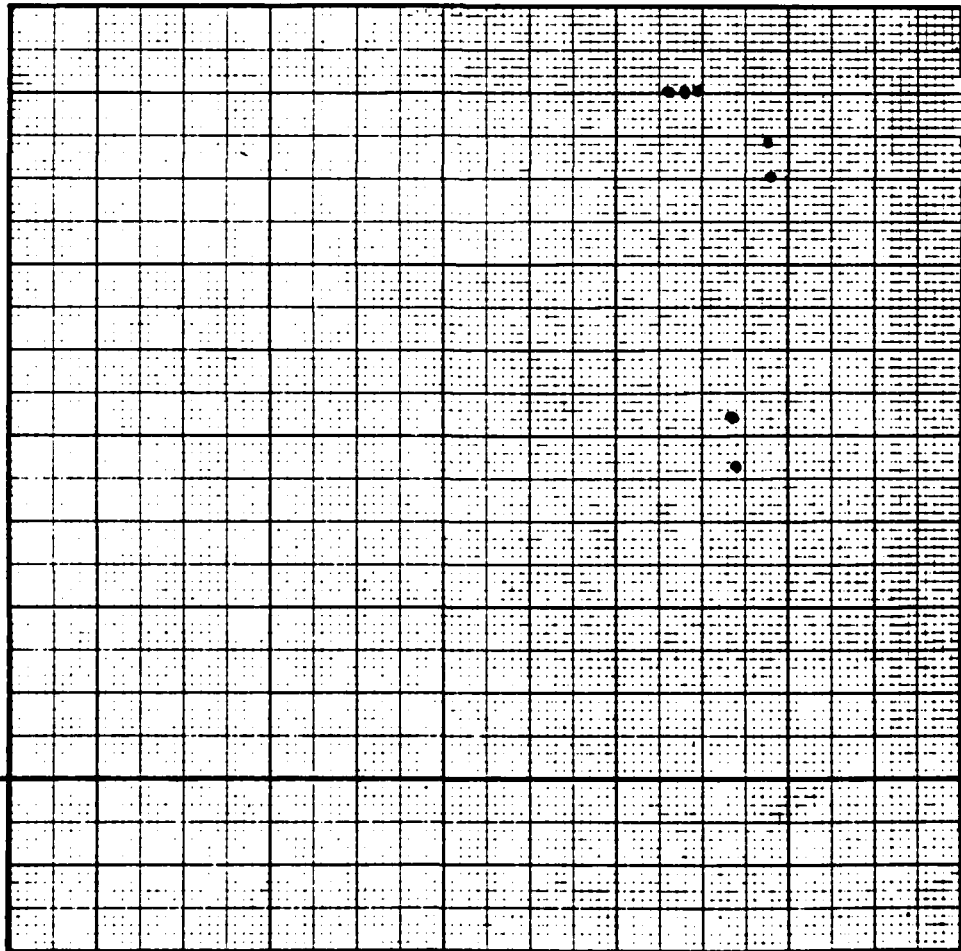
(REMOVED) (STANDARD) - MIN PERCENT MAX STD DRY DEN

(REMOVED) (SPECIFIED) MIN REL DEN

FIELD DRY DENSITY, LB/CU FT

1150

1190



PROJECT: Cave Run Lake
DISTRICT: Louisville
REPORT PERIOD: 1 Mar 71 to 30 Apr 71
REPORT NO. 7
TYPE OF MATERIAL: Filter Sand

	CUMULATIVE TO THIS REPORT	THIS REPORT
TOTAL NO. OF TESTS	91	7
NO. BELOW MINIMUM	0	0
NO. REWORKED	0	0
NO. RETESTED AFTER REWORKING	0	0

LEGEND:

- ABOVE ACCEPTABLE MIN
- X BELOW ACCEPTABLE MIN
- X_R LATER REWORKED ONLY (NO RETEST)
- X₁, X₂ LATER REWORKED & RETESTED
- ₁, ●₂ RESULT OF RETEST AFTER REWORKING
- Δ₁, Δ₂ INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ₁, Δ₂ CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

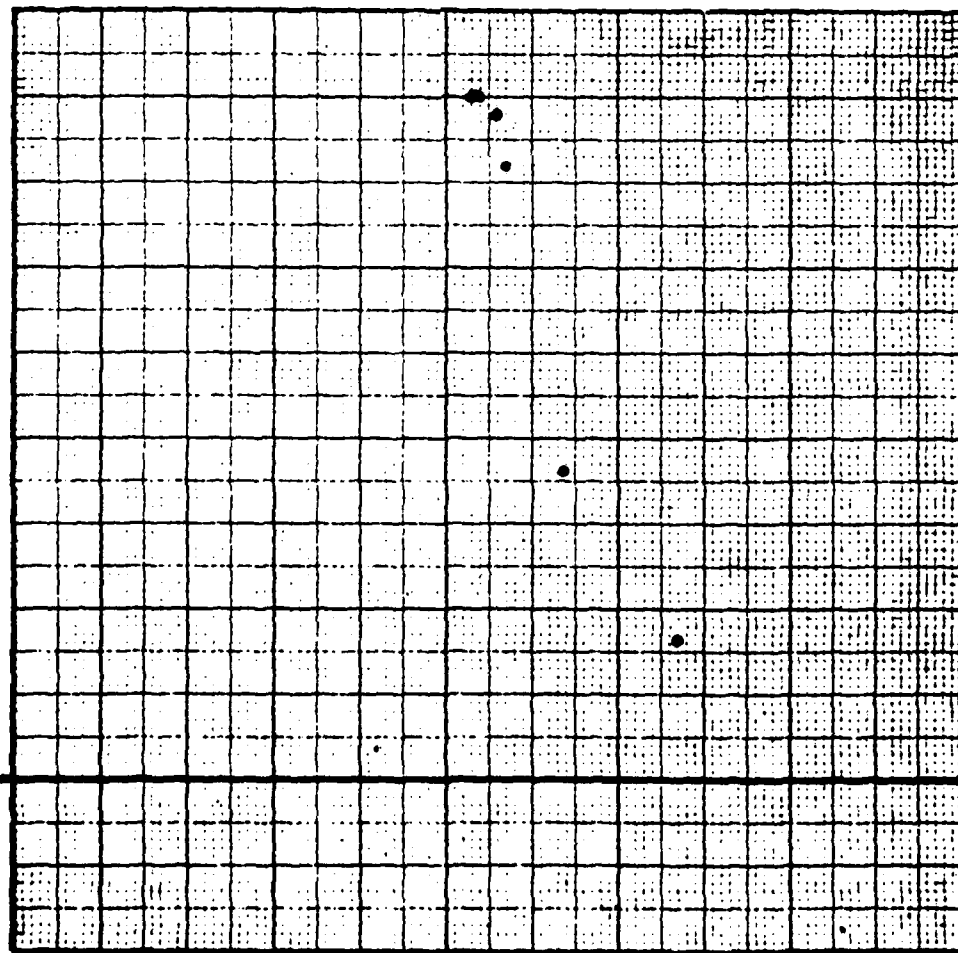
(PERCENT OF MAX (STD) DRY DEN)

ENC Form 4287B
JUN 69

Stationing of Areas Tested	10+25 to 24+35
Elevation of Areas Tested	672.0 to 710.5

(PERCENT OF MAXIMUM RELATIVE DENSITY) MIN REL DEN

(SPECIFIED) MIN REL DEN



FIELD DRY DENSITY, LB/CU FT

PLATE 117

ENC Form 4287B
JUN 69

(PERCENT OF MAXIMUM RELATIVE DENSITY)

