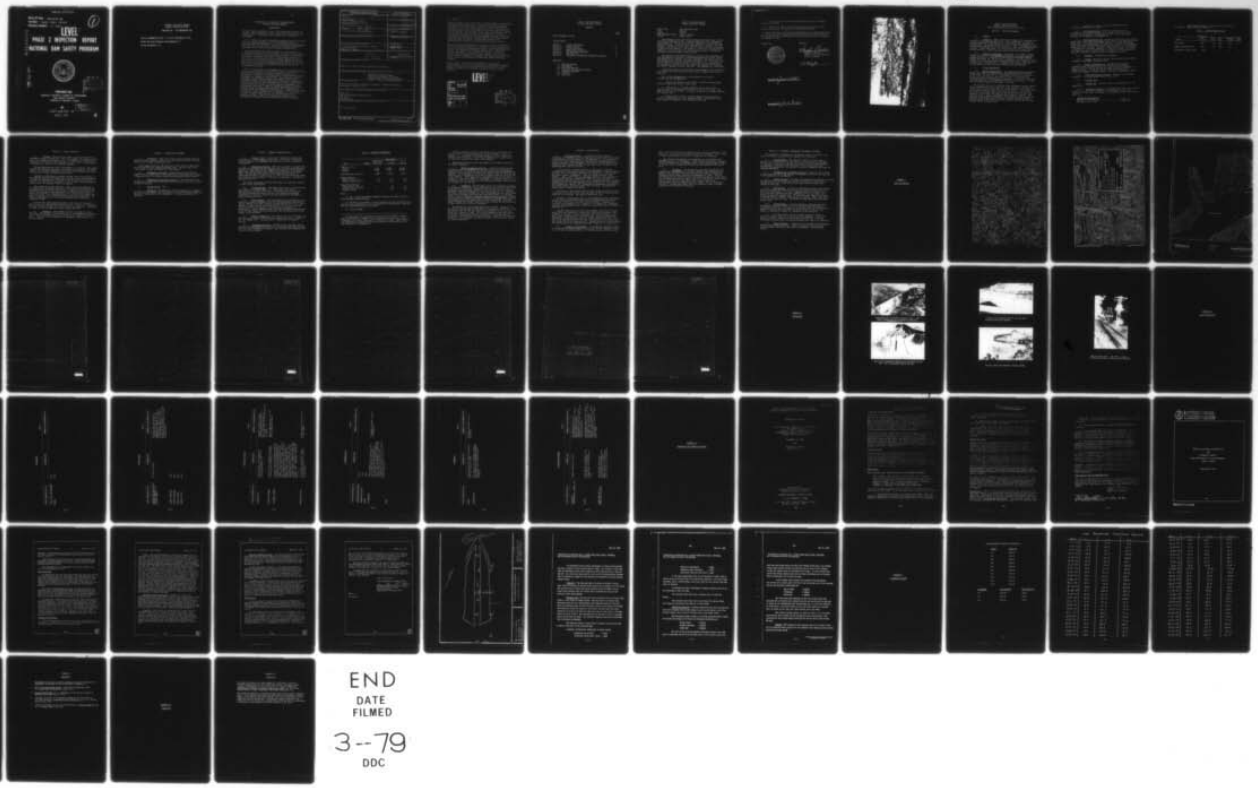
AD-A063 542 GILBERT ASSOCIATES INC READING PA F/G 13/2
NATIONAL DAM SAFETY PROGRAM. BONAVENTURE DAM NUMBER (VA 16704),--ETC(U)
AUG 78 T E ROBERTS DACW65-78-D-0014
UNCLASSIFIED NL

1 OF 1
AD
A063 542



END
DATE
FILMED
3--79
DDC

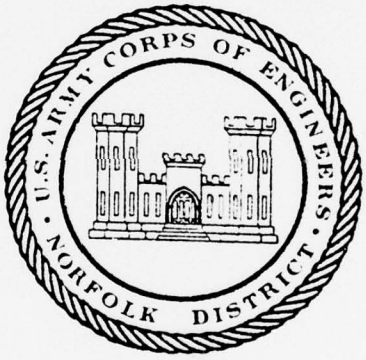
TENNESSEE RIVER BASIN

Name Of Dam: BONAVENTURE DAM
Location: RUSSELL COUNTY, VIRGINIA
Inventory Number: VA 16704

(1)

LEVEL II

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM



PREPARED FOR

NORFOLK DISTRICT CORPS OF ENGINEERS
803 FRONT STREET
NORFOLK, VIRGINIA 23510

BY

GILBERT ASSOCIATES, INC.

AUGUST, 1978

NATIONAL DAM SAFETY PROGRAM
PHASE I INSPECTION REPORT

REVISION NO. 2 TO BONAVENTURE DAM

Delete recommendation No. 1 in brief assessment of dam.

Delete the last sentence from paragraph 7.1.

Delete paragraph 7.2.1.

REVISION NO. 1 TO PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

BONAVENTURE

The cover color is revised to white. The actual cover will not be changed. Each recipient of a copy of this report should notate the existing cover. In addition, add to Section 7, the following paragraphs:

7.1.1 Using the Corps of Engineers screening criteria for initial review of spillway adequacy, it has been determined that the embankment would be overtopped for all storms exceeding approximately 29% of the PMF. The spillway is therefore, adjudged as seriously inadequate and the dam is assessed as unsafe, non-emergency.

The classification of "unsafe" applied to a dam because of a seriously inadequate spillway is not meant to connote the same degree of emergency as would be associated with an "unsafe" classification applied for a structural deficiency. It does mean, however, that based on an initial screening, and preliminary computations, there appears to be a serious deficiency in spillway capacity so that if a severe storm were to occur, overtopping and failure of the dam would take place, significantly increasing the hazard to loss of life downstream from the dam.

7.2.6 In accordance with paragraph 7.1.1, it is recommended that within two months from the date of notification to the Governor of the Commonwealth of Virginia, the owner engage the services of a professional consultant to determine by more sophisticated methods and procedures the adequacy of the spillway. Even though the seriously inadequate spillway would produce a dam failure primarily from hydrologic reasons, remedial measures in structural or geotechnical areas may be needed to remove the dam from an unsafe classification. Within 6 months of the date of notification to the governor, the professional consultant's report of appropriate remedial mitigating measures should have been completed and the owner should have an agreement with the Commonwealth of Virginia to a reasonable time frame in which all remedial measures will be complete. In the interim, a detailed emergency operation plan and warning system should be promptly developed. Also, during periods of unusually heavy precipitation, around-the-clock surveillance should be provided.

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: VA 16704	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE *(and Subtitle)*: Phase I Inspection Report National Dam Safety Program Bonaventure Dam Russel County, Virginia	5. TYPE OF REPORT & PERIOD COVERED: Final
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): Gilbert Associates-Thomas Roberts	8. CONTRACT OR GRANT NUMBER(s): DACW 65-78-D-0014
9. PERFORMING ORGANIZATION NAME AND ADDRESS	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS: U. S. Army Engineering District, Norfolk 803 Front Street Norfolk, VA 23510	12. REPORT DATE: August 1978 13. NUMBER OF PAGES: 59
14. MONITORING AGENCY NAME & ADDRESS *(If different from Controlling Office)*	15. SECURITY CLASS. *(of this report)*: Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT *(of this Report)*

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

National Dam Safety Program. Bonaventure Dam Number (VA 16704), Tennessee River Basin, Russell County, Virginia. Phase I Inspection Report.

18. SUPPLEMENTARY NOTES

Copies are obtainable from National Technical Information Service, Springfield, Virginia 22151

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Dams - VA
National Dam Safety Program Phase I
Dam Safety
Dam Inspection

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

(See reverse side)

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

151850

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

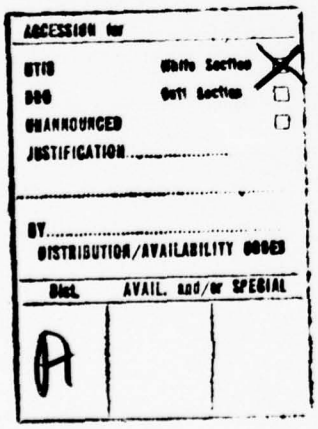
20. Abstract

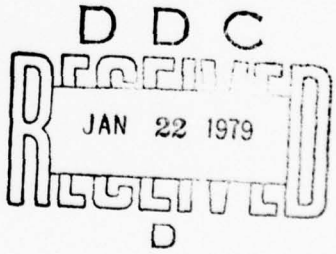
Pursuant to Public Law 92-367, Phase I Inspection Reports are prepared under guidance contained in the recommended guidelines for safety inspection of dams, published by the Office of Chief of Engineers, Washington, D. C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general conditions of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

Based upon the field conditions at the time of the field inspection and all available engineering data, the Phase I report addresses the hydraulic, hydrologic, geologic, geotechnic, and structural aspects of the dam. The engineering techniques employed give a reasonably accurate assessment of the conditions of the dam. It should be realized that certain engineering aspects cannot be fully analyzed during a Phase I inspection. Assessment and remedial measures in the report include the requirements of additional indepth study when necessary.

Phase I reports include project information of the dam and appurtenances, all existing engineering data, operational procedures, hydraulic/hydrologic data of the watershed, dam stability, visual inspection report and an assessment including required remedial measures.

LEVEL II





PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

CONTENTS

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Lake Bonaventure Dam
State:	Virginia
County:	Russell
USGS Quadrangle Sheet:	Carbo 7.5 minute
Stream:	Chaney Creek

Lake Bonaventure Dam (also known as Chaney Creek Dam), built in 1956, was visually inspected on June 7, 1978 and found to be in an apparently stable condition. The dam is an earthfill embankment, about 42 feet high and 600 feet long. A concrete chute type spillway is located on the left abutment. The spillway is the only reservoir outlet and there is no means of dewatering the reservoir. The reservoir is used by the Clinchfield Coal Company as a source of water for their preparation plant. Recreational activities are also allowed on the reservoir.

Our analysis of the spillway capacity indicates that the spillway can pass approximately 29 percent of the probable maximum flood (PMF) without overtopping and is therefore "seriously inadequate" according to the U.S. Corps of Engineers' criteria described in paragraph 5.8. The one-half PMF and the PMF will overtop the dam by 2.0 feet and 4.3 feet, respectively. The inadequacy of the spillway could be hazardous depending on conditions and requires immediate action by the owner. (See Appendix VII, Conditions).

A stability analysis was performed on the embankment by the Clinchfield Coal Company and it was found to be stable under a normal pool elevation condition.

The following recommendations are presented for the owner's consideration and implementation:

1. Enlarge the spillway to pass a PMF. Construction should begin within 120 days after receipt of this report.

2. Confirm the soil strength parameters used in the previous stability analysis and improve the drainage at the toe of the dam. This should be done within 120 days. Clearing of brush and tree stumps should be done within a year.

3. Develop within 30 days a detailed emergency warning system to notify the downstream area of any impending danger, and determine, those areas subject to inundation from a dam break flood wave.

4. Initiate an annual inspection program to monitor the general condition of the dam.

5. Maintain a file of all available documents pertinent to the design, construction, and operation of the Bonaventure Dam.

Until such time as the above recommendations can be implemented during heavy rains, the owner should provide for round-the-clock surveillance of the dam and prepare to implement the warning system procedures recommended in paragraph 4. above.

