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NATIONAL DAM SAFETY PROGRAM. BIG CHERRY DAM (VA 19502) TENNESSE--ETC(U)
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NATIONAL BUREAU OF STANDARDS-1963-A

TENNESSEE RIVER BASIN

Name Of Dam: BIG CHERRY DAM

Location: WISE COUNTY, VIRGINIA

Inventory Number: VA 19502

1

B.S.

LEVEL II

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

U.S. ARMY CORPS OF ENGINEERS · NORFOLK DISTRICT ·

PREPARED FOR

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

BY

GILBERT ASSOCIATES, INC.

AUGUST, 1978

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

BIG CHERRY

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 22% 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.

7.2.1 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.

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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:	Big Cherry Dam
State:	Virginia
County:	Wise
USGS Quadrangle Sheet:	East Stone Gap, Virginia
Stream:	South Fork of Powell River

Big Cherry Dam is a 43-foot high, 225-foot long cyclopean concrete gravity dam with a 65-foot long ogee shaped, ungated spillway located at its center. It has a valved 16-inch pipe discharge to allow withdrawal during dry periods for the water supply for the town of Big Stone Gap. The dam is underlain by sandstone.

This investigation indicated there may be conditions which could become hazardous depending on circumstances. These conditions require the owner's immediate action. See Appendix VI, Conditions.

The dam has a "seriously inadequate" spillway based on the U.S. Corps of Engineers' criteria described in paragraph 5.8. The spillway is not capable of passing a flood in excess of 22% of the PMF without overtopping the dam; the spillway can, however, pass the 100-year flood, but with no freeboard to the top of the masonry dam. The owner should give consideration to enlarging the spillway in the future.

During the one-half PMF storm, the dam will be overtopped by 1.7 feet for 5 hours. This overtopping could have a detrimental effect on the soft sandstone which may exist at the abutments and will cause large forces on the dam which will reduce its structural stability, most significantly with respect to the sliding stability. Calculations based on assumed values for the strength of a weak plane indicated in the drawings (Appendix I) results in a sliding factor of safety for this dam of less than 1.

The surface concrete of the dam shows signs of deterioration and leakage on the downstream face. The deteriorated areas should be repaired during the next year and leakage quantities should be monitored monthly until repaired starting within 3 months. The dam rests on a sandstone stratum which may be conducive to seepage. Information on the original foundation grouting should be obtained by the owner within 30 days.

The recommended remedial measures are as follows:

a. Lower the pool level 12.5 feet immediately.

b. Initiate within three months a program of test borings, soil sampling and analysis to determine the characteristics of the underlying material, revise the stability analysis, and thereafter implement any appropriate remedial actions required.

c. Monitor leakage from the downstream non-overflow face monthly starting within 3 months.

d. Clean out underdrain discharge pipes which appear to be clogged.

e. Improve the method of approach to the control valves.

f. Repair scaling damage to the downstream non-overflow face.

g. The downstream side slopes should be repaired and the downstream channel cleared of fallen trees and other brush.

h. Provide within 60 days an automatic warning system to alert downstream residents of any impending hazardous condition.

i. Perform an inspection of the dam located about one mile upstream of this dam.

The above items of work should be essentially completed within one year from the date of this report except for item "c" which should continue indefinitely or until the leakage is stopped.

Until such time as the above recommendations are implemented, during periods of heavy rainfall the owner should provide round-the-clock surveillance of the dam and be able to provide adequate warning to the downstream residents.

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No 8349
CERTIFIED PROFESSIONAL ENGINEER

James A. Hagen

APPROVED:

Original signed by:

Douglas L. Haller

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Colonel, Corps of Engineers
District Engineer

28 AUG 1978

Date

Submitted By: Original signed by JAMES A. WALSH

Recomended By: Original signed by ZANE M. GOODWIN

June 1978

OVERVIEW PHOTO - BIG CHERRY DAM (LOWER)

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
NAME OF DAM: Big Cherry Dam ID# VA 19502

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 the dams in the Commonwealth of Virginia. Gilbert Associates, Inc. has entered into Contract with the Norfolk District to inspect this dam, Gilbert Work Order No. 06-7250-004.

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 IV) and contract requirements between Gilbet 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: Big Cherry Dam is a 40-year old cyclopean concrete structure approximately 225 feet long with a maximum height of 43 feet and with the top of the dam at elevation 3139.5 feet m.s.l. Approximately 65 feet of the center portion of the dam acts as an ogee spillway with a crest elevation of 3135.0 feet m.s.l.