PROJECT: Cave Run Lake
DISTRICT: Louisville
REPORT PERIOD: May thru 31 May 1971
REPORT NO. 8
TYPE OF Filter Sand
MATERIAL:

	CUMULATIVE TO THIS REPORT	THIS REPORT
TOTAL NO. OF TESTS	97	6
NO. BELOW MINIMUM	0	0
NO. REWORKED	0	0
NO. RETESTED AFTER REWORKING	0	0

LEGEND:

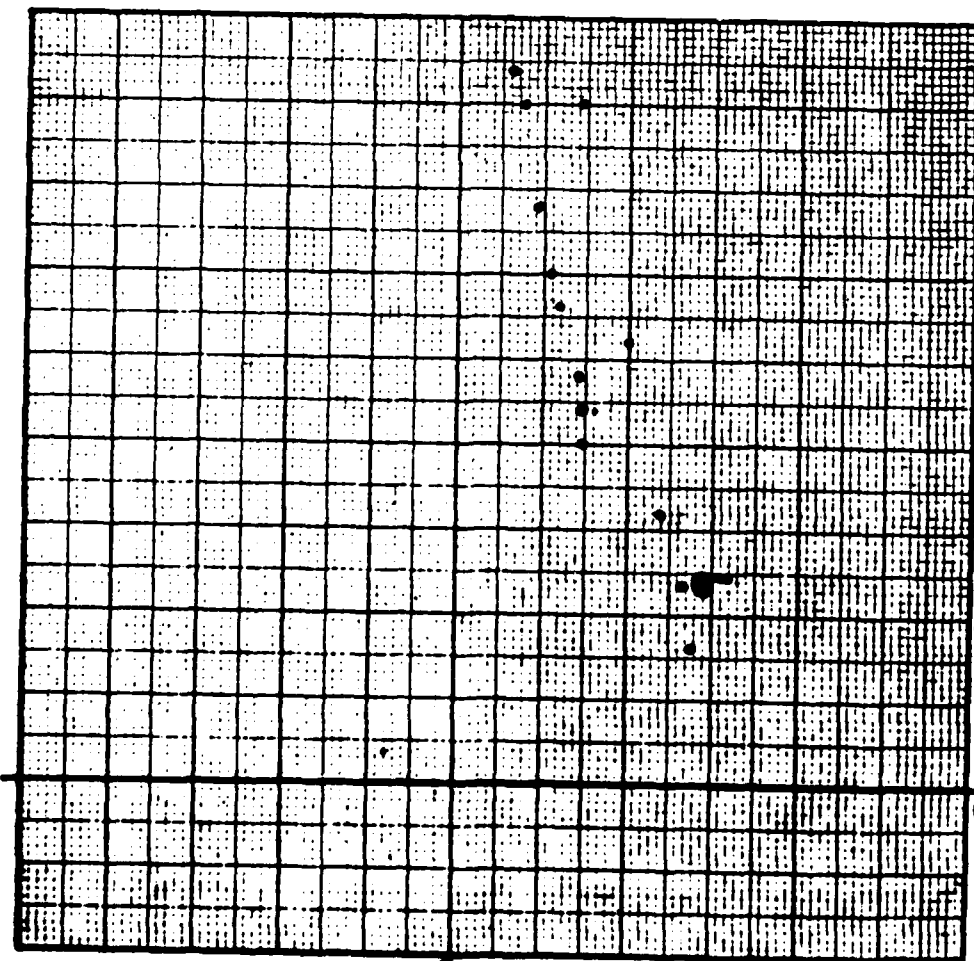
- ABOVE ACCEPTABLE MIN
- x BELOW ACCEPTABLE MIN
- x_r LATER REWORKED ONLY (NO RETEST)
- x₁, x₂ LATER REWORKED & RETESTED
- , ●₂ RESULT OF RETEST AFTER REWORKING
- Δ, Δ₂ INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ₁, Δ₁ CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

Stationing of Areas Tested	13+00 to 23+10
Elevation of Areas Tested	672.0 to 710.5

(SPECIFIED) MIN REL DEN

(SPECIFIED) MIN REL DEN



PROJECT: Cave Run lake
DISTRICT: Louisville
REPORT PERIOD: 1 June - 30 June 1971
REPORT NO. 9
TYPE OF
MATERIAL: Filter Sand

TOTAL NO. OF TESTS	CUMULATIVE TO THIS REPORT	
	REPORT	THIS REPORT
NO. BELOW MINIMUM	11	14
NO. REWORKED	1	1
NO. RETESTED	1	1
AFTER REWORKING	1	1

LEGEND:

- ABOVE ACCEPTABLE MIN
- x BELOW ACCEPTABLE MIN
- X_n LATER REWORKED ONLY (NO RETEST)
- X_n, X_2 LATER REWORKED & RETESTED
- ϕ, ϕ_2 RESULT OF RETEST AFTER REWORKING
- Δ, Δ_2 INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ, Δ_2 CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED AND RETESTED AND RESULT OF RETEST AND FOR INITIAL AND CHECK TEST.

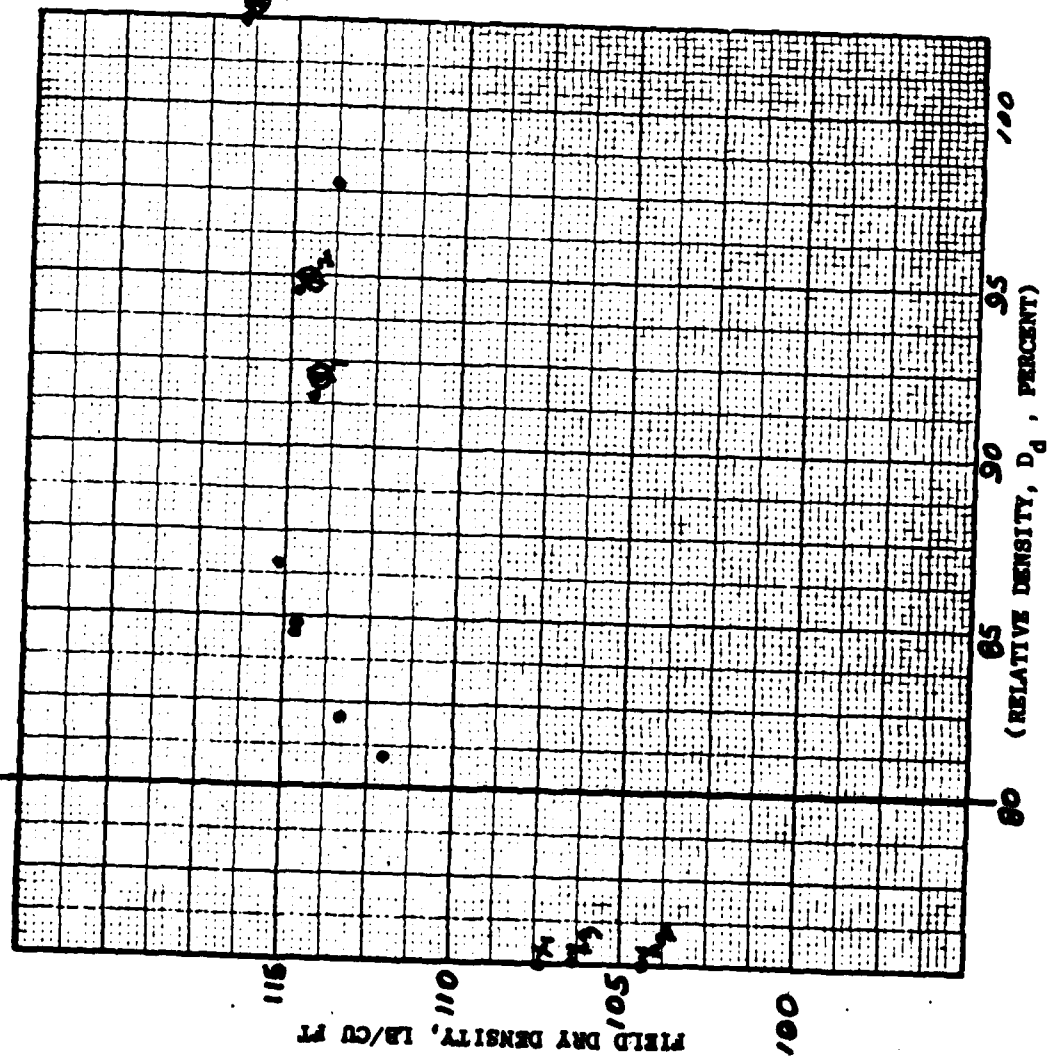
Stationing of Areas Tested	10+99 to 25+05
Elevation of Areas Tested	684.5 to 716.0