Prepared by:

APPROVED:

Douglas L. Haller
Colonel, Corps of Engineers
District Engineer

21 Aug 78
Date

Submitted By: James A. Walsh

Recomended By: James M. Goodman

OVERVIEW - BONAVENTURE

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
NAME OF DAM Bonaventure Dam ID # VA 16704

SECTION 1 - PROJECT INFORMATION

1.1 General

1.1.1 Authority: Public Law 92-367, 8 August 1972, authorized the Secretary of the Army, through the U.S. Corps of Engineers to initiate a national program of safety inspections of non-Federal dams throughout the United States. The Norfolk District of the U.S. Corps of Engineers has been assigned the responsibility of the inspection of dams in the Commonwealth of Virginia. Gilbert Associates, Inc. has entered into a Contract with the Norfolk District to inspect this dam, Gilbert Work Order 06-7250-002.

1.1.2 Purpose of Inspection: The purpose is to conduct a Phase I inspection according to the Recommended Guidelines for Safety Inspection of Dams (Reference 1 of Appendix VI) and contract requirements between Gilbert Associates, Inc. and the Corps of Engineers. The objectives are to expeditiously identify whether this dam apparently poses an immediate threat to human life or property, and to recommend future studies and/or any obvious remedial actions that may be indicated by the inspection.

1.2 Project Description

1.2.1 Dam and Appurtenances: Lake Bonaventure Dam (also known as Chaney Creek Dam) is an earthfill dam, approximately 600 feet long and 42 feet high. The dam crest is at approximate elevation 1,553 feet m.s.l., 20 feet wide, with a gravel road along the crest. The upstream and downstream slopes are approximately 2 horizontal to 1 vertical. The toe of the downstream slope is at approximate elevation 1,510 feet m.s.l. at the concrete diversion pipe near the center of the dam.

The spillway consists of a 200-foot long, rectangular concrete channel with a retaining wall on the right side of the spillway for the entire length and for 85 feet on the left side of the spillway. The channel angles to the right 38 degrees about 40 feet past the crest. A 12-inch high, 50.5-foot long concrete weir forms the spillway entrance with the crest elevation at 1,543 feet. The channel slope is about 2.3 percent. The reservoir water is used by Clinchfield Coal Company for their preparation plant and is distributed to the plant by two 8-inch steel pipes from a pumping station on the right side of the reservoir 500 feet from the dam. No other outlet structures exist.

1.2.2 Location: The dam is located on Chaney Creek about 1-1/2 miles north of Carbo, Virginia.

1.2.3 Size Classification: The dam is classified as an intermediate size structure because of its storage potential of 2240 acre-feet and its height of approximately 42 feet, in accordance with Section 2.1.1 of Reference 1 of Appendix VI.

1.2.4 Hazard Classification: The dam is located in a rural area on Chaney Creek, which empties into Dumps Creek, which in turn empties into the Clinch River 1-1/2 miles downstream of the dam. A railroad and highway follow the valley of Dumps Creek, and the village of Carbo is at the Dumps Creek-Clinch River Junction. Therefore, based on Section 2.1.2 of Reference 1 of Appendix VI the hazard potential is classified as high. The hazard classification used to categorize dams is a function of location and size only and is unrelated to the stability or probability of failure.

1.2.5 Ownership: Clinchfield Coal Company.

1.2.6 Purpose: The dam is used for recreation and water supply to Clinchfield Coal Company preparation plant.

1.2.7 Design and Construction: The dam was designed and constructed under the supervision of the Clinchfield Coal Company. Construction was started in 1955 by the Slusher Construction Company of Roanoke, Virginia. In 1956 the work was taken over by the Green Construction Company of Oakton, Indiana. All work was completed in 1956.

1.2.8 Normal Operational Procedures: There are no operational procedures. All excess inflows pass over the spillway.

1.3 Pertinent Data

1.3.1 Drainage Area: The dam is fed by a drainage area of 7.61 square miles.

1.3.2 Discharge at Damsite: The maximum known water level occurred in April 1977, according to the owner's representative, with a pool elevation of 1546.1 feet. According to our estimate, spillway discharge was 890 c.f.s.

Ungated Spillway Capacity

Spillway at 100-year flood	2,680 c.f.s.
Spillway at top of dam	4,930 c.f.s.

1.3.3 Dam and Reservoir Data: Pertinent data on the dam and reservoir are shown in the following table:

Table 1.1 DAM AND RESERVOIR DATA

Item	Reservoir Elev. ft. m.s.l.	Area acres	Acre feet	Watershed inches	Length miles
Top of Dam	1553	115	2240	5.52	1
Ungated Spillway Crest	1543	78	1260	3.10	
Streambed at Base of Dam	1510±	x	x	x	x

SECTION 2 - ENGINEERING DATA

2.1 Design: The dam was designed and constructed under the direction of the Clinchfield Coal Company. As-built sections and aerial maps are available from the Clinchfield Coal Company, Dante, Virginia, 24237. Some of the maps are included in Appendix I. Two pages of specifications for the dam are also available.

The dam has undergone three inspections prior to this one. Law Engineering Testing Company inspected the dam on June 15, 1976 and again on November 17, 1976. The Mining Enforcement and Safety Administration (MESA) inspected it on December 9, 1976. The major finding of the MESA inspection was the deficiency of the spillway capacity. The possibility of seepage was noted by MESA but none was observed.

The Law Engineering Testing Company inspection did not note any seepage conditions. Their studies included core borings, a foundation investigation, and soils analysis. A typical core boring through the embankment revealed a very stiff, tan, light brown and gray, sandy clayey silt with some shale fragments in the embankment fill, and a very hard, gray clayey silt-partially weathered shale foundation material. Density tests showed the materials to be well compacted, and permeability tests found a permeability of 2×10^{-7} cm/sec. Three piezometers were installed in the embankment during the foundation investigation to determine if water pressures at the foundation of the dam were higher than the pressures within the embankment. These are discussed further in paragraph 2.3.

Using the results of the foundation investigation, engineers of the Clinchfield Coal Company performed a stability analysis of the embankment. The computer analyses used the Simplified Bishop Method and found the factor of safety for a large number of trial failure surfaces. The minimum factor of safety was 1.88. A drawing showing the cross section of the dam, the assumed distribution of the soil types, and the soil strength parameters is given in Appendix I. The strength parameters used were determined from triaxial tests. Copies of the two inspection reports are in Appendix IV.

2.2 Construction: The project was started in 1955 by the Slusher Company of Roanoke, Virginia. In 1956 the work was taken over by the Green Construction Company from Oakton, Indiana. Green Construction Company completed the work, starting in September 1956 and finishing in October 1956. On May 31, 1956 the Hydraulic Data Branch of the Tennessee Valley Authority (TVA) inspected the dam site and areas influenced by the dam. At the time of the inspection the core trench had been excavated to bedrock which was described in the report as "Blue Slate" at an average depth of 8 feet. The width of the trench was 44 feet. Apparently the plans for the dam were changed after this inspection because the dam, as described in the report, does not correspond with the actually constructed embankment. A copy of this report is in Appendix IV.

2.3 Operation: Aside from the uncontrolled spillway, the only operating features of the dam are the two pumps. These have little effect on the pool level. No records are kept of the reservoir levels. The piezometers installed in 1976 are read on a weekly basis. Readings from January 1977 through May 1978 are in Appendix V.

2.4 Evaluation: While very little original design and construction data are available, subsequent investigation has indicated that the dam apparently was well constructed and has a stable embankment. The stability analysis is discussed further in section 6. Because of the low permeability of the embankment soil, the type of piezometers used will give only a rough indication of pore water pressure within the embankment. The piezometer readings given in Appendix V do not show any unusual buildup of pressure. The major flow was pointed out in the MESA inspection which noted the deficient spillway. Our studies (Section 5) have verified this determination.

SECTION 3 - VISUAL INSPECTION

3.1 Findings: The dam did not appear to have any flaws in the embankment related to instability. The crest alignment was straight with no sags in the roadbed traversing the crest. No slumping was evidenced on the downstream slope which was field measured to be at a ratio of approximately 2 horizontal to 1 vertical, as originally designed.

The upstream slope was also at 2 horizontal to 1 vertical. Some slight erosion was occurring at the water line, which is an indication of a riprap failure. The riprap was generally in relatively good condition but should be monitored for signs of further deterioration.

Seepage was indiscernible, although a marshy area at the right toe of the slope may indicate some seepage was occurring. Water in the downstream streambed was approximately 2 feet deep at the grouted 48-inch diversion pipe, but it could not be ascertained if it was a result of backup from the stream itself. No movement of water was apparent.

The spillway was in good condition. Minor erosion and weathering on the bedrock which formed the left side of the channel had occurred but was determined not to be of major significance. Minor backcutting beneath the floor of the spillway at the transition of the channel from concrete to bedrock had occurred to a maximum distance of 1-1/2 feet, but normally was only a few inches. This condition was also considered insignificant. The bedrock slopes appear to be in a stable condition with no evidence of incipient sliding.

Six-inch tree stumps supplied evidence of past excessive vegetative growth both on the upstream and downstream slopes. However, all large brush and trees had been cut back prior to the time of the inspection. New growth from many of the old stumps will require cutting back soon.

3.2 Evaluation: The earthfill portion of the dam is in good condition. Some erosion of the upstream face of the embankment has occurred and it should be watched regularly in the future to determine the need for repair. The brush and tree stumps on the embankment slopes should be cut back and removed.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 Procedures: There are no outlet structures other than the ungated spillway; therefore, there are no operational procedures affecting the reservoir storage or downstream flows.

The two pumps located on the right side of the reservoir supply water to the Clinchfield Coal Company processing plant. The flow rate is not large enough to affect the operation of the reservoir.

4.2 Maintenance of the Dam: Large brush and trees had been removed from the slopes prior to the inspection but new growth has returned. A depression noted in a previous inspection had apparently been repaired.

4.3 Maintenance of Operation Facilities: The spillway was free of obstructions which may deleteriously affect or restrict the flow of water through the spillway.

4.4 Warning System: None.

4.5 Evaluation: Maintenance of the site appeared to be adequate. The only condition which called for attention was the new growth of vegetation which had re-established on the embankment. A warning system should be developed.

SECTION 5 - HYDRAULIC/HYDROLOGIC DATA

5.1 Design: There is very little information concerning the actual design of the embankment and spillway. More recent studies have included mapping of the embankment and reservoir area, and a foundation investigation.

5.2 Hydrological Records: There are no records for Chaney Creek, the source of drainage into the reservoir, but a flood plain map has been prepared for Dumps Creek which is immediately downstream. The flooding of Dumps Creek also influences water levels on the lower portion of Chaney Creek. The map shows the level of the PMF downstream of the dam at approximately elevation 1,530 feet m.s.l. This is 13 feet below the normal pool elevation of the reservoir. This map is in Appendix I. The map was prepared by the TVA.

The nearest stream gage (#3-5240 Clinch River at Cleveland, Virginia) is about 2 miles from the dam.

5.3 Flood Experience: The highest water level of recent history was a result of a storm in April 1977. According to the owner's representative, the water level rose 3.1 feet above the spillway crest. This storm produced the flood of record at the Cleveland stream gage (operating for a period of 58 years) and was estimated (by the USGS) to exceed the 100 year flood.

5.4 Flood Potential: The flood potential was evaluated by using generalized rainfall information with the flood hydrographs and reservoir routing computed by the HEC-1 computer program supplied by the U.S. Corps of Engineers. Based upon the hazard classification of the dam, the design flood is the PMF. The results of this analysis are presented in paragraph 5.6. These analyses pertain to present hydrologic conditions and do not consider future uncertain conditions, such as urbanization or other changes in the watershed.

5.5 Reservoir Regulation: The reservoir has no outlet other than the spillway and the two 8-inch pipelines through which water is pumped to the coal company plant. The pool level is regulated by the ungated spillway.