The available design drawings by Wiley & Wilson, Consulting Engineers, indicate there is an older dam located about one mile upstream with a spillway elevation about 3 feet higher than this dam. The owner's representatives confirmed the existence of this dam and the fact that it was only partially visible due to the water level in the reservoir. This dam is considered a separate structure, the inspection of which is not within the assigned scope of this report.

The flow over the spillway is supplemented during periods of low rainfall by a 16-inch diameter cast iron pipe. This pipe discharges several feet above the downstream channel. It is controlled by a square sluice gate with a manual gate operator located on the right side of the dam. It discharges from an intake well which has three 16-inch diameter circular openings, to the reservoir, each with square gates operated from the top of the dam to allow withdrawal of water at elevations 3104.5, 3113.4, and/or 3125.7 MSL. It was reported by the owner's representatives that the 16-inch pipe was to enable a connection to the town's water supply; however, this was never done because the quality of the water was improved by allowing it to flow down the open riverbed to the treatment plant.

According to the drawings, there is also a 30-inch square concrete tunnel passing through the dam which is controlled by a sluice gate operated from the right abutment. The invert of this tunnel is at elevation 3104.5. Based on the drawings reference in Appendix I, both the inlet to this tunnel and the lowest level inlet to the intake well are protected by bar type trash screens.

According to the drawings, the dam has been anchored to the existing sandstone bedrock by a series of key trenches and benches. There also is an underdrain system which discharges on the emergency spillway via 1-1/2-inch cast iron discharge pipes. One of these pipes appeared partially clogged.

1.2.2 Location: Big Cherry Dam is located in Wise County, approximately 5 miles east of Big Stone Gap.

1.2.3 Size Classification: The dam is classified as intermediate based upon its height of 43 feet, in accordance with Section 2.1.1 of Reference 1 of Appendix IV.

1.2.4 Hazard Classification: The dam is located above a water treatment plant, where there is a potential for loss of life, and upstream of a fairly narrow valley at the community of Cracker Neck, Virginia. Based upon the requirements of Section 2.1.2 of Reference 1 of Appendix IV, the dam is classified as a high hazard potential. The hazard classification used to categorize dams is a function of location only and has nothing to do with its stability or probability of failure.

1.2.5 Ownership: The dam is owned and maintained by the town of Big Stone Gap, Virginia.

1.2.6 Purpose of Dam: The Big Cherry Dam serves primarily to supply the town of Big Stone Gap with potable water. It also serves to augment the South Fork of the Powell River during low flow periods.

1.2.7 Design and Construction History: The dam was designed by Wiley and Wilson Consulting Engineers of Lynchburg and Richmond, Virginia. The drawings were prepared by the engineers in June 1934, and were approved by the Federal Emergency Department of Public Works in August 1934. The actual dates of construction, construction history, and the name of the contractors are not known.

1.2.8 Normal Operating Procedure: The town of Big Stone Gap is supplied water from the reservoir by the uncontrolled flow of water over the ogee spillway during periods of high reservoir levels or during periods of normal or low water through the 16-inch cast iron pipe controlled by a 16-inch circular sluice gate with operator at the top of the dam. Water is released downstream of the dam into the South Fork. Approximately 1,000 feet downstream of the dam, the creek flows to the water treatment plant's intake system. The operation of the valves at the dam is on a demand basis; therefore, there are no specific operating procedures.

1.3 Pertinent Data

1.3.1 Drainage Area: 5.54 square miles.

1.3.2 Discharge at the Dam Site: The maximum historic flood at the dam site is not known.

Principal Spillway:

Pool level at top of dam . . . . 2450 c.f.s.

1.3.3 Dam and Reservoir Data: Pertinent data on the dam and reservoir are shown in Table 1.1.

Table 1.1 DAM AND RESERVOIR DATA

Item	Elevation[1] feet m.s.l.	Reservoir Area acres	Reservoir Acre-feet	Capacity Watershed inches	Length miles
Top of Dam	3139.5	191	1630	5.5	-
Ungated Spillway Crest	3135	76[2]	1084	3.7	1.1
Streambed at Centerline of Dam	3095	0	0	0	0

Notes: [1] Elevations taken from U.S.G.S. quadrangle sheets indicate a 100-foot difference in elevation from those elevations shown on the design drawings. Elevations in this report reflect the U.S.G.S. maps, in that 100.00 feet has been added to all elevations indicated on the design drawings.

[2] Includes only lower reservoir.