(PERCENT OF DRY - (STD) - DRY - DEN)

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JUN 69

(SPECIFIED) MIN PERCENT MAX STD DRY DEN

(SPECIFIED) MIN REL DEN



PROJECT: Cave Run Lake
DISTRICT: Louisville
REPORT PERIOD: 1 Nov. 1971 to 30 Nov. 1971
REPORT NO. 11
TYPE OF

MATERIAL: Filter Sand (pervious)

	CUMULATIVE TO THIS REPORT	THIS REPORT
TOTAL NO. OF TESTS	141	12
NO. BELOW MINIMUM	7	3
NO. REWORKED	7	3
NO. RETESTED AFTER REWORKING	7	3

LEGEND:

- ABOVE ACCEPTABLE MIN
- x BELOW ACCEPTABLE MIN
- x_r LATER REWORKED ONLY (NO RETEST)
- x₁, x₂ LATER REWORKED & RETESTED
- _p, ●₂ RESULT OF RETEST AFTER REWORKING
- Δ₁, Δ₂ INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ₁, Δ₂ CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED AND RETESTED AND RESULT OF RETEST AND FOR INITIAL AND CHECK TEST.

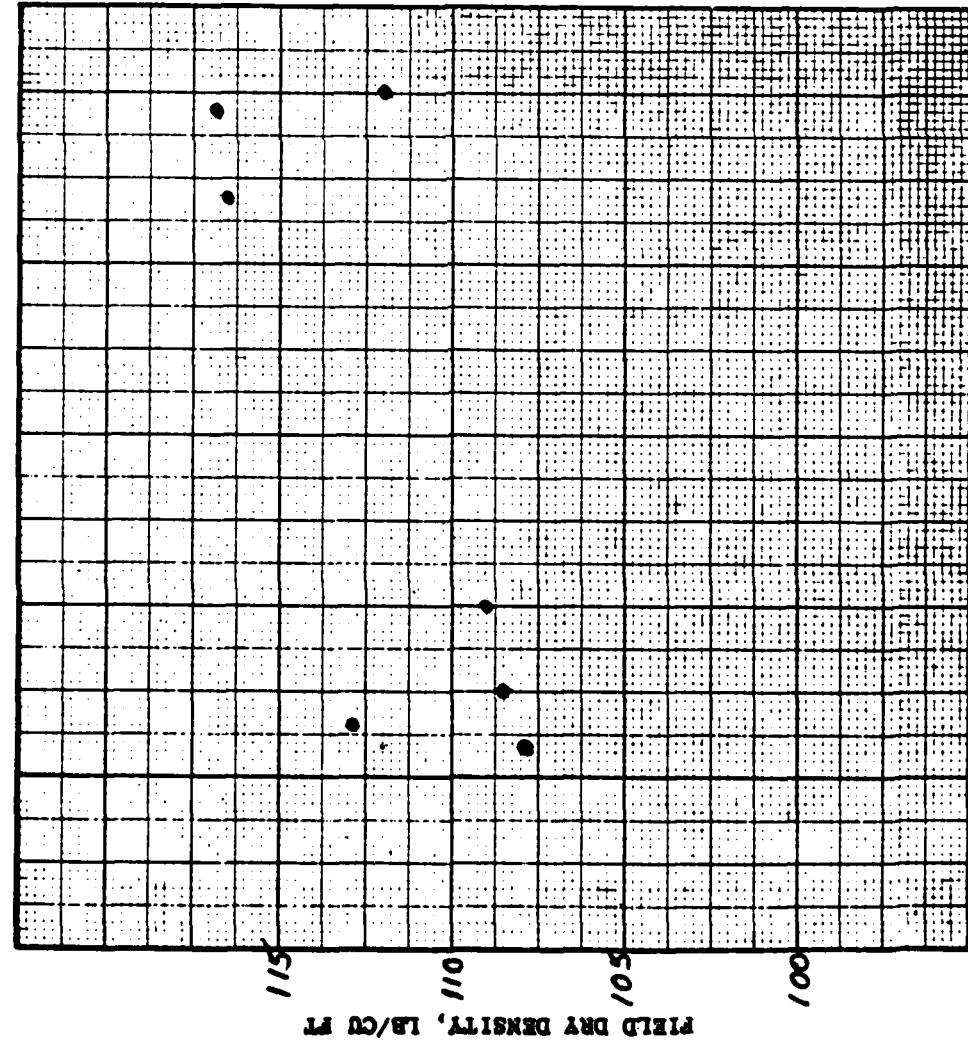
(PERCENT OF MAX (STD) DRY DEN)

Stationing of Areas Tested	4+20 to 11+75
Elevation of Areas Tested	677.5 to 700.0

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JUN 69

(REQUIRED) (SPECIFIED) MIN PERCENT MAX STD DRY DEN

(REQUIRED) (SPECIFIED) MIN REL DEN



80 85 90 95 100
(RELATIVE DENSITY, D_d , PERCENT)

(PERCENT OF MAX (STD) DRY DEN)

ENG Form 4287B
JUN 69

PROJECT: Cave Run Lake
DISTRICT: Louisville
REPORT PERIOD: 5-1 to 5-31-72
REPORT NO. 12
TYPE OF MATERIAL: Previous (Filter Sand)

TOTAL NO. OF TESTS	CUMULATIVE TO THIS REPORT	
	REPORT	THIS REPORT
NO. BELOW MINIMUM	7	0
NO. REWORKED	7	0
NO. RETESTED AFTER REWORKING	7	0