5.6 Overtopping Potential: The PMF, one-half the PMF, and the 100-year flood hydrographs were developed for the Lake Bonaventure drainage basin and routed through the reservoir. The following table summarizes the results of this procedure:

Table 5.1 RESERVOIR PERFORMANCE

Item	Normal	Hydrograph: One Percent Flood (a)	Hydrograph: 1/2 PMF	Hydrograph: PMF (b)
Peak flow, c.f.s.				
Inflow		5,140	11,800	23,700
Outflow		2,680	11,100	23,100
Peak Elevation, feet m.s.l.		1,549.6	1,555.0	1,557.3
Ungated Spillway				
Depth of Flow, feet		3.5	6.4	7.6
Average velocity, f.p.s.		19.0	26.0	28.0
Non-overflow Section				
Depth of Flow, feet (c)		-	1.3	2.7
Average Velocity, f.p.s.		-	6.4	9.4
Duration, hours		-	4.0	5.5

Notes:

(a) The 1 percent exceedence frequency flood has one chance in 100 of being exceeded in any given year.

(b) The PMF is an estimate of flood discharges that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonable possible in the region.

(c) Critical depth.

The hydrographs were developed and routed by using the HEC-1 computer program (Reference 2 of Appendix VI) and appropriate precipitation, unit hydrograph, and storage volume versus outflow data as input. The triangular unit hydrograph was developed from the drainage area and estimated time to peak (Reference 3 of Appendix VI).

Probable maximum precipitation and 100-year precipitation data were obtained from U.S. Weather Bureau publications (References 4 and 5 of Appendix VI). Information from design drawings was used to compute the storage - outflow relation. Losses were estimated at an initial loss of 1.0 inch and a constant loss rate of 0.30 inch/hour.

Appropriate reduction factors were applied to the PMP as directed by the Corps of Engineers.

5.7 Reservoir Emptying Potential: A 48-inch concrete pipe was constructed under the embankment for the diversion of the stream during construction, but this pipe was sealed with concrete when the embankment was completed. The only means of lowering the reservoir below the level of the spillway crest is through the use of the two pumps located on the right side of the reservoir. These pumps are not intended for such use and would be ineffective. The total capacity of both pumps is estimated at about 3.5 c.f.s. Assuming no inflow to the reservoir from upstream, the pumps could lower the pool at about 0.1 feet per day.

5.8 Evaluation: The screening criteria for assessing the adequacy of the spillway design flood allow essentially no risk of loss of life from dam failure by overtopping. Experience indicates that very few existing non-Federal dams were designed with such conservative criteria. Therefore, the Phase I inspection findings will indicate noncompliance with the spillway design flood screening criteria for most non-Federal dams. In accordance with U.S. Corps of Engineers' Engineer Technical Letter 1110-2-234 a further classification is required based upon the percent of the PMF flood passed by the spillway before overtopping occurs, and the consequences of the dam being overtopped and failing. Based upon these criteria the spillway may be further classified as "seriously inadequate."

The design flood for the Bonaventure Dam is the PMF. The results of our analysis indicate that the dam would be overtopped by the PMF by 4.3 feet and the flow over the dam crest would be at velocities of 10 f.p.s. for durations as long as 5.5 hours. This would presumably lead to the failure of the dam. The spillway capacity is sufficient to pass approximately 29 percent of the PMF before overtopping the dam. Based upon the inspection guidelines it is considered "seriously inadequate" and the spillway should be enlarged immediately.

SECTION 6 - DAM STABILITY

6.1 Stability Analysis: A boring and testing program to investigate the embankment soils and foundation materials was carried out by Law Engineering & Testing Company in 1976 (Appendix IV). Using the results of the soils study, engineers of the Clinchfield Coal Company prepared a stability analysis of the embankment. The analysis was performed for the downstream slope assuming a normal reservoir pool level, the level of the ungated spillway crest of 1543 feet.

A cross section of the dam was taken at the location of the old streambed, and at the greatest height of the embankment. A drawing showing the cross section of the dam, the zones of different soils, and the soil properties is given in Appendix I. Four soil types were used in the analysis. Types I and IV were the embankment materials in an unsaturated and saturated condition, respectively. Type II soil was the natural overburden material and type III soil was the foundation material. Strength properties of the soils were determined from triaxial tests. The analysis was performed on a computer with a program which automatically searched for the failure surface giving the lowest factor of safety. The Simplified Bishop Method of analysis was applied.

The results of the analysis found that the failure surface would occur at the base of the type II soil, with the center of the arc almost directly above the toe of the dam. The factor of safety was 1.88.

The dam is located within Zone 2 on the Algermissen Seismic Risk Map of the United States (1969 Edition) and there are uncertainties with respect to the static stability of the dam, as described above. Therefore, in accordance with paragraph 3.6.4 of Reference 1 of Appendix VI, assessments should be made regarding seismic stability, based on the studies outlined in paragraph 7.2.2.

A marshy condition exists in the old streambed at the toe of the dam which, while not hazardous in itself, could conceal other problems. The streambed is very flat. Water, presumably from natural drainage, collects there, nearly submerging the old diversion pipe. Pipelines through dam embankments are sometimes the source of seepage problems which could even lead to the eventual failure of the dam. The presence of the water at the base of the dam can be an indication of a seepage condition, but unfortunately the standing water will completely mask such a condition if it does exist.

6.2 Foundation and Abutments: The foundation investigation made by Law Engineering Testing Company revealed that the dam foundation consists of 7 to 8 feet of sandy clayey silt of a residual nature, overlying a gray

shale. The soil overburden is probably thicker toward the abutments. Some deposits of alluvial soil were found along the old streambed. A core trench to bedrock was apparently constructed through the soil overburden.

The available information on the properties of the foundation and embankment materials is inadequate to reach definite conclusions. However, both the foundation and the abutment appear to be providing adequate support to the dam, since no significant distress has been observed in the dam to date.

6.3 Evaluation: The studies which have been performed to date indicate that the embankment is in stable condition but further analysis appears to be justified. The method used for the stability analysis was acceptable and the results indicate the embankment is stable. The only shortcoming with the analysis is that the strength properties of the type II soil was based upon only one sample of the soil. The material forms a large portion of the failure surface and a lower strength value could significantly reduce the computed factor of safety. The wet condition at the base of the downstream slope should be eliminated so that a seepage condition can be detected if one exists.

SECTION 7.0 ASSESSMENT, RECOMMENDATIONS/REMEDIAL MEASURES

The assessment, recommendations and remedial measures contained in this report are based on the provisions of Appendix VII, Conditions.

7.1 Dam Assessment: The inspection found no critical signs of distress in the condition of the dam; however, calculations have shown that the spillway can pass only 29 percent of the PMF flood before the embankment is overtopped. According to the screening criteria and the guidelines described in paragraph 5.8, the spillway is seriously inadequate and should be enlarged immediately.

7.2 Recommendations and Remedial Measures: Based upon the findings of this inspection and in the interest of improving the safety of the dam, the following measures are recommended:

7.2.1 Enlarge Spillway: The owner should immediately undertake the design and construction of a new spillway such that the PMF can be safely passed through the reservoir. Construction should begin within 120 days after receipt of this report.

7.2.2 Dam Stability: In order to confirm the finding of the previous stability analysis, the owner should verify the strength of the type II soil used in the calculation. It is also recommended that the drainage of the toe of the dam be improved such that standing water will not conceal the presence of possible seepage zones. The brush and tree stumps on the slopes of the dam should be removed, including the root systems. These items should be carried out within 120 days. The brush and stump removal should be done within a year.

7.2.3 Warning System: A detailed emergency warning system should be developed as soon as possible to notify the downstream inhabitants of an impending dam failure. In order for the warning system to be effectively applied, a study of the downstream area should be made so that the areas subject to flooding as a result of a dam break can be identified.

7.2.4 The owner should initiate an annual inspection program to monitor the general condition of the spillway and embankment. Particular attention should be given to the riprap on the upstream face of the dam. The riprap is showing signs of wear and eventually will need to be reinforced.

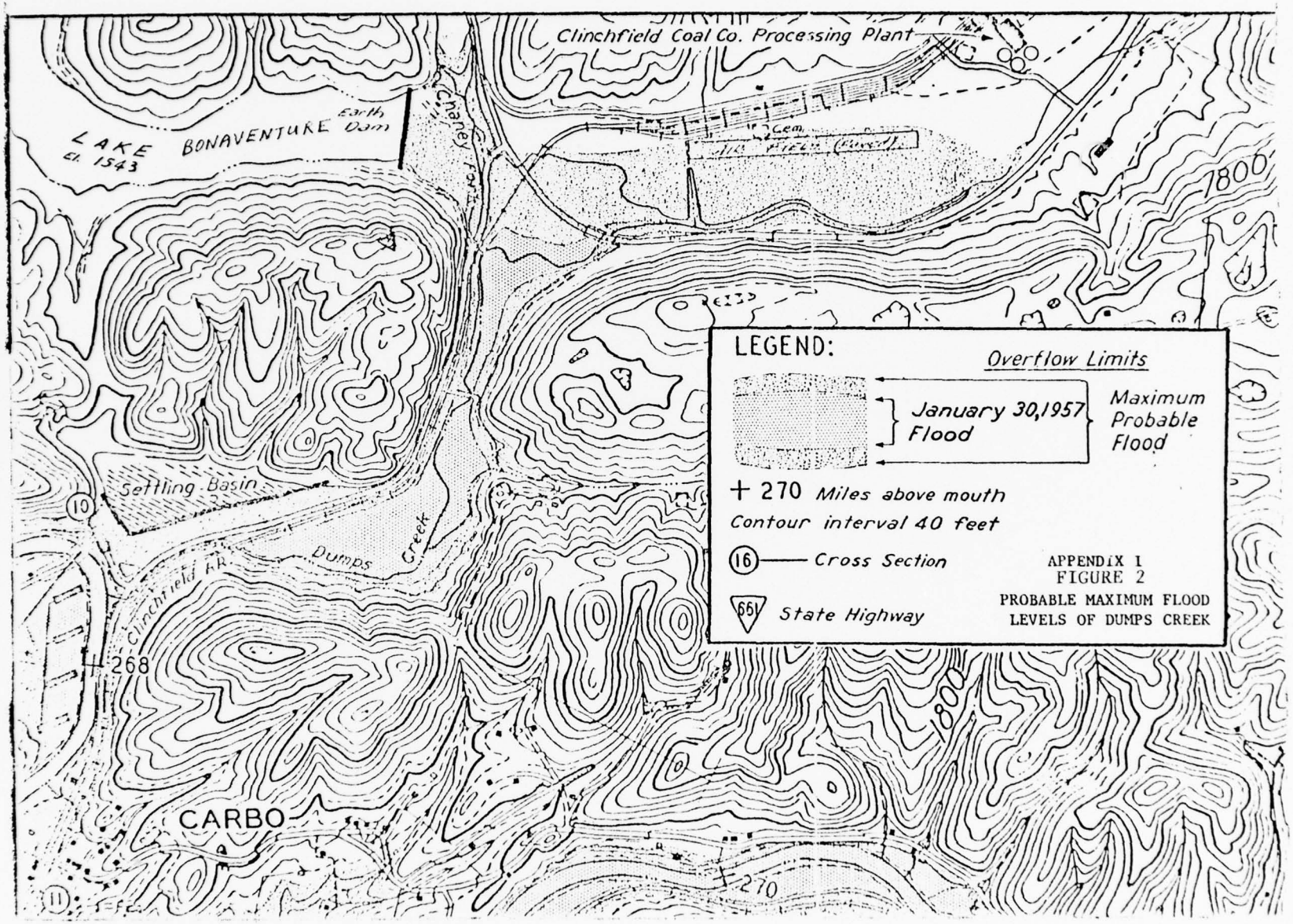
7.2.5 Design Documents: A complete set of available design documents should be maintained by the owner. These files should include available design drawings, calculations, pertinent correspondence, and maintenance records.