SECTION 2 - ENGINEERING DATA

2.1 Design: There are no design calculations or reports available. A set of design drawings, approved by the Federal Emergency Administration for Public Works, is available in the owner's files.

2.2 Construction: There is no information available on the construction of the dam.

2.3 Operation: Water is released and regulated based upon the water demands of the town of Big Stone Gap. The valves were reported by the owner to be in working order. No records are kept of the operation of these valves.

2.4 Evaluation: The previously mentioned plans provide adequate information to determine the configuration of the dam and appurtenant structures.

Although a number of borings were taken beneath the dam to a depth of 20 feet into the rock, the description of the rock strata is inadequate. The description and recovery data of the sandstone strata are not available. Also, some weak seams were encountered in the borings; however, an adequate description of the material in the seams is not available. Borings, if taken a sufficient distance upstream and downstream of the dam, may give further information on the continuity of the seams. No laboratory testing of rock or other materials encountered in the borings was apparently accomplished.

SECTION 3 - VISUAL INSPECTION

3.1 Findings

3.1.1 General: The inspection of this dam was conducted on June 13, 1978 by a team of engineers from Gilbert Associates, Inc., accompanied by a State Water Control Board representative and the owner's representatives.

The dam site is approachable by four-wheel drive vehicles. The road leads to the left abutment. There is no vehicular access to the right abutment or to the base of the dam. The right abutment is reached by walking along the crest of the dam and then the spillway by holding a steel wire stretched across the spillway. The sluice gate operating wheels are at the right of the spillway. The dam is built across a U-shaped narrow valley, with rather steep valley walls composed of bedded sandstone underlying a very thin soil cover.

3.1.2 Dam: No major sign of distress such as tilting or significant cracking is visible on the dam. However, the concrete lining on the downstream face of the dam was observed to be deteriorated and eroded at several locations. The left downstream side abutment-dam junction was covered with brush and fallen trees and was soggy. The junction at the right did not show any sign of distress except normal weathering effects. However, 2-to 3-foot thick lenses of conglomeratic sandstone were observed exposed within the sandstone strata a few feet downstream of the right abutment on the downstream channel slope. This stone was highly decomposed,friable and disintegrated readily when thrown in water. (This was probably the stone described as soft sand and gravel in boring no. 11 between elevation 3107 feet and 3109 feet, as given in Figure 5 of Appendix I.) Large pieces of sandstone of a harder variety occupied the toe area of the spillway showing good resistance to erosion and providing good protection to the toe.

The 65-foot long overflow ogee spillway was functioning normally at the time of our inspection. There were signs of cracking, or spalling of concrete mortar on the spillway chute. At the time of inspection, water was flowing over the spillway, at a depth of approximately 1 inch.

All the valves were reported by the owner to be in good operating condition. The 16-inch diameter pipe discharge is used frequently.

The non-overflow face showed signs of severe deterioration, indicating that the face may not have as thick a covering of concrete as the overflow weir face (the drawings indicate that the overflow weir is to have a 3-inch covering of concrete over the reinforcement bars). The non-overflow face appears to have been capped with a relatively thin layer of mortar cement.

3.1.3 Seepage: Three areas of slight leakage were observed on the left downstream non-overflow face. They were located at the horizontal mortar joints approximately 8 feet and 11 feet below the top of the dam and within a distance of 6 feet to 25 feet from the left edge of the weir. Small vegetation was observed to be growing from the joints, indicating that the flow of was fairly continuous. The flow rate was estimated at 2-5 gpm, total. No other seepage areas were observed on the dam. No seepage was visible at the junction of the dam and the right abutment. Significant seepage was not suspected at the left junction, although direct observation of this area was obstructed by brush. About 5 gpm of seepage was observed a few feet downstream of the right abutment through a horizontal bedding plane between two sandstone strata on the slope.

3.1.4 Reservoir Area: The reservoir shoreline is densely wooded to the water line, with side slopes of approximately 40° (±10°) to the horizontal. No active landslide activity (e.g. exposed rock or soil) was observed.

3.1.5 Downstream Channel: The downstream channel is narrow and rocky. The side slopes of the channel appeared to have questionable stability. There was no sign of a severe erosion of the streambed. The rest of the channel has numerous fallen trees across it, and there was some undermining of the left side of the channel.

3.2 Evaluation: The concrete at the surface shows deterioration, and the open and soft seams that exist at shallow depths in the sandstone strata at the site, as encountered in the borings, are not favorable to the seepage and stability aspects of the dam. These seams are likely to be sources of excessive seepage and planes of weakness for sliding to occur. Data is lacking on the grouting procedures, e.g. information on the diameter of the holes, their depth and spacing, and the grout mix and injection pressure. These conditions need further examinations and annual observations.