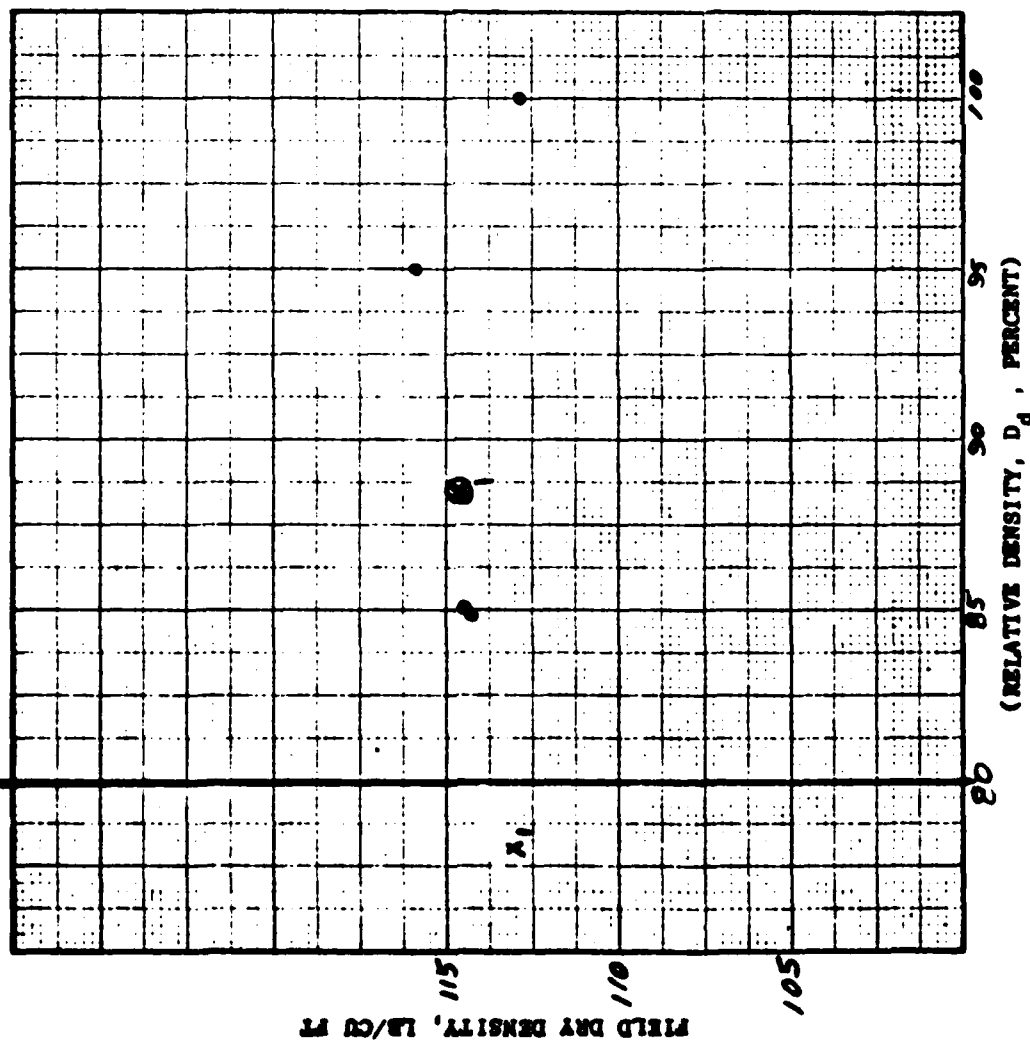
LEGEND:

- ABOVE ACCEPTABLE MIN
- x BELOW ACCEPTABLE MIN
- x_1 LATER REWORKED ONLY (NO RETEST)
- x_1, x_2 LATER REWORKED & RETESTED
- ₁ ●₂ RESULT OF RETEST AFTER REWORKING
- Δ_1, Δ_2 INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ_1, Δ_2 CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED AND RETESTED AND RESULT OF RETEST AND FOR INITIAL AND CHECK TEST.

Stationing of Areas Tested	5+80 to 24+20
Elevation of Areas Tested	666.4 to 719.5

(200000) (SPECIFIED) MIN REL DEN



ENC Form 4287B
JUN '69

PLATE 129

LEGEND:

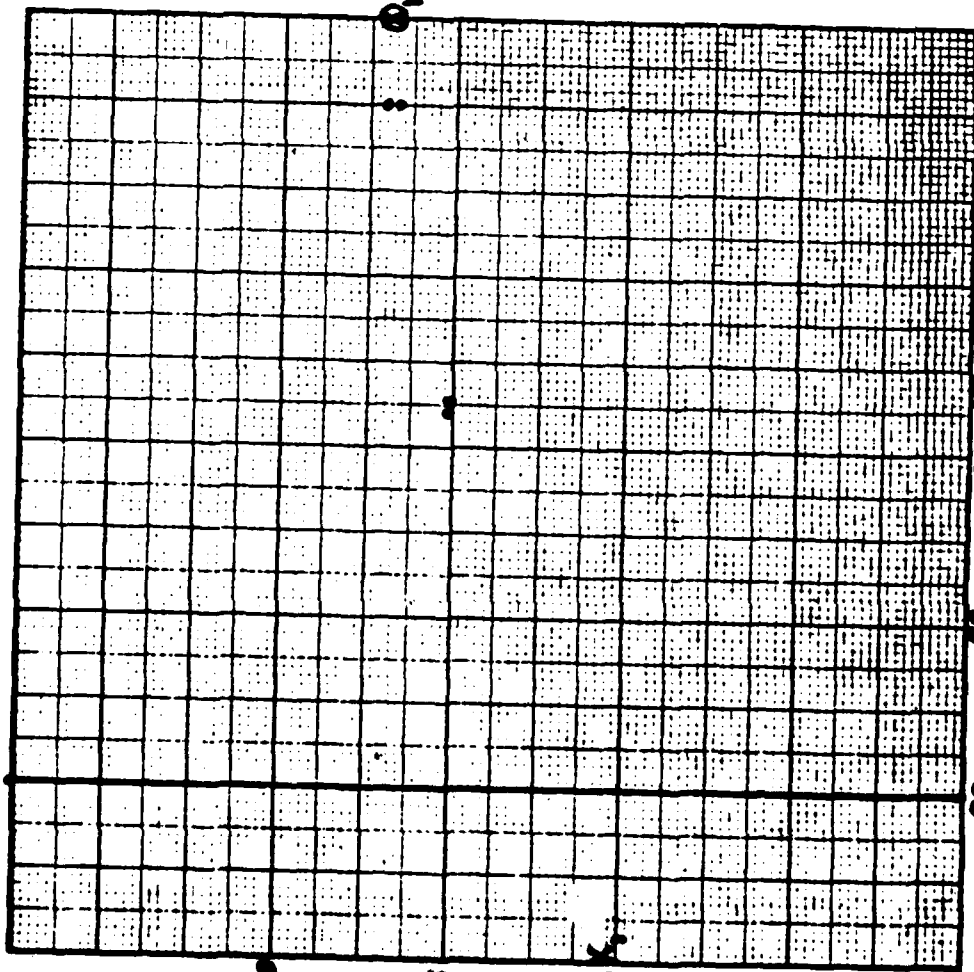
- ABOVE ACCEPTABLE MIN
- × BELOW ACCEPTABLE MIN
- X_R LATER REWORKED ONLY (NO RETEST)
- X_1, X_2 LATER REWORKED & RETESTED
- , ●₂ RESULT OF RETEST AFTER REWORKING
- Δ_0, Δ_2 INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ_1, Δ_2 CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED AND RETESTED AND RESULT OF RETEST AND FOR INITIAL AND CHECK TEST.