APPENDIX I

MAPS AND DRAWINGS

FIGURE 1

VICINITY
MAP



APPENDIX 1
FIGURE 2
PROBABLE MAXIMUM FLOOD
LEVELS OF DUMPS CREEK

CONTINENTAL
AERIAL SURVEYS INC.

Sheet Index

MAP SCALE 1"=100'

CONTOUR INTERVAL 2 FEET

TEST BORINGS LEGEND

- Piezometer
- Test Boring

FIG 3

[redacted]

REVISION DESCRIPTION	DATE
9	
8	
7	
6	
5	
4	
3	
2	
1	

DRAWN BY _____
CHECKED BY _____
APPROVED BY _____
DATE _____ SCALE _____

TITLE

FOR

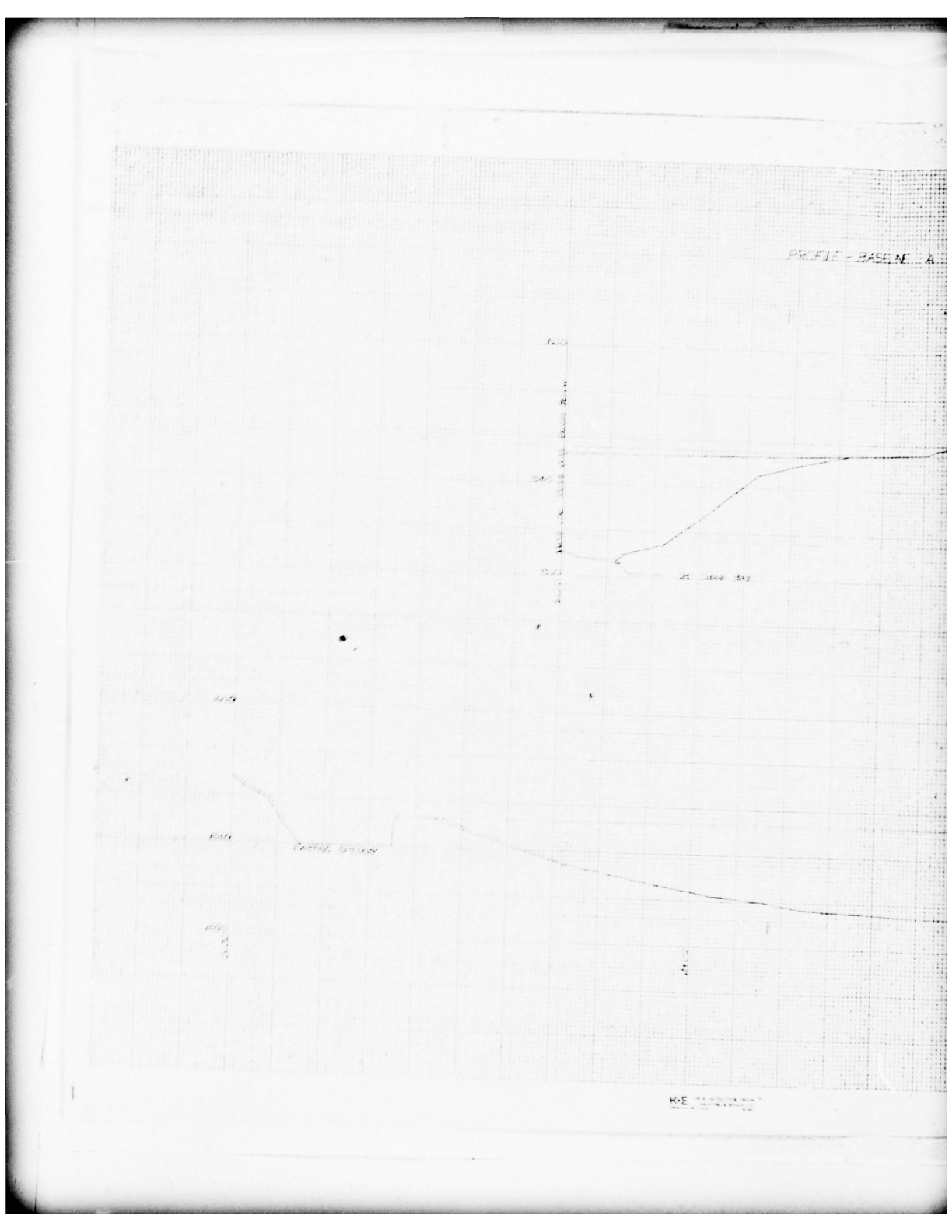
CLINCHFIELD COAL COMPANY

DIVISION OF THE HUTTON COMPANY
DANTE VIRGINIA

DRAWING IDENTIFICATION NUMBER

MINE NO.	MINE INDEX NO.	COAL SEAM NO.	TYPE DRAWING

SHEET NO. ___ OF ___ SHEETS	DRAWER NO.	FILE NO.