The dam site is not easily accessible, and access to the right abutment to operate the gates can be risky, especially during winter.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 Procedures: There are no formal operating procedures, except that the control valves are opened on an as-needed basis to release water for the town's water supply demand.

4.2 Maintenance: Apparently, there has been no maintenance or maintenance procedures for the dam, except for visual observation, valve maintenance and minor patching work.

4.3 Maintenance of Operating Facilities: Operating facilities are operable, according to the owner's representative.

4.4 Description of Any Warning System in Effect: None

4.5 Evaluation: The operation and maintenance procedures for the valves seem adequate for what little operation is involved. Because the ungated spillway cannot adequately pass the PMF or one-half the PMF, a warning procedure should be developed. The warning procedure should be automatic and indicate when an excessive flow of water occurs over the dam and provide a warning to downstream residents of any impending hazardous condition.

SECTION 5 - HYDRAULIC/HYDROLOGY DESIGN

5.1 Design: Design of the dam was done by Wiley and Wilson Consulting Engineers. Drawings showing necessary dimensions and sections of dam are available.

5.2 Hydrologic Data: None available.

5.3 Flood Experience: No experience data are available except that, according to the maintenance crew, the maximum water level over the spillway has been about 2.5 to 3.0 feet. According to the owner's representative, the dam has never been overtopped.

5.4 Flood Potential: Various hydrographs have been routed through the reservoir and the results are presented in paragraph 5.6 and Table 5.1.

5.5 Reservoir Regulation: In case of a large flood, the water can be released through 16-inch water supply pipes via the intake tower and also through the 30-inch x 30-inch sluiceway.

5.6 Overtopping Potential: The PMF, one-half the PMF, and the 100-year flood hydrographs were developed for the Big Cherry Reservoir drainage basin and routed through the reservoir. Table 5.1 summarizes the results of this procedure:

Table 5.1 BIG CHERRY RESERVOIR FLOOD ROUTING

Item	Flood Hydrograph PMF	1/2 PMF	100-year
Peak Flow, c.f.s.			
Inflow	20,500	10,240	5,270
Outflow	15,300	7,070	2,290
Peak Elevation, feet m.s.l.	3,145.1	3,142.1	3,139.3
Ungated Spillway			
Depth of Flow, feet*	8.0	5.7	3.4
Average Velocity, f.p.s.	16.0	13.5	10.4
Dam Overtopping			
Depth of Flow, feet*	3.9	1.7	-
Average Velocity, f.p.s.	11.2	7.6	-
Duration hours	7.7	5.2	
Tailwater Elevation, feet	Not Available	Not Available	Not Available

*Critical depth

The hydrographs were developed and routed by using the HEC-1 computer program (Reference 2 of Appendix IV) 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 IV). Probable maximum precipitation and 100-year precipitation data were obtained from U.S. Weather Bureau publications (References 4 and 5 of Appendix IV). The appropriate reduction factor (0.20) was applied to the PMP in accordance with a Corps of Engineers' directive and guideline. Information from field observations and measurements 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.

5.7 Reservoir Emptying Potential: The Big Cherry Reservoir can be drawn down with the use of the 30-inch x 30-inch sluiceway and the 16-inch diameter cast iron water pipe, both located near the base of the dam with inverts at elevation 3104.5 feet. These allow drawdown of the reservoir from the spillway crest, elevation 3135.0 feet to elevation 3105.0 feet in about 4.0 days.

5.8 Evaluation: The results indicate that the Big Cherry Dam is not capable of passing the PMF nor one-half the PMF without overtopping the dam and is considered "seriously inadequate" in accordance with the criteria of Reference 6, Appendix IV. The peak elevations during the PMF and one-half PMF are 3145.1 feet and 3142.1 feet m.s.l. respectively; and the durations of overtopping for the PMF and one-half the PMF are 7.7 and 5.2 hours respectively. The spillway is capable of passing the 100-year flood but with a very small margin of safety, only 0.2 foot of freeboard at the peak water surface elevation. The spillway is capable of passing 22% of the PMF. These conclusions are based on present day conditions of the drainage basin; therefore, the effects on hydrology due to future developments have not been considered.