Stationing of Areas Tested	8+55 to 21+00
Elevation of Areas Tested	668.0 to 724.0

(REMARKS) (SPECIFIED) MIN REL DEN

(REMARKS) (SPECIFIED) MIN REL DEN



FIELD DRY DENSITY, LB/CU FT

(RELATIVE DENSITY, D_r , PERCENT)

(PERCENT OF MAX (STD) - 50% - 50%)

ENG Form 4287B
JUN '69

PROJECT: Cave Run Lake
DISTRICT: Louisville
REPORT PERIOD: 1 July - 31 July 1972
REPORT NO. 14
TYPE OF MATERIAL: Filter Sand (Pervious)

	CUMULATIVE TO THIS REPORT	THIS REPORT
TOTAL NO. OF TESTS	150	5
NO. BELOW MINIMUM	9	1
NO. REWORKED	9	1
NO. RETESTED AFTER REWORKING	9	1

LEGEND:

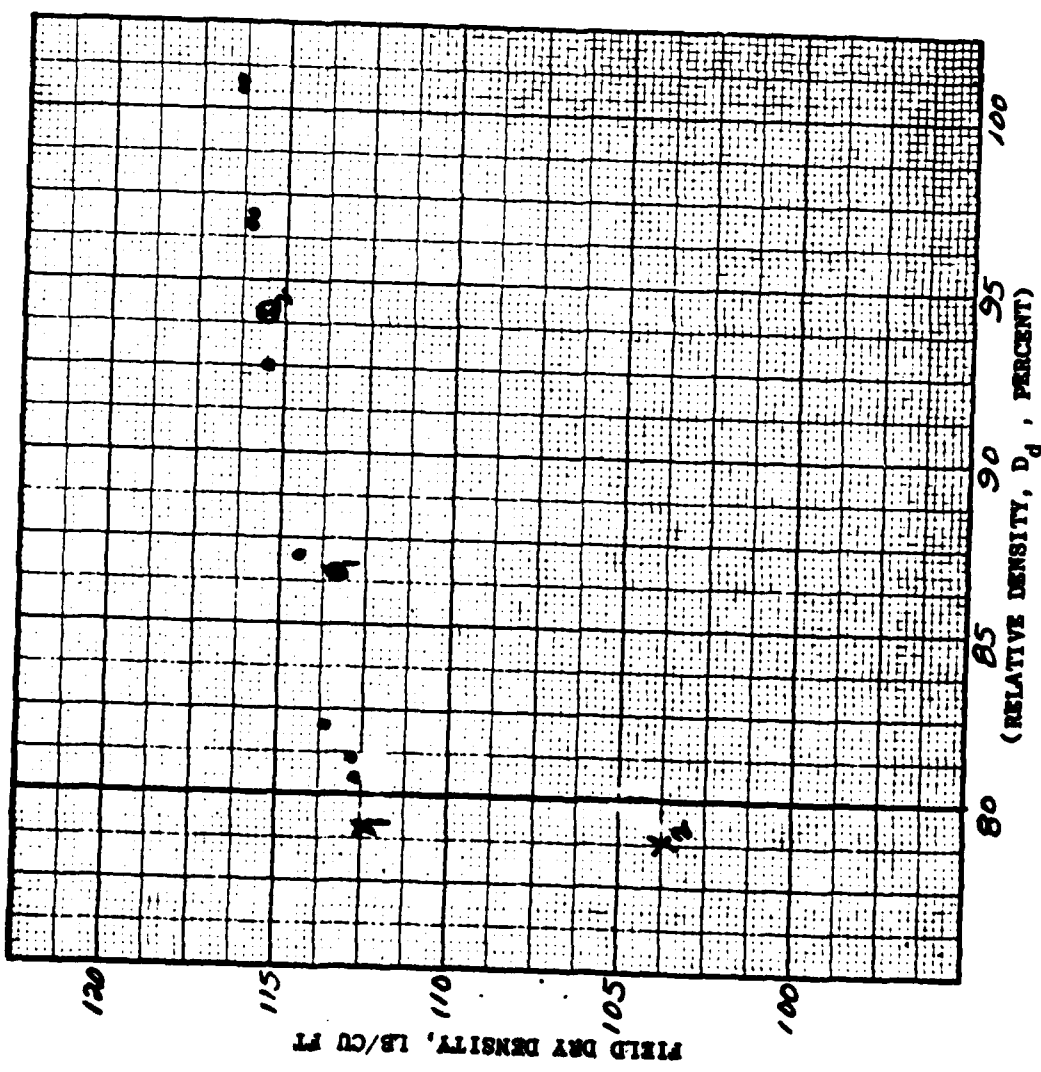
- ABOVE ACCEPTABLE MIN
- x BELOW ACCEPTABLE MIN
- X_R LATER REWORKED ONLY (NO RETEST)
- X_1, X_2 LATER REWORKED & RETESTED
- $\oplus, \ominus$ RESULT OF RETEST AFTER REWORKING
- A_1, A_2 INITIAL TEST (USE ONLY w/CHECK TEST)
- A_1, A_2 CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

Stationing of Areas Tested	1+90 - 25+00
Elevation of Areas Tested	668.0 - 734.0

(SPECIFIED) MIN REL DEN

(SPECIFIED) MIN REL DEN



PROJECT: Cave Run Lake
DISTRICT: Louisville
REPORT PERIOD: 8-1-72 thru 8-31-72
REPORT NO. 15
TYPE OF
MATERIAL: Filter Sand (Pervious)

	CUMULATIVE TO THIS REPORT	THIS REPORT
TOTAL NO. OF TESTS	169	11
NO. BELOW MINIMUM	11	2
NO. REWORKED	11	2
NO. RETESTED AFTER REWORKING	11	2

LEGEND:

- ABOVE ACCEPTABLE MIN
- x BELOW ACCEPTABLE MIN
- x_R LATER REWORKED ONLY (NO RETEST)
- x_1, x_2 LATER REWORKED & RETESTED
- $\odot_1, \odot_2$ RESULT OF RETEST AFTER REWORKING
- Δ_1, Δ_2 INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ_1, Δ_2 CHECK TEST

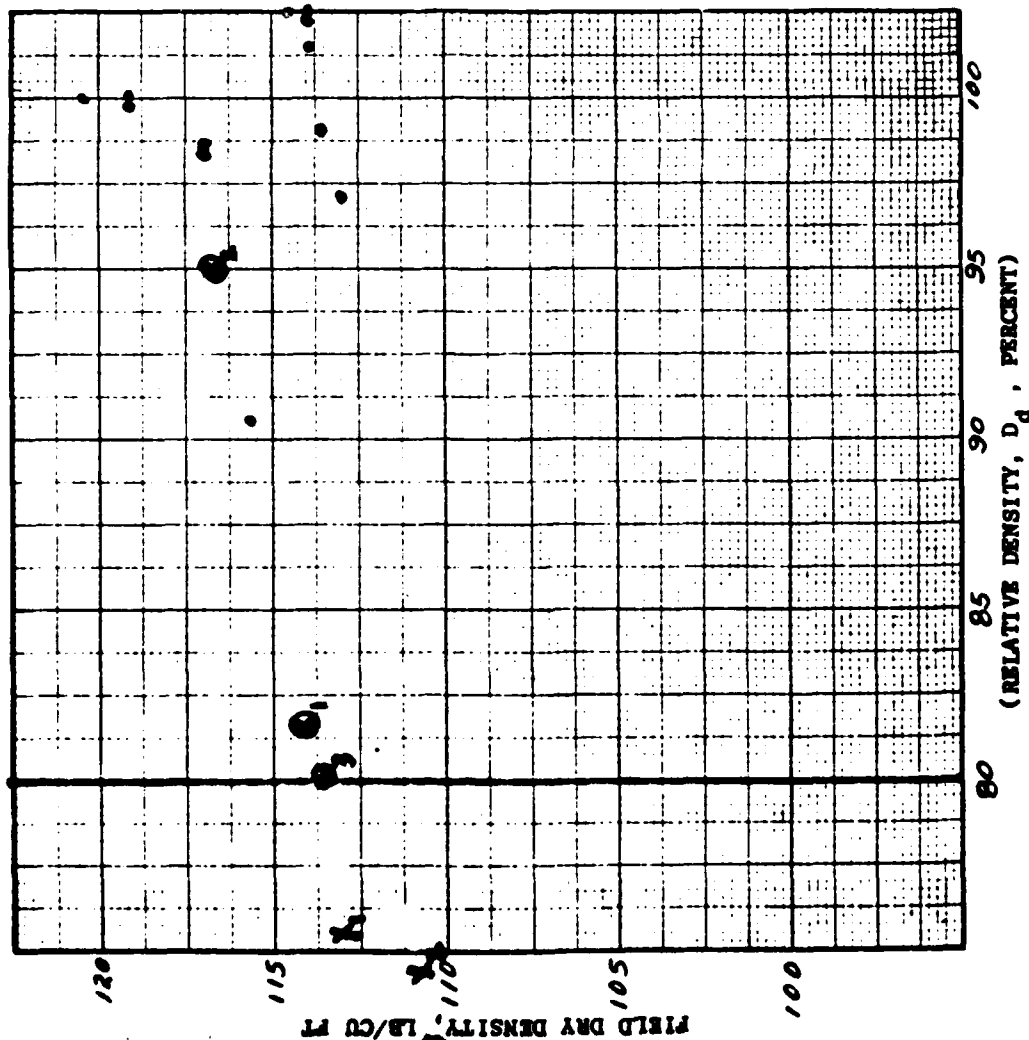
NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