PROFILE - BASELINE A
EXISTING GROUND

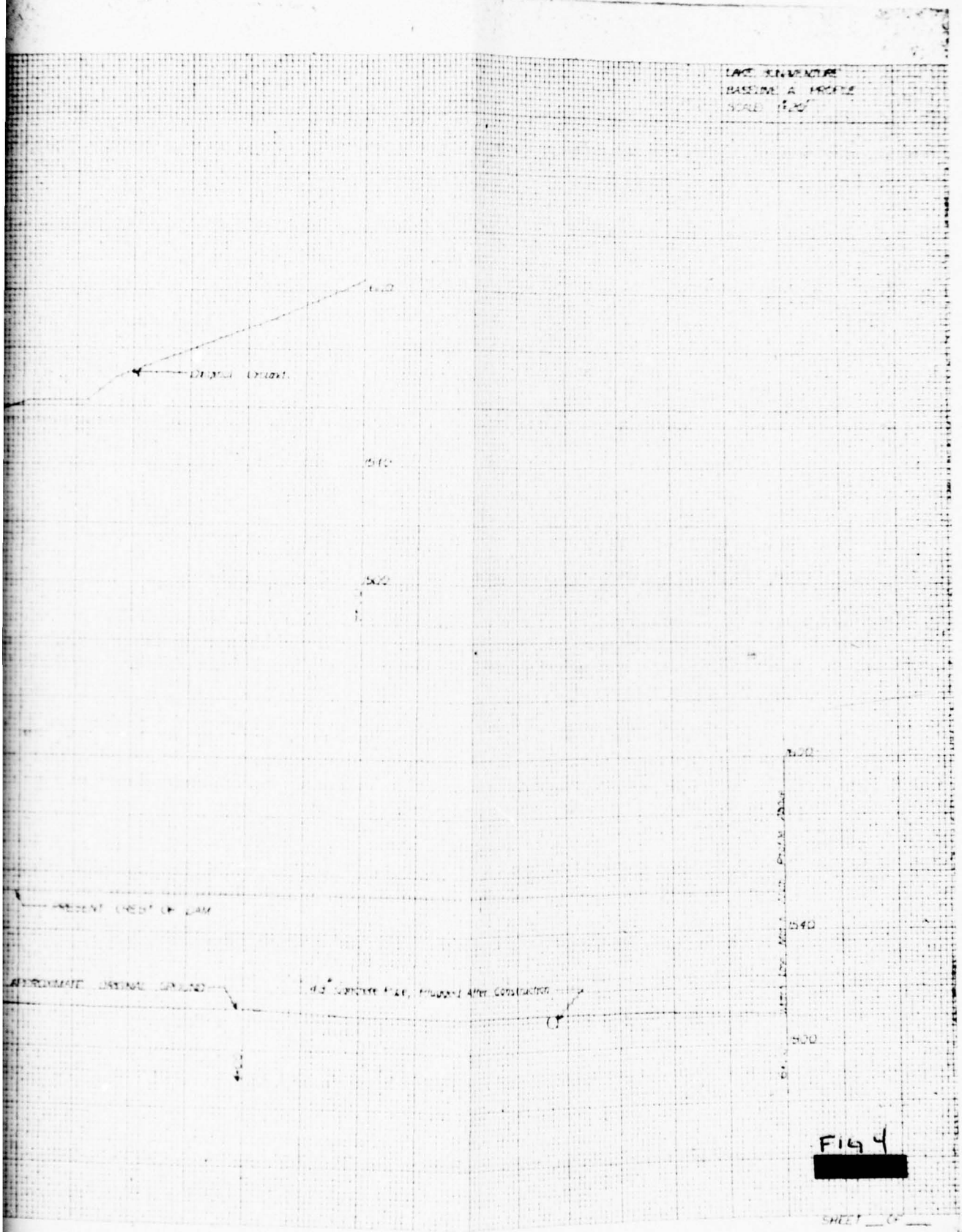


Fig 4

SHEET __ OF __

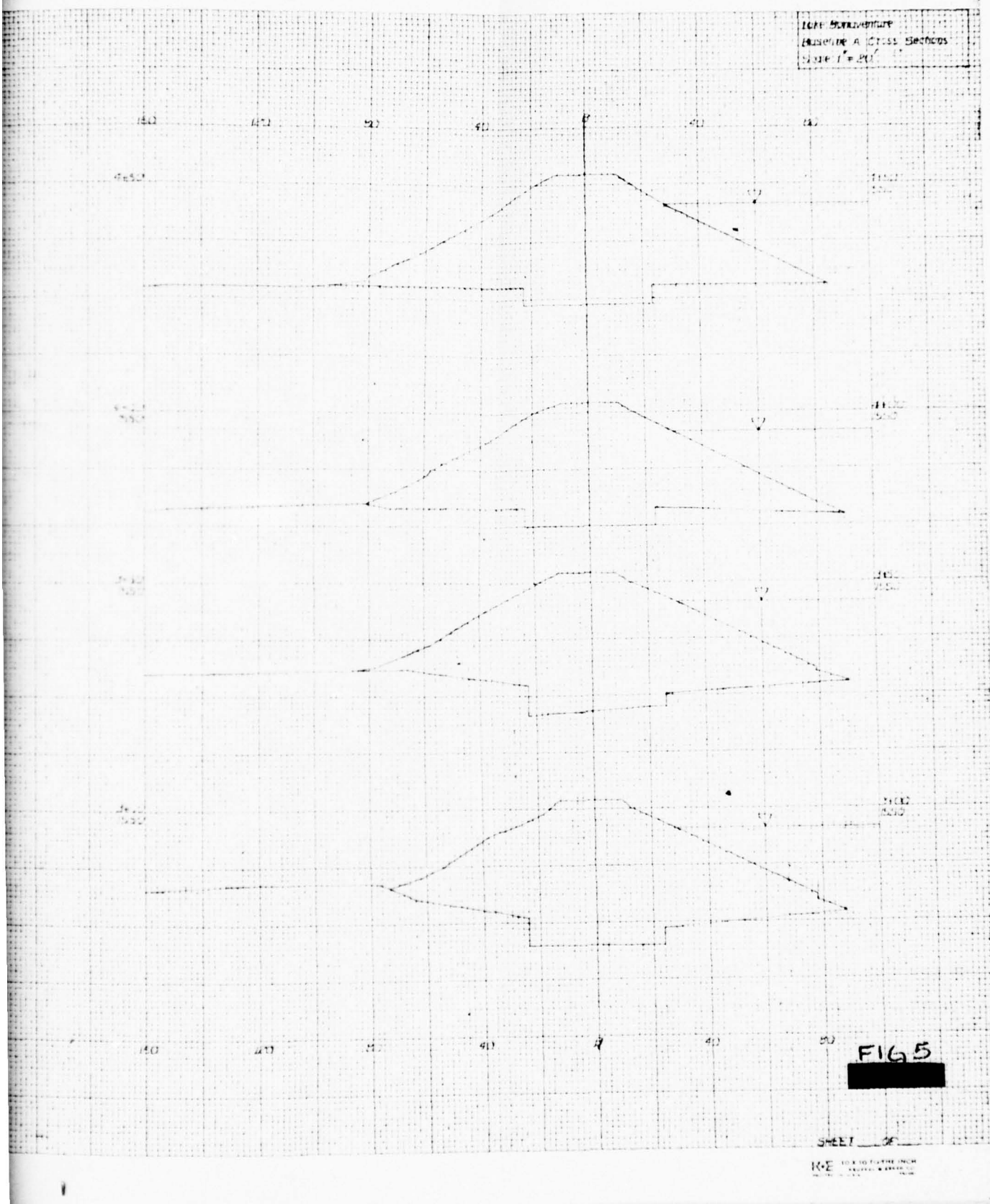
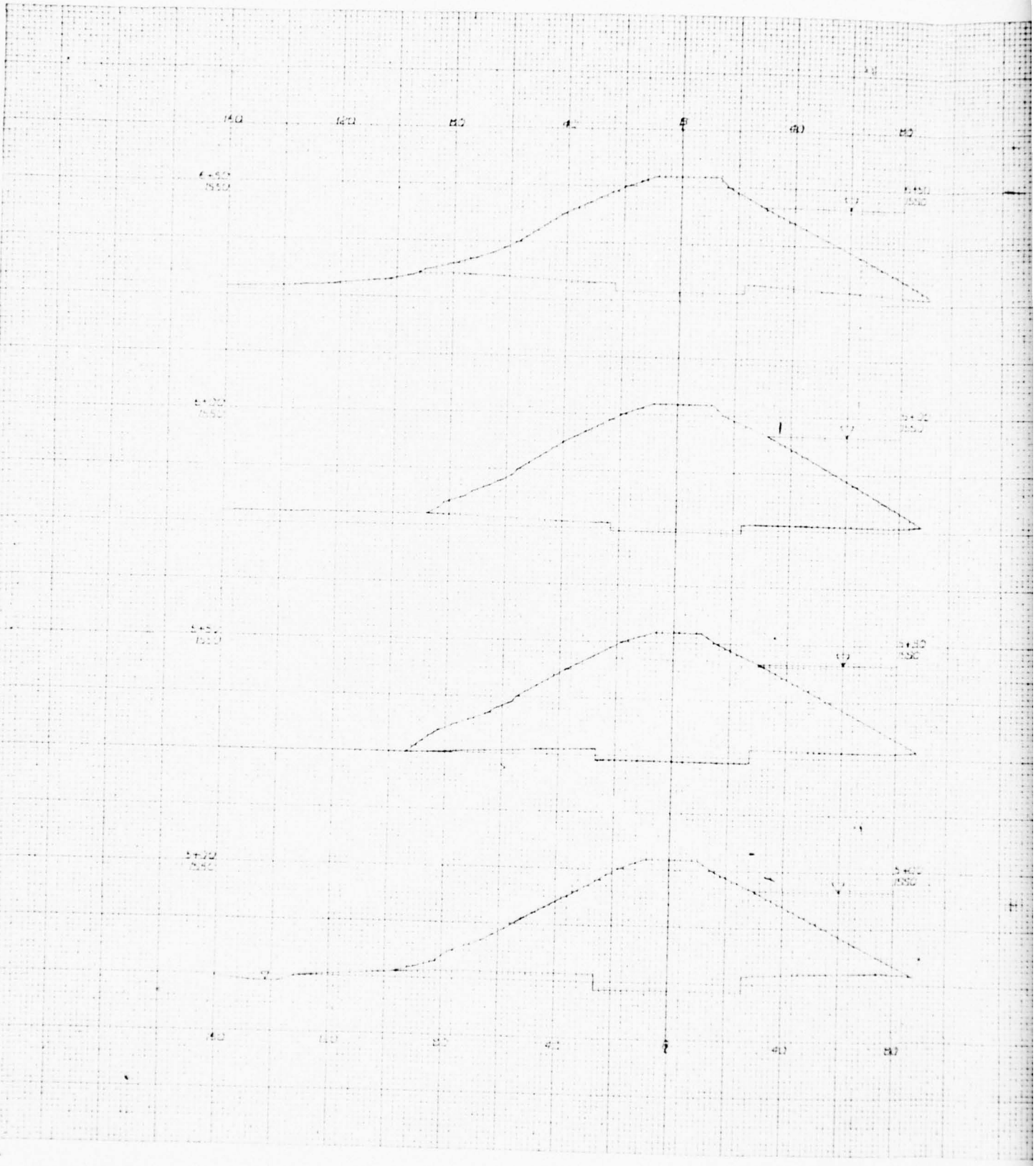


FIG 5

SHEET 2 OF

K·E

2



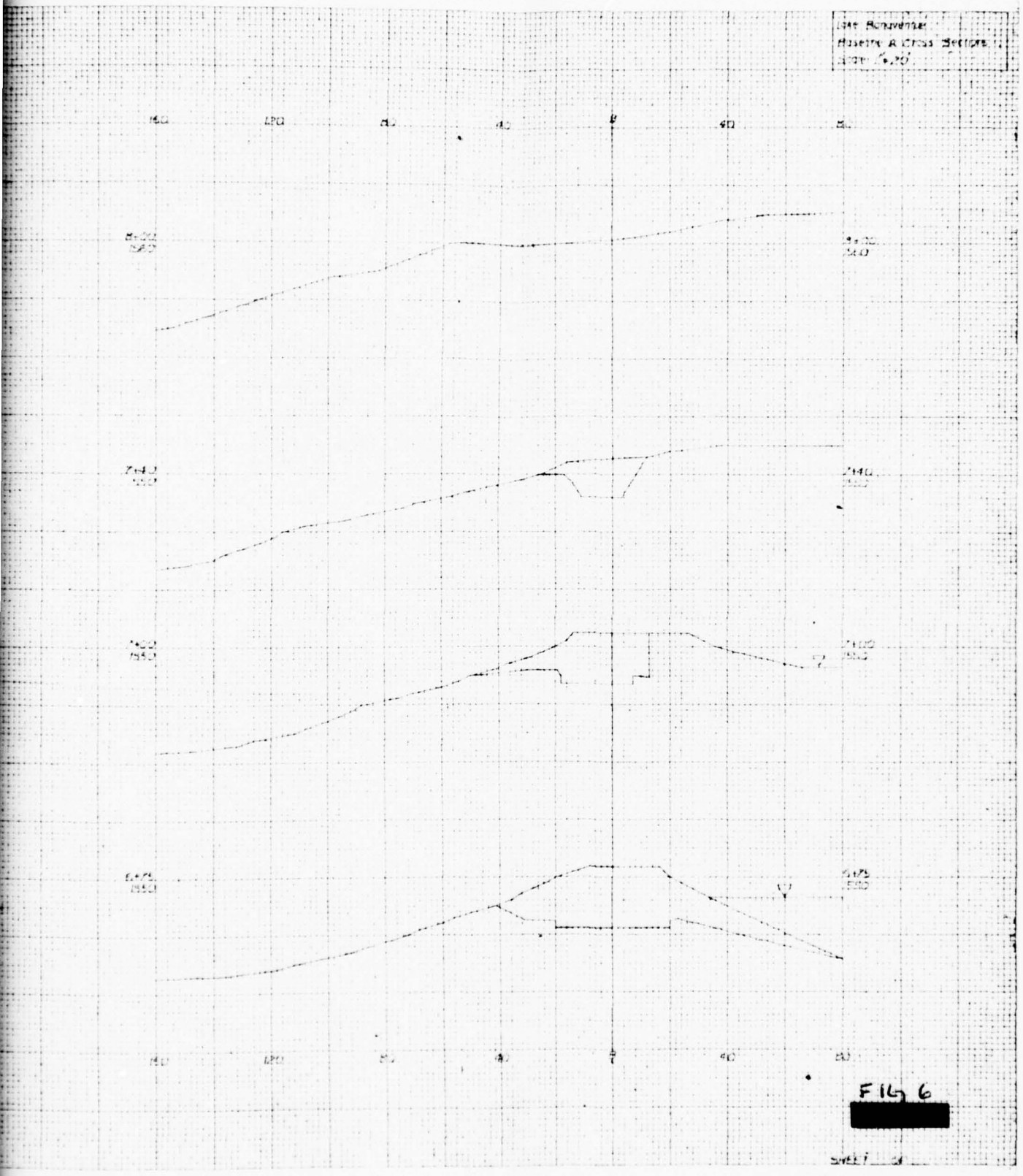


FIG 6

[redacted]

SHEET 3 OF

K&E

3

SOIL PARAMETERS			
LAYER	PHI ANGLE (DEG)	COHESION (PSF)	UNIT WT (PCF)
I	36.0	7	13.0
II	24.0	56	11.5
III	25.0	694	19.9
IV	20.0	17	28.7

LAKE BONAVENTURE
12INVA5:0010-01R
SECTION AT 15+00
STABILITY ANALYSIS
SCALE 1" = 20'

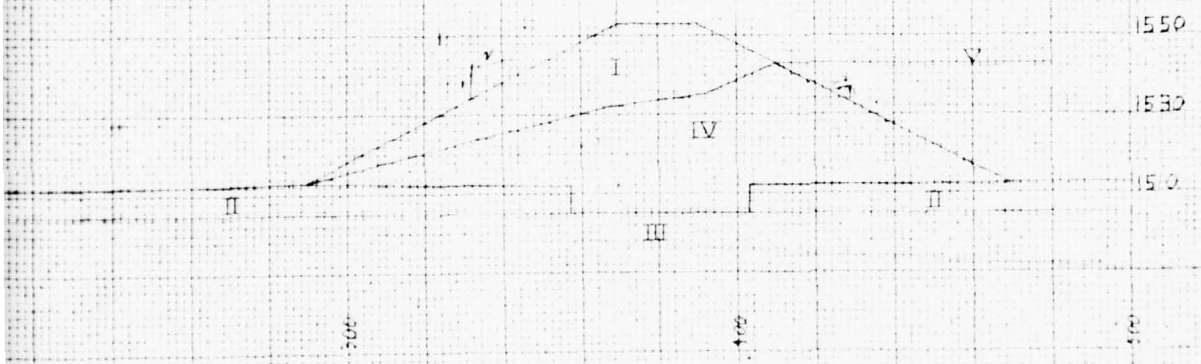


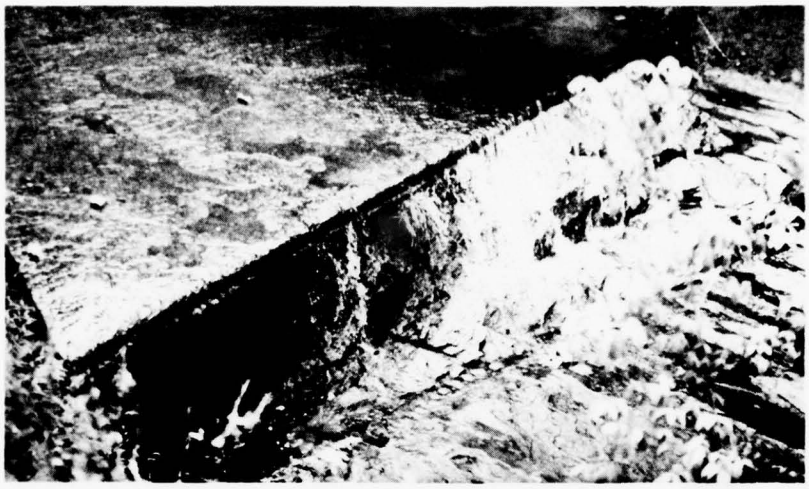
FIG 7

K+E 10 X 10 TO THE INCH

2

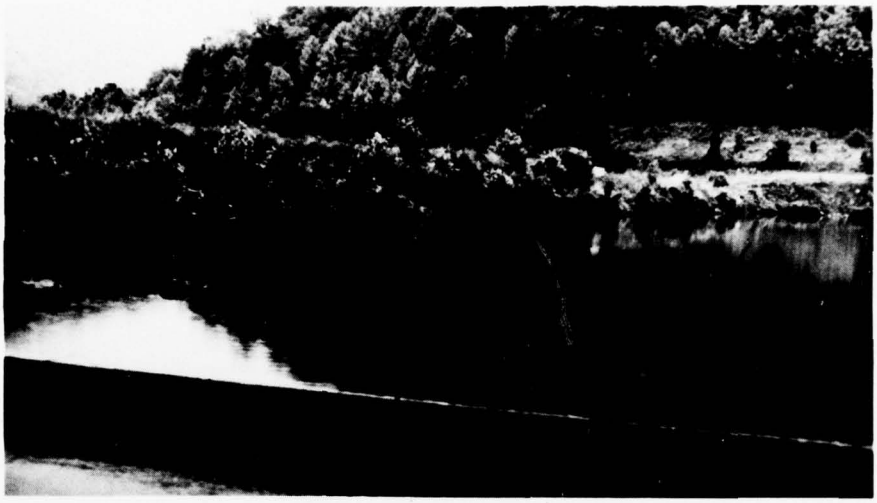
APPENDIX II

PHOTOGRAPHS



DOWNSTREAM END OF CONCRETE SPILLWAY CHUTE. SOME MINOR UNDERCUTTING HAS OCCURRED ON THE LEFT.