SECTION 6 - DAM STABILITY

6.1 Stability Analysis: No record of any stability analysis is available for this dam. Therefore, stability checks were made by making several pertinent assumptions. Based on the boring data given in the drawings (see Appendix I), a weakened horizontal seam is assumed to exist 3 feet below the base of the dam. As mentioned earlier, the characteristics of the material along the seam are not adequately known. Hence, it is assumed for this preliminary analysis that the shearing strength along the seam is composed of the cohesion "c" equal to zero and the friction angle "Ø" equal to 32 degrees.

The drawings also show a line of drain holes starting approximately 6 feet from the heel of the dam, apparently installed to reduce the uplift pressure. It is possible that the drains may become partly or fully inoperative. Hence, the analyses were made for the case when the drains are inoperative. The summary sheet in Appendix V give other details of the analysis and assumptions.

The stability checks indicate that the resultant force falls within the middle third of the base, except for the full PMF condition. The computed maximum toe pressure is 3.66 k.s.f. Overturning pressure exhibit an apparent problem, in that Corps of Engineers' criteria are not satisfied under PMF conditions. The computed factors of safety against sliding are low, varying between 0.54 and 1.07. It should be noted that all these calculations are made for 1-foot width of the most critical section of the dam, ignoring any side resistance forces, which, if included, would substantially increase the computed factors of safety and also reduce the values of the computed toe pressures.

Examination of the side resistance, and stability of the entire dam as a unit, needs further studies before arriving at a conclusion concerning stability of the dam.

6.2 Foundation and Abutment: The open seams indicated on the attached figures seem to be parallel to the bedding planes and may have been originally caused by stress relief or shearing forces. The short durations of overtopping (see Table 5.1) are not likely to cause significant erosion at the abutments; however, increased seepage pressures along the weak seams during the floods are likely to cause sliding. Excessive seepage and resulting deterioration of strength along the weak seams or planes at shallow depths needs further examination and studies.

6.3 Evaluation: The dam needs further examination of its long-term, as well as the true available factor of safety under all loading conditions. The nature, composition, and the strength parameters of the weak seams should be known more precisely for a proper evaluation of the stability of the dam.

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 in paragraph 6.1. Therefore, in accordance with paragraph 3.6.4 of Reference 1 of Appendix IV, assessments should be made regarding seismic stability, based on the studies outlined in paragraph 7.2.a.

SECTION 7 - ASSESSMENT, RECOMMENDATIONS/REMEDIAL MEASURES

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

7.1 Dam Assessment: Hydraulic analyses indicate that the emergency spillway is "seriously inadequate" and cannot pass a flood in excess of 22% of the PMF without overtopping the dam. The ogee spillway is just barely capable of passing the 100-year flood, in that only 0.2 feet of freeboard from the top of the dam would exist. During the one-half PMF, the dam would be overtopped 1.7 feet for 5.2 hours.

The structural integrity of the dam is questionable, and as mentioned earlier, additional tests of the weak underlying seams should be undertaken.

The non-overflow downstream face needs repair. The surface is scaling, and at least one of the horizontal construction joints leaks.

Vehicular access to the outlet valves is possible only from the left side of the dam. It is necessary to walk along the top of the left side of the dam crest and on the flow surface of the spillway with no protective handrails and only a wire or rope to hold onto over the spillway. This approach is dangerous, especially during winter.

7.2 Recommendation/Remedial Measures: The following measures should be completed within one year:

a. A program of test borings, sampling, and analysis should be initiated within 3 months to determine the characteristics, including shear strength, of the underlying weak seams and the rock strata to a depth of 15 to 20 feet below its surface. This should be followed by a revision of the stability analysis.

b. A monitoring program should be established within 3 months to detect any change in seepage characteristics. This includes establishing weirs to measure the flow, measuring flow frequently, and noting water clarity.

c. The downstream channel side slopes should be repaired to prevent further erosion. The channel should be cleaned of all fallen trees.

d. The downstream non-overflow face should be repaired to minimize additional scaling.

e. The one observed 1-1/2-inch underdrain relief pipe and all other clogged relief pipes should be unclogged, and checked annually for free operation.

f. An improved approach to the operational valves should be developed to provide for gate operation under all weather conditions.

g. A warning system which would automatically warn the water treatment plant, the city police and downstream residents of a potentially hazardous condition should be installed.

h. Until the properties and extent of the weak seams under the dam can be determined, and a revised stability analysis performed, it is recommended that the water level in the reservoir be maintained at a normal level of 12.5 feet below the spillway overflow elevation. (This is to allow storage for the 100-year storm and maintan minimal factors of safety.) It is anticipated that the revised stability analysis will indicate at what elevation the reservoir can be maintained with conventional factors of safety.

i. The owner should give consideration to enlarging the spillway in the future.

j. A qualified engineer should perform an inspection of the dam located one mile upstream of this dam.