Stationing of Areas Tested	12+70 to 24+70
Elevation of Areas Tested	714.0 to 744.7

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JUN 69

(REQUIRED) (SPECIFIED) MIN PERCENT MAX GFD DRY DEN

(REQUIRED) (SPECIFIED) MIN REL DEN



(PERCENT OF MAX (GFD) DRY DEN)

ENG Form 4287B
JUN 69

PROJECT: Cave Run Lake
DISTRICT: Louisville
REPORT PERIOD: 1-30 September 72
REPORT NO. 16
TYPE OF MATERIAL: Filter Sand (Pervious)

	CUMULATIVE TO THIS REPORT	THIS REPORT
TOTAL NO. OF TESTS	184	15
NO. BELOW MINIMUM	14	3
NO. REWORKED	14	3
NO. RETESTED AFTER REWORKING	14	3

LEGEND:

- ABOVE ACCEPTABLE MIN
- x BELOW ACCEPTABLE MIN
- x_R LATER REWORKED ONLY (NO RETEST)
- x₁, x₂ LATER REWORKED & RETESTED
- ₁, ●₂ RESULT OF RETEST AFTER REWORKING
- Δ₁, Δ₂ INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ₁, Δ₂ CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED AND RETESTED AND RESULT OF RETEST AND FOR INITIAL AND CHECK TEST.

Stationing of Areas Tested	4+25 to 23+25
Elevation of Areas Tested	718.4 to 747.5

TEST	TEST RESULT	TEST RESULT (SPECIFIED)	MIN REL DEN
1	100	100	100
2	100	100	100
3	100	100	100
4	100	100	100
5	100	100	100
6	100	100	100
7	100	100	100
8	100	100	100
9	100	100	100
10	100	100	100
11	100	100	100
12	100	100	100
13	100	100	100
14	100	100	100
15	100	100	100
16	100	100	100
17	100	100	100
18	100	100	100
19	100	100	100
20	100	100	100
21	100	100	100
22	100	100	100
23	100	100	100
24	100	100	100
25	100	100	100
26	100	100	100
27	100	100	100
28	100	100	100
29	100	100	100
30	100	100	100
31	100	100	100
32	100	100	100
33	100	100	100
34	100	100	100
35	100	100	100
36	100	100	100
37	100	100	100
38	100	100	100
39	100	100	100
40	100	100	100
41	100	100	100
42	100	100	100
43	100	100	100
44	100	100	100
45	100	100	100
46	100	100	100
47	100	100	100
48	100	100	100
49	100	100	100
50	100	100	100
51	100	100	100
52	100	100	100
53	100	100	100
54	100	100	100
55	100	100	100
56	100	100	100
57	100	100	100
58	100	100	100
59	100	100	100
60	100	100	100
61	100	100	100
62	100	100	100
63	100	100	100
64	100	100	100
65	100	100	100
66	100	100	100
67	100	100	100
68	100	100	100
69	100	100	100
70	100	100	100
71	100	100	100
72	100	100	100
73	100	100	100
74	100	100	100
75	100	100	100
76	100	100	100
77	100	100	100
78	100	100	100
79	100	100	100
80	100	100	100
81	100	100	100
82	100	100	100
83	100	100	100
84	100	100	100
85	100	100	100
86	100	100	100
87	100	100	100
88	100	100	100
89	100	100	100
90	100	100	100
91	100	100	100
92	100	100	100
93	100	100	100
94	100	100	100
95	100	100	100
96	100	100	100
97	10		

PROJECT: Cave Run Lake
DISTRICT: Louisville
REPORT PERIOD: 1 Oct - 31 Oct 72
REPORT NO. 17
TYPE OF
MATERIAL: Pervious (Filter Sand)

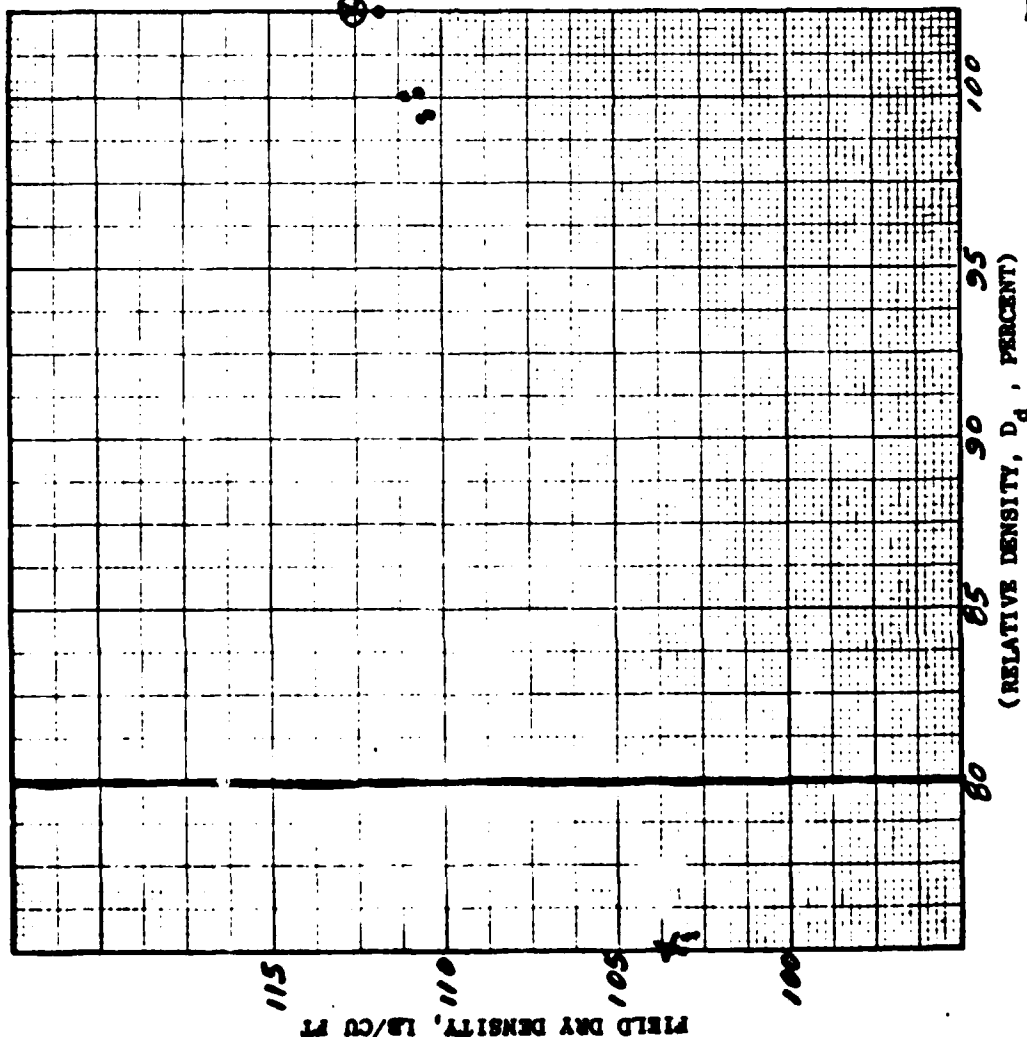
CUMULATIVE TO THIS REPORT	TOTAL NO. OF TESTS	THIS REPORT
189		5
15	NO. BELOW MINIMUM	1
15	NO. REWORKED	1
15	NO. RETESTED AFTER REWORKING	1