ONE OF THE PIEZOMETERS INSTALLED ON THE CREST OF THE DAM. BOX IN BACKGROUND HOUSES ANOTHER.



A VIEW OF THE UPSTREAM SLOPE OF THE DAM FROM WITHIN THE SPILLWAY CHANNEL.

SPILLWAY CREST AND CONCRETE SPILLWAY CHANNEL

PROCESS WATER PUMPS. ONE PUMP IS SHOWN IN BACKGROUND ANOTHER IS HOUSED WITHIN STRUCTURE.

APPENDIX III

FIELD OBSERVATIONS

Check List
Visual Inspection
Phase I

Name Dam: Bonaventure Dam
Also known as:
Chaney Creek Dam

County: Russell State: Virginia Coordinators: Norfolk District
Corps of Engineers

Date(s) Inspection: June 7, 1978 Weather: Showers Temperature: 70°F

III-1

Gilbert Associates, Inc.
Inspection Personnel:

Thomas E. Roberts
Thomas W. Schreffler
William J. Santamour

Also Present:

Buck Arnold - Virginia State Water Control Board
R. Michael Holbrook - Clinchfield Coal Company

Recorder:

Thomas W. Schreffler - Gilbert Associates, Inc.

EMBANKMENT

Sheet 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	Unpaved gravel-dirt road along crest of dam -- no cracks evidenced on surface.	Upstream slope riprapped. Some vegetation -- bushes, stumps up to 6 inches in diameter. Downstream slope vegetated with grasses, vines, and bushes--stumps up to 6 inches in diameter.
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	Non observed -- area heavily vegetated, swampy.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	None observed.	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	No observed settlement.	
RIPRAP FAILURES	Some erosion of embankment at waterline.	
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	No observed seepage or erosion at any of the junctions	
ANY NOTICEABLE SEEPAGE	Marshy vegetated area, on right downstream toe area. Unable to determine if seepage was from embankment.	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
STAFF GAGE AND RECORDER	None.	
DRAINS	None.	

OUTLET WORKS

Sheet 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	No outlet conduit.	Concrete pipe type diversion structure at base of dam was plugged with concrete at end of construction. Water in channel at the downstream end of culvert. Unclear if any seepage is occurring around culvert but does not appear to be the case.
INTAKE STRUCTURE	None.	
OUTLET STRUCTURE	None.	
OUTLET CHANNEL	None.	
EMERGENCY GATE	None.	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Concrete weir 1 foot high above floor of spillway. Appears to be in good condition.	Original concrete estimate drawings show 40-foot width of weir. Actually measured at 50.5 feet. Weir is not perpendicular to channel.
APPROACH CHANNEL	Depth of water immediately adjacent to weir on lake side was 3-1/2 feet.	Lake is approach area. No well defined approach channel.
DISCHARGE CHANNEL	Concrete channel-approximately 200 feet in length, concrete retaining wall on right side of channel extends entire length. Concrete retaining wall on left side ends after 85 feet. Left side then is shale bedrock. Slope of floor approximately 2:3 feet per 100-foot length. Width of channel-39 feet. Concrete is in good condition. End of channel undercut up to 1-1/2 feet-not seriously eroded. Channel becomes shale bedrock. Rock strikes N to E with dips south at 230°. Infrequent jointing at N 15° W.	
BRIDGE AND PIERS	A small metal footbridge crosses the spillway channel at elevation of top of dam.	Bridge would not obstruct flow in the channel.

INSTRUMENTATION

Sheet 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None.	
OBSERVATION WELLS	None.	
WEIRS	None.	
PIEZOMETERS	Three piezometers are located at the crest of the dam near the center. One is located at the upstream crest and the other two are at the downstream crest. All the piezometers are PVC pipe, slotted along the bottom 10 feet. Piezometers 1 and 2 are set to a depth of 45 feet and piezometer 3 is to a depth of 30 feet.	Piezometer readings included as Appendix V.
OTHER		

RESERVOIR

Sheet 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Borrow material for dike was obtained from left reservoir bank.	Reservoir perimeter was not traversed.
SEDIMENTATION	None observed but topographic mapping shows characteristic meandering stream and marshy area at upstream end of reservoir.	

DOWNSTREAM CHANNEL

Sheet 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Channel condition is good.	The downstream end of the spillway-channel becomes a bedrock channel (shale) dropping approximately 20 feet in 200-foot distance to a pool. The creek was not traversed below pool.
SLOPES	Shale Bedrock is exposed on the north side of the spillway channel where no retaining wall exists.	Thinly bedded shale bedrock strikes approximately N 70° E with a 23° dip to the south. Some shale beds daylight in the cut channel. Surface slope of adjacent hill is approx. 3 horizontal to 1 vertical. Slopes appear stable.
APPROXIMATE NO. OF HOMES AND POPULATION	USGS mapping (1969) shows no more than 30 buildings along Dumps Creek about 1.3 miles below reservoir. A large power plant is along river in same area.	

APPENDIX IV

INSPECTION AND FOUNDATION REPORTS

D1200 - W700

UNITED STATES DEPARTMENT OF THE INTERIOR
MINING ENFORCEMENT AND SAFETY ADMINISTRATION

TECHNICAL SUPPORT

MINE WASTE PLAN REVIEW AND SITE VISIT
LAKE BONAVENTURE
I.D. NO. 1211-VA5-00010-01K
CLEVELAND, RUSSELL COUNTY, VIRGINIA
CLINCHFIELD COAL COMPANY

December 9, 1976

by

Stephen W. Dmytriw
Civil Engineer

Issuing Office
Division of Safety Technology
Donald Hutchinson, Chief

DENVER TECHNICAL SUPPORT CENTER

A. Z. Dimitroff, Chief

P.O. Box 25367, Denver Federal Center
Denver, Colorado 80225

Location and Description

The facility consists of a clean water lake, a cross-valley embankment constructed primarily of clay, and a concrete spillway at the left abutment. The dam was constructed in 1955 and 1956 under the direction of the company. It is approximately 46 feet high and 600 feet long. The impoundment is about 4800 feet long and contains 1036 acre-feet ("National Program of Inspections of Dams," Corps of Engineers, May 1975.) The reservoir is used for public recreation and as a water supply for the Clinchfield Coal Company preparation plant.

The structure dams Chaney Creek near its confluence with Dumps Creek, which flows into the Clinch River. The community of Cleveland is 2.5 miles east. An electricity generation facility, the Clinch River Steam Plant and Switch Yard, is located 7000 feet downstream of the dam. The hamlet of Carterton is an additional 3.2 miles downstream of the Steam Plant. The site is more specifically located by coordinates on the USGS Carbo quadrangle; 36°56'50"N, and 82°11'47"W.

Data Reviewed

The information submitted was prepared and assembled by the company. It contains: (1) information received by GAI Consultants, or statements relative thereto; (2) preliminary hydrologic and hydraulic calculations; (3) a proposal for further investigation and evaluation; (4) a historic dissertation; (5) original design comments and documentations dated September 1955 through June 1956; and (6) as-built embankment cross-sections, dam plan-view, and spillway detail.

Site Visit

The facility was visited with the following personnel:

Dave Allen, Civil Engineer, Clinchfield Coal Company
Mike Holbrook, Civil Engineer, Clinchfield Coal Company
Phillip K. Muron, Jr., Civil Engineer, MESA, District #5
Frank C. Young, Jr., Mining Engineer, MESA, District #5
Edward J. Beck, Civil Engineer, MESA-DTSC
Stephen W. Dmytriw, Civil Engineer, MESA-DTSC

The description presented in the submittal is essentially as observed in the field. The only deviations noted are as follows:

1. The downstream slope is covered with dense brush and small-to medium-size deciduous and evergreen trees. The company has initiated a tree-cutting program but is not grubbing.

2. A six-inch-deep, four-foot-diameter depression was noted in the middle of the crest approximately 200 feet south of the spillway.

3. Some slight wave cutting is occurring on the upstream face above the normal pool elevation.

4. Ponded water was observed at the toe near the right third point. Seepage was suspected in the vicinity of the right abutment contact and from around the 42-inch concrete pipe. This could not be precisely determined, however, due to the amount of vegetation and lack of ditch fall below the conduit.

Review Comments

Judging from the original investigation, testing, design, drawings, and specifications in the submittal, it appears as though the company has attempted to conform to standard, prudent, engineering practice. However, there are still several significant deficiencies which must be addressed and modified so that the facility conforms to CFR 77.216.

Hydrology: Due to the size of the watershed, it is suggested that the company investigate pertinent inflow parameters very thoroughly. As an additional reference, the engineer may wish to examine MESA's Engineering and Design Manual for Coal Refuse Disposal Facilities. Currently, the spillway is incapable of passing a 6-hour, 1/2 PMP storm. If a PMP size storm occurred over the drainage area, the resulting flood crest would overtop the embankment by several feet for at least an hour and certainly cause a breach. The Corps of Engineers report states that the hazard potential for this site is significant, and the writer concurs.

According to the submittal, a future report will address the hydrologic question with greater accuracy as soon as the area is sufficiently mapped. The company, in preparing the subsequent report, should consider the alternatives available: (1) contain the flow with a larger structure, (2) pass the flow with a larger more efficient spillway, (3) eliminate the impoundment.

Hydraulics: Any weir coefficient utilized must be documented. The coefficient C, as submitted, appears large for the structure observed. References available in selecting hydraulic parameters include texts by the Soil Conservation Service and King and Braters, Handbook of Hydraulics. The engineer should also investigate the need for additional riprap on the upstream face.

Geotechnique: The program outlined by the company to determine the structure's mass stability is acceptable with the following exceptions:

1. The original boring logs and locations should be submitted.

2. Four borings will probably not define the internal geometry, composition, and properties adequately. Borings will be required in the various embankment zones and in the toe area. Furthermore, the engineer should determine the cause of the soft spot mentioned in item 2 under Site Visit.

3. The testing program appears adequate. However, if significant deviation in test results occurs (particularly strength parameters), additional testing may be required. An experienced geo-technical engineer should be on-site during the subsurface exploration.