APPENDIX I

MAPS AND DRAWINGS

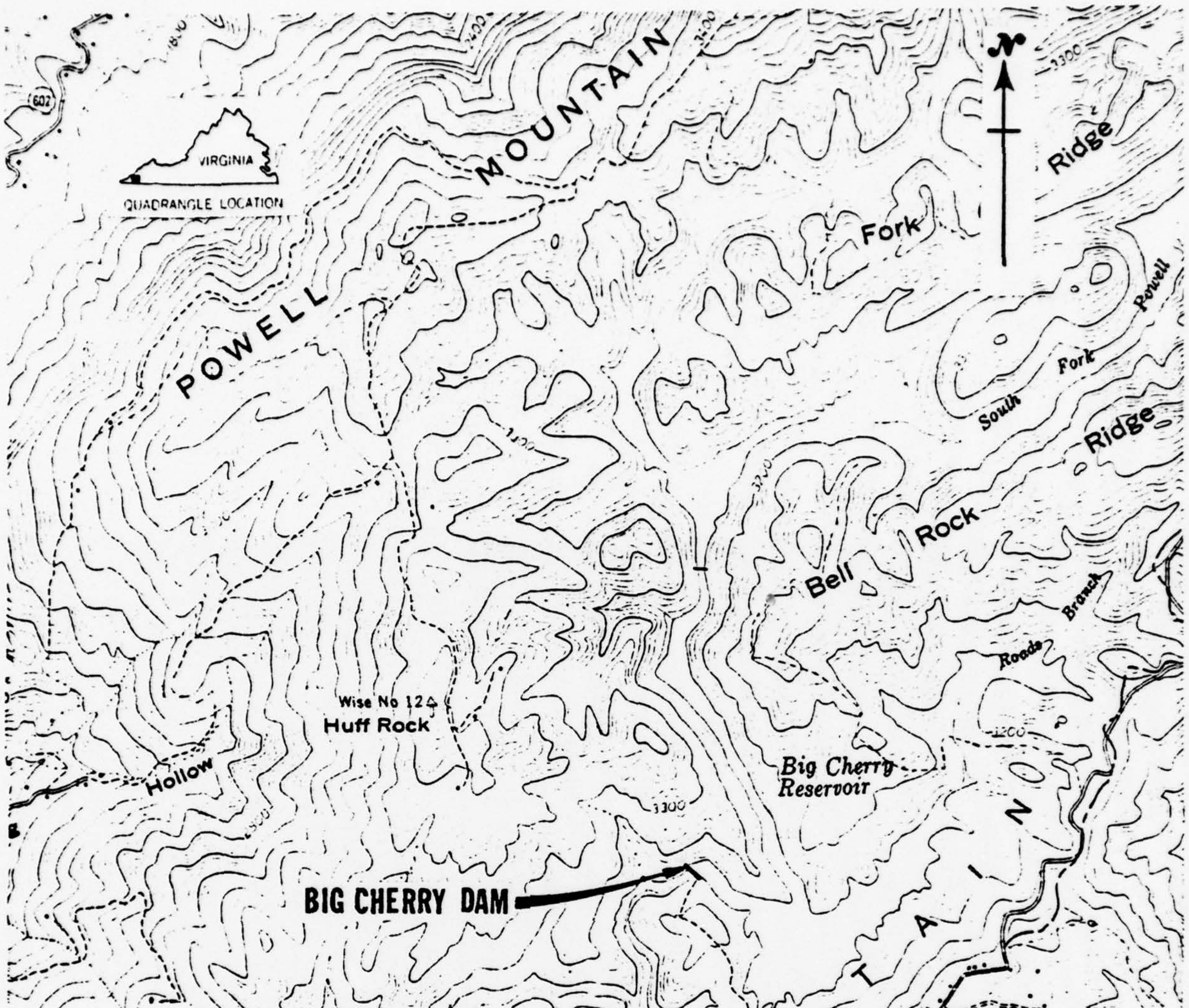