LEGEND:

- ABOVE ACCEPTABLE MIN
- X BELOW ACCEPTABLE MIN
- X_R LATER REWORKED ONLY (NO RETEST)
- X₁, X₂ LATER REWORKED & RETESTED
- ₁, ●₂ RESULT OF RETEST AFTER REWORKING
- Δ₁, Δ₂ INITIAL TEST (USE ONLY ▼/CHECK TEST)
- Δ₁, Δ₂ CHECK TEST

**NOTE: USE SAME NUMBER FOR LATER REWORKED
' AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.**

Stationing of Areas Tested	4+60 to 19+08
Elevation of Areas Tested	728.0 to 740.0



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JUN 69.

PLATE 125

PROJECT: Cave Run Lake
DISTRICT: LOUISVILLE
REPORT PERIOD: 4-1-73 thru 4-30-73
REPORT NO. 18
TYPE OF MATERIAL: Filter Sand

	CUMULATIVE TO THIS REPORT	THIS REPORT
TOTAL NO. OF TESTS	192	3
NO. BELOW MINIMUM	15	0
NO. REWORKED	15	0
NO. RETESTED AFTER REWORKING	15	0

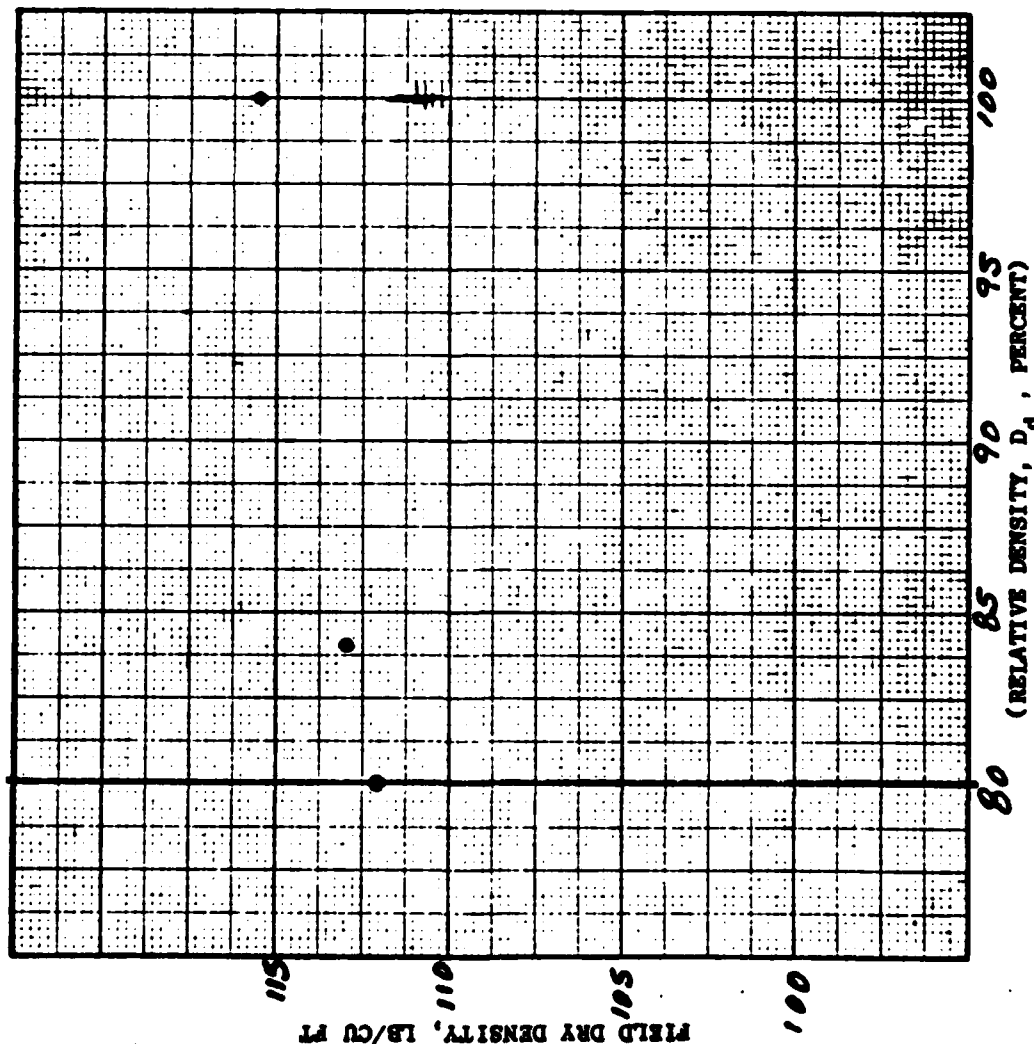
LEGEND:

- ABOVE ACCEPTABLE MIN
- x BELOW ACCEPTABLE MIN
- X_R LATER REWORKED ONLY (NO RETEST)
- X_R X₂ LATER REWORKED & RETESTED
- ₁ ●₂ RESULT OF RETEST AFTER REWORKING
- Δ₁ Δ₂ INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ₁ Δ₂ CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

Stationing of Areas Tested	6+50 to 12+65
Elevation of Areas Tested	730.0 to 735.0