4. The embankment area should be thoroughly investigated for areas of seepage once vegetation is removed to permit examination. Furthermore, periodic inspections should be conducted thereafter. Should seepage be observed, remedial measures should be implemented to prevent piping and (if required) to control the phreatic surface in any buttressing material.

Schedule: According to the submittal, a complete analysis and proposed modification will be available by May 1, 1977. The future report should include a statement of responsibilities and supervision responsibilities to facilitate the review and aid MESA inspection.

Conclusions and Recommendations

The plan is unacceptable as submitted for the reasons identified in the preceding two sections. Because of the significant hazard potential of this facility, the company should consider the items herein and address those which are applicable.

Stephen W. Dmytryiw

Approved by:

R. L. Ferriter, Acting Chief date: Dec 10, 76

Law Engineering
Testing Company

REPORT OF SUBSURFACE INVESTIGATION

AND

LABORATORY TESTING

MESA CERTIFICATION OF LAKE BONAVENTURE

DANTE, VIRGINIA

JOB NUMBER K-7626

Knoxville, Tennessee

Law Engineering Testing Company
Geotechnical and Materials Engineers
333 Troy Circle / Suite W, Knoxville, Tenn. 37919 / (615) 588-8544

March 11, 1977

Clinchfield Coal Company
Dante, Virginia 24237

Attention: Mr. David Allen

Subject: Report of Subsurface Investigation and Laboratory Testing
MESA Certification of Lake Bonaventure near Dante, Virginia
Job Number K-7626

Gentlemen:

Law Engineering Testing Company has completed the authorized subsurface investigation and laboratory evaluation for the stability analysis of the Lake Bonaventure Dam and Embankment. This work was authorized by your Purchase Order 027639. The purpose of the investigation and testing was to determine subsurface conditions within the dam embankment and subgrade and to determine soil parameters for stability analyses of the dam. We understand that a certification of the embankment is required by the Mine Enforcement Safety Act, and that Clinchfield Coal Company's engineering department will perform the analyses.

INVESTIGATIVE PROCEDURES

Field Investigation: The nature and consistency of the soils at this site were determined by soil test borings drilled at ten locations. Standard penetration tests were performed at regular intervals within the borings. The drilling and sampling procedures used conform to ASTM Designation D 1586-67 (1974). The borings were drilled at the approximate locations shown on the accompanying Test Boring Plan. At one location, an offset boring was drilled nearby the initial boring primarily to obtain undisturbed samples.

Shallow hand auger borings were extended to depths of approximately four feet in two locations along the face of the dam. These borings were drilled to determine the character and consistency of soil on the dam face. This area of the dam was inaccessible to the truck-mounted drilling equipment.

Three piezometers were set to determine water levels within the dam embankment. One piezometer was installed near the upstream crest and two piezometers were installed at varying monitoring levels near the downstream crest of the dam. The purpose of installing the group of piezometers at different levels was to determine if water pressures in lower portions of the dam embankment near foundation level were different from water pressures in upper portions of the dam embankment. The piezometers are constructed of 2-inch PVC pipe. The lower 10-feet section of the piezometer is slotted and the upper portion is solid. A sand filter was installed surrounding the lower slotted section of the pipe with a seal of clay installed above the sand. Above the clay seal, cement grout was placed.

A number of undisturbed samples were obtained for possible laboratory testing. Undisturbed samples were obtained by forcing sections of 3-inch diameter thin walled sampling tube into the soil as outlined by ASTM Designation D 1587-67

Test Boring Logs are included in the Appendix and graphically show soil descriptions, ground surface elevations, penetration resistances, and undisturbed sample locations. The methods of boring, undisturbed sampling and piezometer installation are discussed in more detail in the Appendix.

The borings were located in the field by Clinchfield Coal Company surveyors. Ground surface elevations as shown on the boring records have been rounded to the nearest foot from elevations provided by the surveyors.

After completion of the drilling operations the borings were filled with cement grout.

Laboratory Investigation: Soil strength was determined for selected soil samples by laboratory triaxial testing. The triaxial tests were performed by the consolidated undrained method and pore pressures were measured. Shear strengths for both total and effective stress conditions were determined. Total stress parameters were determined for Mohr Diagrams. Effective stress parameters have been determined by use of "P" vs "Q" plots.

The compaction characteristics of embankment soils have been determined by three laboratory standard Proctor compaction tests, ASTM D 698-70. The results of these tests are shown in the

Appendix. The in-place density of the soil has been determined for several samples by the procedures outlined in ASTM Designation D 2937-71.

Several classification tests have also been performed and outlined in ASTM Designation D 2487-69. These tests determined the grain size distribution of the soils tested and also their liquid and plastic limits.

Soil permeability was determined for one soil sample by a falling head permeability test.

SITE CONDITIONS

We understand that the Lake Bonaventure Dam was built during the latter part of 1955 and early 1956. The drainage area for the lake is approximately 6.73 square miles, and the lake's surface area is approximately fifty acres. The water level of the lake is near elevation 1543. At the present time, water is pumped from the lake and used at the Moss No. 3 Preparation Plant. A forty-foot wide emergency spillway is located at the north abutment.

The dam is approximately 600 feet long with the crest at elevation 1553. The maximum dam height is approximately 45 feet. Both the upstream and downstream slopes of the dam are approximately 2(H):1(V). The crest width of the dam is approximately 18 feet wide. A 48-inch diameter concrete pipe passes through the dam, but has been plugged with concrete since construction.

We initially visited the site on June 15, 1976 and visually inspected the dam. This inspection indicated that the dam was in very good condition. Movements of the dam embankment or seepage at the downstream toe were not noted. Considerable vegetation and small trees had grown on the dam. The dam was again inspected on November 17, 1976. At this time, all the trees and vegetation had been cleared from the dam. During this inspection bulging or slope movement on the downstream face of the dam, even minor surface slippage, was not noted. Seepage at the downstream toe of the dam was not noted and the downstream toe area of the dam was generally dry.

SUBSURFACE CONDITIONS

Four major subsurface material types were encountered by the exploration. These are: (1) fill; (2) residual or colluvial soils; (3) alluvium and (4) partially weathered shale.

Fill: Fill was encountered in borings B-2 through B-6, in borings B-8, B-9 and B-10, and in the two hand auger borings A-1 and A-2. In borings B-2 through B-6 drilled from the crest of the dam, the fill ranged in thickness from 38 to 50 feet. Borings B-8 through B-10 were drilled near the downstream toe of the dam. The fill varied in thickness from 3½ to 6½ feet. Fill extended from the ground surface to termination depths of 4 feet in borings A-1 and A-2. The composition of the fill was generally very stiff to hard brown sandy clayey silt with numerous shale fragments. While the consistency of the fill was generally very stiff to hard, several zones within the dam were of only soft to firm consistency. Softer zones were encountered in boring B-2 between 13 and 16½ feet and between 24 and 27½ feet, in boring B-6 between 13 and 18 feet, in boring B-8 from the ground surface to a depth of 3½ feet and in boring B-10 from the ground surface to a depth of 6½ feet. Based on the results of the standard penetration test along with the results of the laboratory standard Proctor compaction test and laboratory unit weight test, it is our opinion that the mass of the fill is generally well compacted with some smaller isolated zones within the dam embankment which are not compacted as well. The borings at or near the toe of the dam encountered fill which was also compacted to a lesser degree than the dam embankment in general. The fill soils at this location were probably either outside the area of compaction control or were placed on a wetter subgrade.

Residual Soils or Colluvium: Borings B-1 and B-7 encountered soils which have been identified as being either residual soils or colluvium to depths of 37 and 19 feet, respectively. Residual soils are those soils which have been formed in-place by the weathering process of rock. Colluvial soils are soils which have been formed and transported short distances primarily by gravity or flowing water. The soils encountered in boring B-1 and B-7 are either residual soils or soils which have been transported short distances by landslides or other downslope movements.

Alluvium: Soils which are identified as alluvial were encountered in boring B-8 between the depths of 3½ and 8 feet. Alluvial soils are soils which have been transported to their present location by the action of flowing water. The alluvium consists of soft dark gray sandy silty clay extending from below the fill to a depth of 7 feet in boring B-8. Firm gray fine to coarse sand with gravel which was identified as alluvium was encountered below the clayey zone between the depths of 7 and 8 feet.

Partially Weathered Shale: All borings except B-10A and the hand auger borings were extended into the underlying partially weathered shale for depths ranging from approximately 1 to approximately 5 feet. This material has been described as very hard gray clayey silt and has penetration resistances in excess of 100 blows per foot. The material retains the structure and hardness of shale.

All borings except boring B-7, B-10A and the hand auger borings were extended to refusal on the underlying shale. Refusal is defined as material which cannot be further penetrated with the mechanical drilling equipment. Boring B-7 was terminated at a depth of 20 feet within the underlying partially weathered shale. Boring B-10A which was drilled primarily to secure undisturbed samples for laboratory testing was terminated at a depth of 5½ feet in fill.

Groundwater levels were measured both at the time of drilling and 24 hours thereafter. Water levels varied considerably and it is thought that sufficient time was not allowed for water levels to reach stable levels in the relatively impermeable soils at this site. Within the dam embankment, permanent piezometers have been established for long term measurements of groundwater levels. We understand that the piezometer readings are near elevation 1543. Groundwater in two of the borings drilled at the toe of the dam, boring B-8 and B-9, indicate groundwater level near the presently existing ground surface.

OBSERVATIONS

It is our opinion that the fill within the embankment of Lake Bonaventure Dam is generally well compacted. Some minor zones of softer fill were encountered near the center line within the dam embankment and also at the downstream toe of the dam. It is thought that these softer zones are of relatively small areal extent.

The embankment appears to be relatively homogenous. The borings do not indicate the existence of a well defined clay core in this dam. But rather, the dam appears to be compacted of relatively impermeable sandy clayey silts with considerable coarse sand and gravel sized shale fragments. The results of the permeability tests indicate that the dam embankment has a permeability of approximately 2×10^{-7} centimeters per second. Based on visual examination of the permeability sample, it is our opinion

that vertical and horizontal permeabilities do not vary greatly. Any variation in vertical and horizontal permeability is thought to be less than one order of magnitude and would be very difficult to measure. Therefore, we recommend that in design permeability be considered uniform in all directions.

The soil strength parameters for use in design are shown on the accompanying Triaxial Shear Test sheets. The results of these tests indicate that the fill at this site is relatively strong. Strength, as expected, is greater for the denser samples

We appreciate the opportunity of assisting you on this project. If you have any questions regarding this report or if we may be of further assistance to you, please contact our Knoxville office: (615) 588-8544.