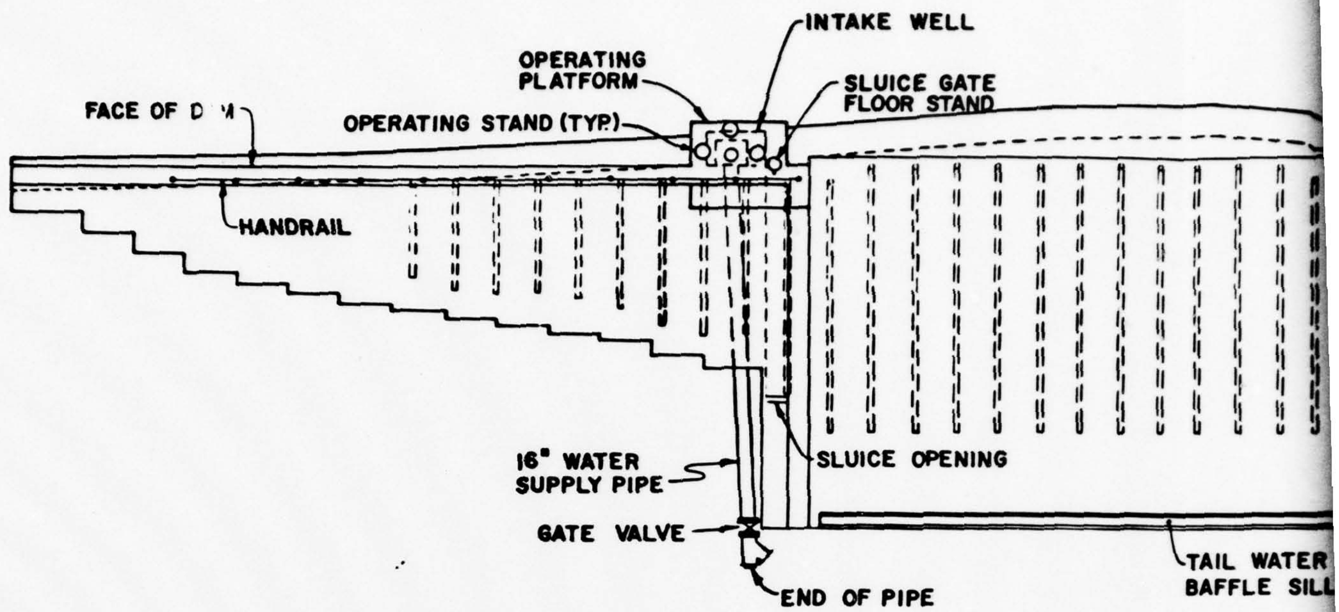
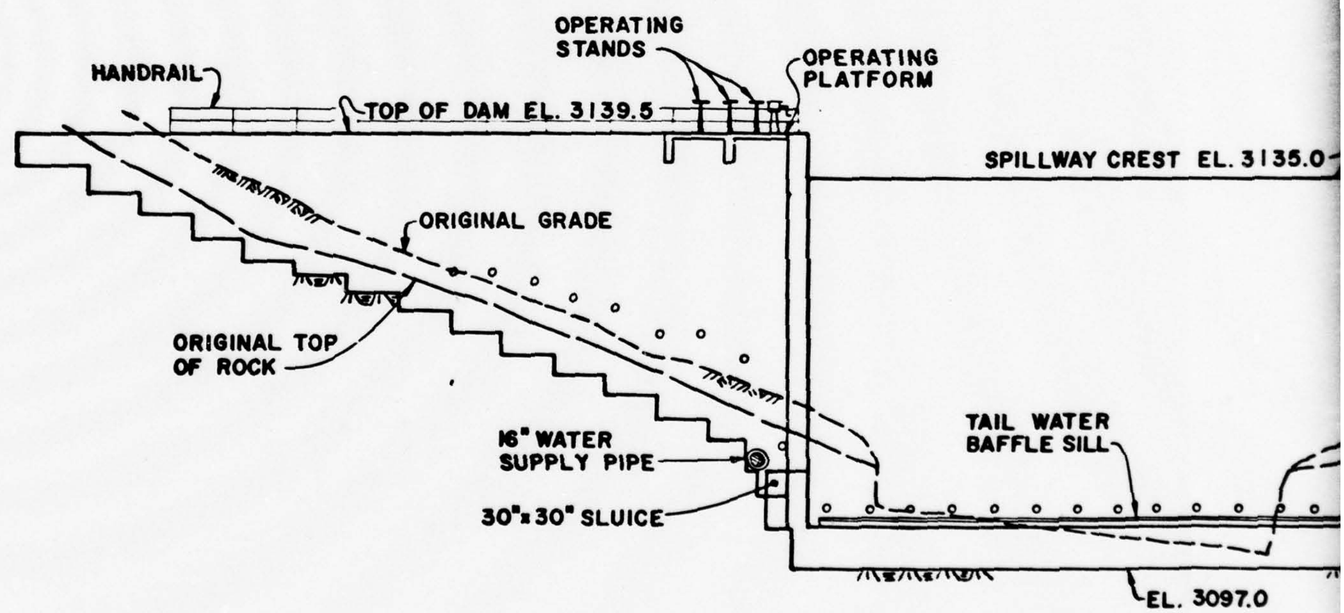