(SPECIFIED) MIN REL DEN

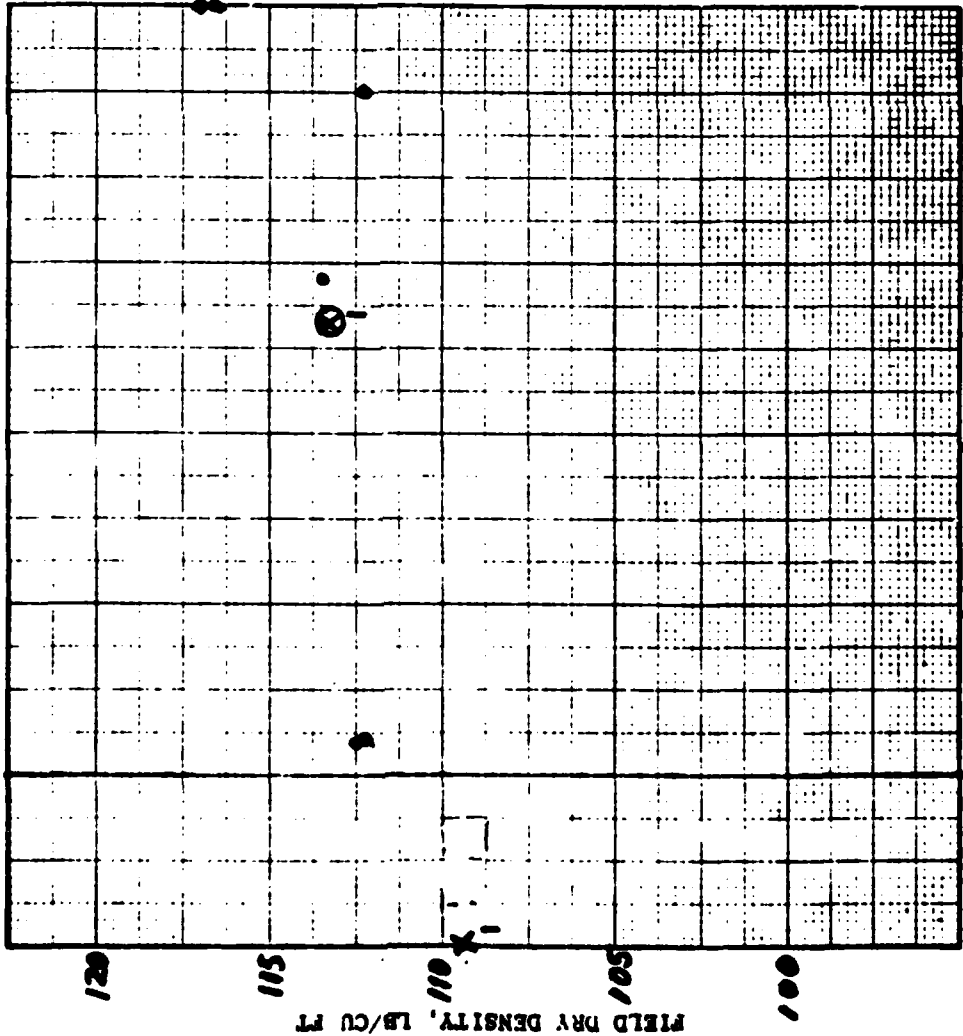


(PERCENT OF SPECIFIED) MIN REL DEN

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JUN 69

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(SPECIAL) (SPECIFIED) MIN REL DEN



PROJECT: Cave Run Lake
DISTRICT: Louisville
REPORT PERIOD: 1 May 73 to 31 May 1973
REPORT NO. 19
TYPE OF
MATERIAL: Pervious (Filter Sand)

	CUMULATIVE TO THIS REPORT	THIS REPORT
TOTAL NO. OF TESTS	199	7
NO. BELOW MINIMUM	16	1
NO. REWORKED	16	1
NO. RETESTED AFTER REWORKING	16	1

LEGEND:

- ABOVE ACCEPTABLE MIN
- x BELOW ACCEPTABLE MIN
- x_R LATER REWORKED ONLY (NO RETEST)
- x_1, x_2 LATER REWORKED & RETESTED
- ₁ ●₂ RESULT OF RETEST AFTER REWORKING
- Δ_1, Δ_2 INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ_1, Δ_2 CHECK TEST

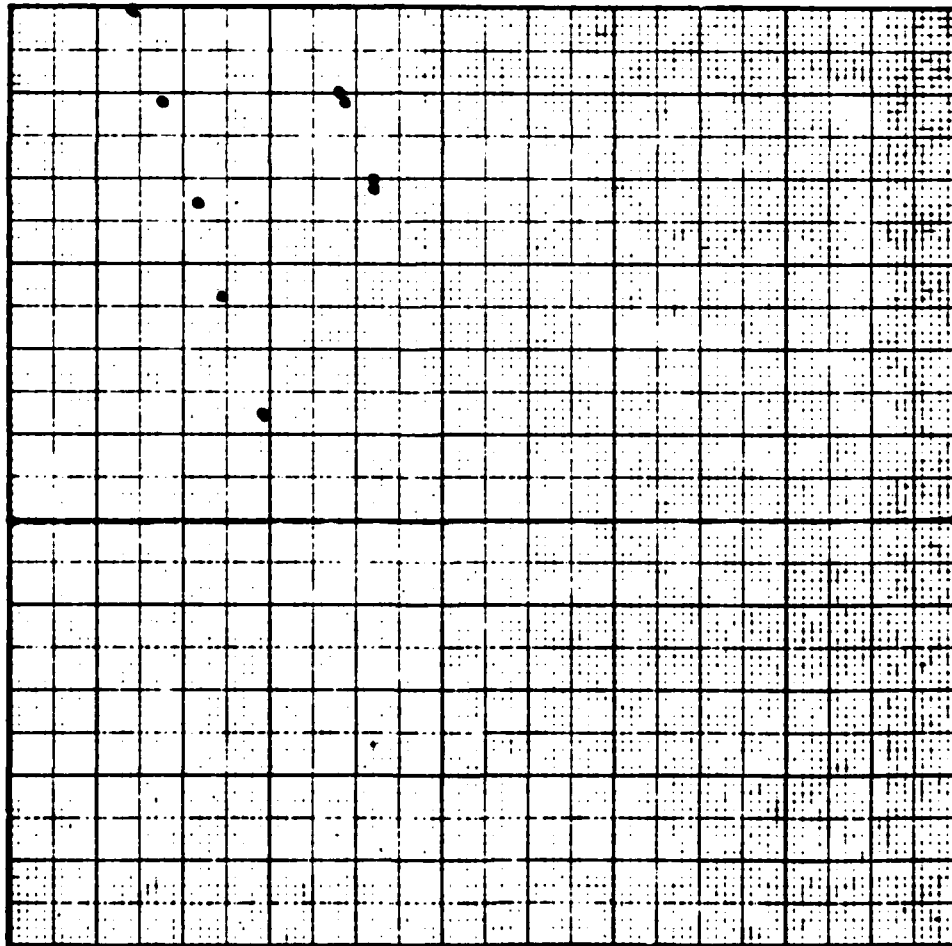
NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

Stationing of Areas Tested	10+67 to 26+00
Elevation of Areas Tested	739.0 to 751.0

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(REMOVED) (SPECIFIED) MIN REL DEN

(REMOVED) (SPECIFIED) MIN REL DEN



PROJECT: Cave Run Lake
DISTRICT: Louisville
REPORT PERIOD: June - 30 June 73
REPORT NO. 20
TYPE OF
MATERIAL: Pervious (Filter Sand)

TOTAL NO. OF TESTS	CUMULATIVE TO THIS	
	REPORT	REPORT
208	16	9
NO. BELOW MINIMUM	16	0
NO. REWORKED	16	0
NO. RETESTED AFTER REWORKING	16	0

LEGEND:

- ABOVE ACCEPTABLE MIN
- x BELOW ACCEPTABLE MIN
- x_1 LATER REWORKED ONLY (NO RETEST)
- x_1, x_2 LATER REWORKED & RETESTED
- $\odot, \odot_2$ RESULT OF RETEST AFTER REWORKING
- Δ, Δ_2 INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ_1, Δ_2 CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

Stationing of Areas Tested	4+30 to 16+10
Elevation of Areas Tested	739.2 to 752.0

APPENDIX A

PHOTOGRAPHS



(1) 15 December 1970
View of the dam prior to diversion.



(2) 20 July 1971
View of the barrier dam being raised to prevent overtopping.



View of the barrier dam being raised to prevent overtopping.



(4) 20 July 1971

View of the flooding situation showing the barrier dam being raised to prevent overtopping.



(5) 29 July 1971

View from the right abutment area showing the barrier dam being raised to prevent overtopping.



(c) 19 September 1973
View of the upstream side of the dam showing the riprap being placed near the crest.

DATE
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-8