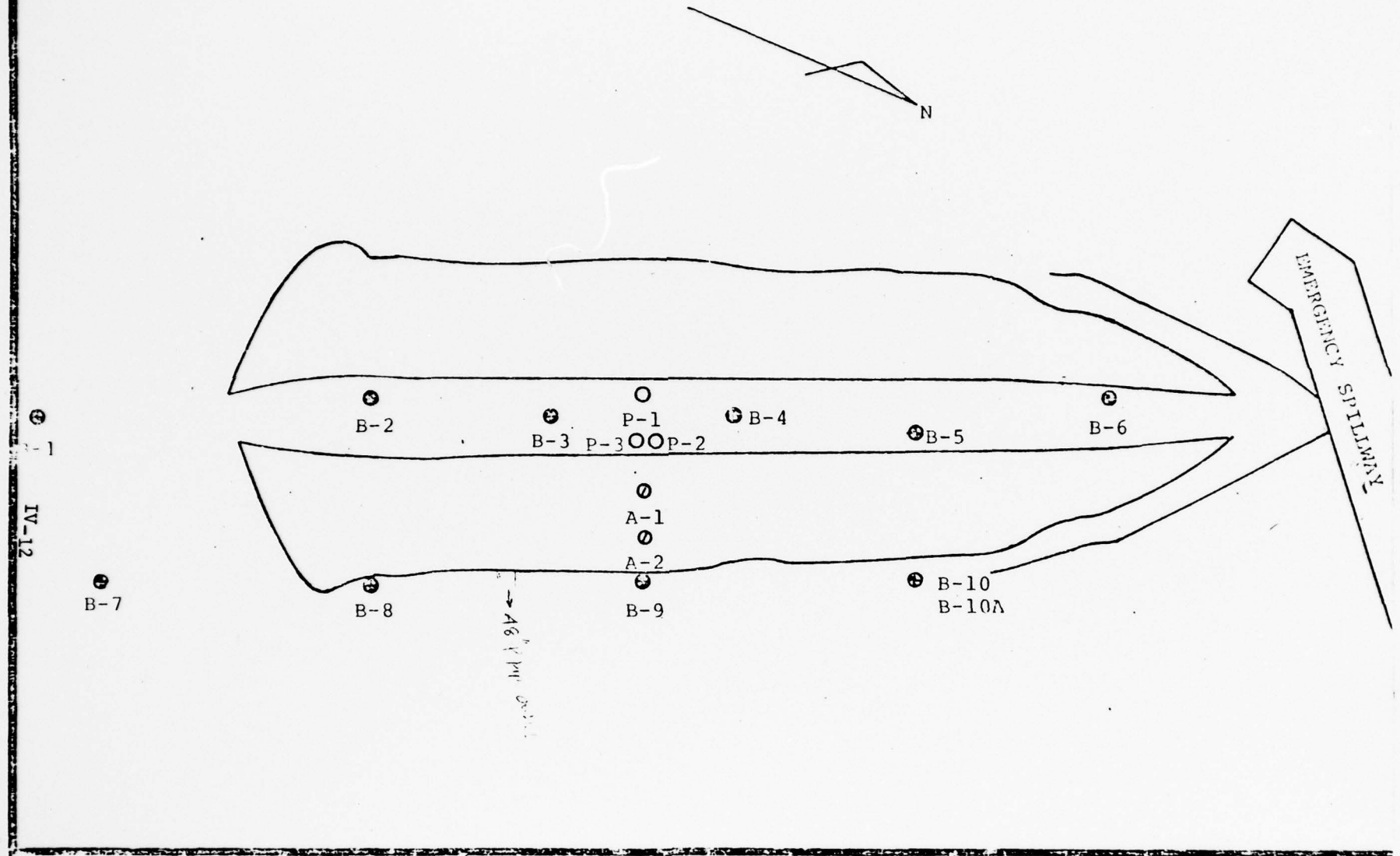
Very truly yours,

LAW ENGINEERING TESTING COMPANY

William Allen Lancaster
Civil Engineer
Registered, Tennessee 10775

WAL:la

Enclosures



LEGEND

- Soil Test Boring
- Piezometer Boring
- Hand Auger

SCALE 1" = 75' approximate

LAW ENGINEERING TESTING COMPANY

Knoxville, Tennessee

PROJECT

BORING LOCATION PLAN
LAKE BONAVENTURE DAM
JOB NUMBER K-7626

May 31, 1956

INSPECTION OF PROPOSED DAM - CHANEY CREEK NEAR CARBO, VIRGINIA, AND DOWNSTREAM AFFECTS (ASF-923/56)

In accordance with subject assignment, a field investigation was made on May 25 by the writer and Mr. Daly. Mr. Thomas G. Spear was away on business on this date, however he was contacted by Mr. Daly on May 28. Mr. Daly also contacted Mr. Cox of the Virginia Highway Department at Bristol in regard to the proposed new highway and bridge across Chaney Creek.

Location - The proposed dam is located in Russell County, near Carbo, Virginia, on Chaney Creek which is a tributary of Dumps Creek. The proposed dam is about 1.2 miles upstream from the Clinch River. Dumps Creek empties into the Clinch River opposite the site of the proposed Carbo steam plant.

Proposed Dam - The dam is located as shown on the attached map, Plate 1, near mouth of Chaney Creek. The dam will be an earth fill structure with 2.5 to 1 side slopes, with maximum height of about 34 feet and average height of about 24 feet, with a crown width of 22 feet. An inspection trench at center of fill under the core wall has been excavated to a width of about 44 feet and down to blue slate at average depth of about 8 feet. The upstream face of the dam is to be riprapped with about 2 feet of stone. The overall length of dam will be 555 feet (not including spillways).

The attached Plates 2 and 3 show a typical cross section and a plan of the base of the proposed dam.

A summary of pertinent elevations is given below.

Elevation Top of Fill	- 1541
Elevation Normal Water Level	- 1533

May 31, 1956

INSPECTION OF PROPOSED DAM - CHANEY CREEK NEAR CARBO, VIRGINIA, AND DOWNSTREAM AFFECTS (ASF-923/56)

Elevation Spillways*	- 1533
Elevation Base (Average)	- 1517
Elevation Creek Bed (At Axis)	- 1507

* The left endspillway will be at elevation of 1533, with a bottom width of 40 feet and to be lined with concrete. The right bank spillway, with a bottom width of 40 feet, will be cut through rock and will be unlined.

In addition to the 2 spillways a 48-inch concrete pipe is to be installed at base of fill.

The proposed lake will have a surface area of about 73 acres.

The drainage area above the dam is about 7.4 square miles and ranges in elevation from 1500 up to about 2300.

Downstream Features - Located downstream from the proposed dam site are a highway and railway bridge and one house which is near the railway bridge, and a private landing strip along Dumps Creek.

The existing highway bridge is a wooden structure with a width of 12 feet and length of 17 feet and pertinent elevations of:

Bridge Floor	- 1507.5
Bridge Clearance	- 1506.5
Creek Bed	- 1498.5

Mr. Cox of the Virginia Highway Department stated that they hope to re-locate the road on the west side of the railway tracks and

May 31, 1956

INSPECTION OF PROPOSED DAM - CHANEY CREEK NEAR CARBO, VIRGINIA, AND DOWNSTREAM AFFECTS (ASF-923/56)

that the new bridge would be built over Chaney Creek above the railway bridge near present bridge and probably not as high as the railway bridge but higher than the existing road bridge. He also stated that grades and bridge section have not yet been determined and no figures will be available for a month or more.

A new railway steel bridge has recently been completed. The bridge has a clear span of 90 feet (not including two 5 feet concrete piers) and pertinent elevations of:

Top of Rail	- 1517.3
Clearance	- 1514.0
Creek Bed	- 1498.0

The only house now standing in the flood plain below the proposed dam is located just downstream from the new railway bridge and is owned by the Clinchfield Coal Corporation and is to be torn down at an early date. All other houses is the low areas below the proposed dam, as shown on the topo map, have already been torn down.

The private landing strip, as shown on Plate 1, is now under construction and is owned by the Clinchfield Coal Corporation. The elevation of this strip ranges from 1520 at the SW end to 1524 at the NE end.

General - The purpose of the proposed dam is to create a lake for an auxiliary water supply for the company's coal washing plant located upstream on Dumps Creek.

William P. Clark

APPENDIX V

PIEZOMETER READINGS

LAKE BONAVENTURE SUBSURFACE EXPLORATION

BORING	ELEVATION
B-1	1560.38
B-2	1552.41
B-3	1552.67
B-4	1553.01
B-5	1553.05
B-6	1552.97
B-7	1535.49
B-8	1513.46
B-9	1513.50
B-10	1523.62

PIEZOMETER	TOP ELEVATION	BASE ELEVATION
P-1	1553.88	1508.0
P-2	1553.99	1508.0
P-3	1553.23	1523.0

LAKE BONAVENTURE PIEZOMETER READINGS

Date	P-1	P-2	P-3
1-19-77	18.6	20.9	19.6
1-26-77	18.4	20.9	19.5
2-2-77	18.7	21.1	20.1
2-9-77	18.8	21.3	20.2
2-16-77	18.7	21.3	20.0
2-23-77	18.7	21.3	20.1
3-2-77	18.8	21.5	20.5
3-9-77	18.8	21.6	20.5
3-16-77	18.5	21.5	20.3
3-23-77	18.6	21.5	20.3
3-30-77	18.6	21.6	20.4
4-6-77	18.5	18.5	20.3
4-13-77	18.8	21.2	20.5
4-20-77	18.7	20.4	20.3
4-27-77	18.5	21.2	20.0
5-4-77	18.8	21.4	20.0
5-11-77	18.8	21.2	19.9
5-18-77	18.8	21.2	19.8
5-25-77	18.9	21.1	19.4
6-1-77	18.8	20.8	19.2
6-8-77	18.7	20.7	19.0
6-15-77	18.9	20.7	19.2
6-22-77	19.0	20.5	20.0
7-13-77	19.0	20.2	18.8
7-20-77	19.0	20.2	18.7
7-27-77	19.0	20.0	18.5

Date	P-1	P-2	P-3
8-3-77	19.0	20.0	18.4
8-10-77	19.2	19.8	18.2
8-17-77	19.2	19.7	18.0
8-24-77	19.3	19.6	18.0
8-31-77	19.4	19.6	18.0
9-7-77	19.3	19.7	18.0
9-14-77	19.5	19.5	18.0
9-21-77	19.4	19.4	17.8
9-28-77	19.4	19.4	17.8
10-5-77	19.5	19.5	18.0
10-12-77	19.4	19.4	17.8
10-19-77	19.3	19.3	17.8
10-27-77	19.3	19.4	17.8
11-2-77	19.0	19.6	18.0
11-9-77	18.7	19.5	17.8
11-18-77	18.9	19.6	18.0
11-22-77	18.9	19.8	18.2
11-29-77	18.6	18.2	17.9
12-9-77	18.7	18.5	18.0
12-14-77	18.6	19.3	18.0
12-21-77	18.3	19.0	18.0
1-5-78	18.7	19.7	18.8
2-14-78	18.5	20.0	19.2
4-5-78	18.9	20.9	20.0
4-12-78	19.0	20.5	20.0
4-18-78	18.8	20.5	19.8
4-26-78	18.8	20.3	21.5

Date	P-1	P-2	P-3
5-5-78	18.7	12.5	19.4
5-11-78	19.0	19.0	19.7
5-19-78	18.8	19.9	19.5

APPENDIX VI

REFERENCES

APPENDIX VI

REFERENCES

1. Recommended Guidelines for Safety Inspection of Dams, (Washington, D.C., Department of the Army, Office of the Chief of Engineers).

2. HEC-1 Flood Hydrograph Package, (Hydrologic Engineering Center, U. S. Army Corps of Engineers, January 1973).

3. Design of Small Dams, (U. S. Department of the Interior, Bureau of Reclamation, Second Edition, 1973).

4. "Seasonal Variation of the Probable Maximum Precipitation East of the 105th Meridian," Hydrometeorological Report No. 33, (U. S. Weather Bureau, April 1956).

5. "Rainfall Frequency Atlas of the United States," Technical Paper No. 40, (U. S. Weather Bureau, May 1961).

APPENDIX VII

CONDITIONS

APPENDIX VII

CONDITIONS

This Report is based on a visual inspection of the dam, a review of available engineering data and a hydrologic analysis performed during a Phase I Investigation as set forth in the U.S. Corps of Engineers' "Recommended Guidelines for Safety Inspection of Dams" and the contract between the U.S. Corps of Engineers and Gilbert Associates, Inc.

The foregoing inspection, review and analysis are by their nature limited in scope. It is possible that conditions exist which are hazardous, or which might in time develop into safety hazards, that are not detectable by this inspection, review and analysis. Accordingly, Gilbert Associates, Inc. cannot and does not warrant or represent that conditions which are hazardous, or which may in time develop into safety hazards, do not exist.