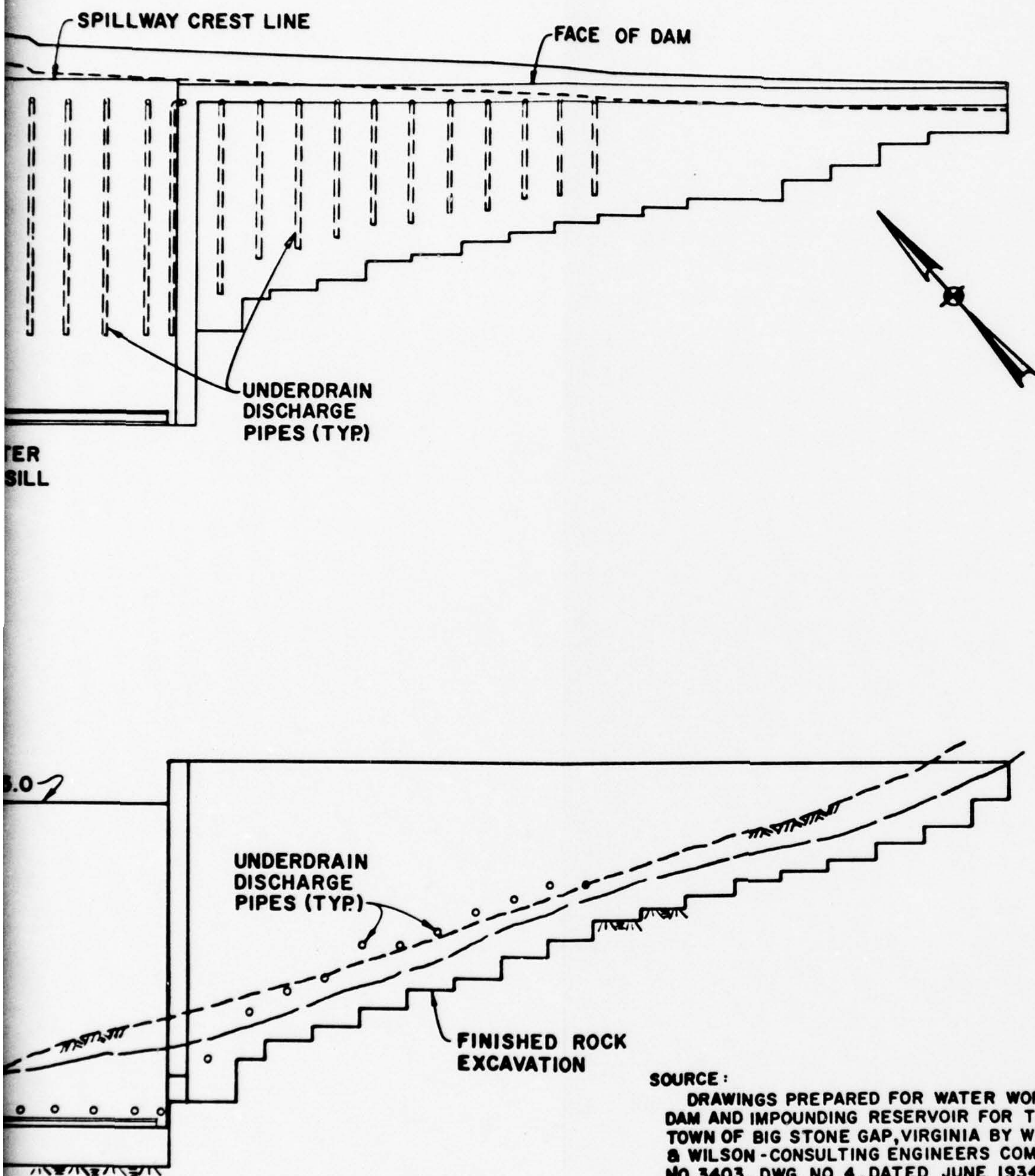
FIGURE I
LOCATION PLAN
BIG CHERRY DAM



PLAN OF DAM

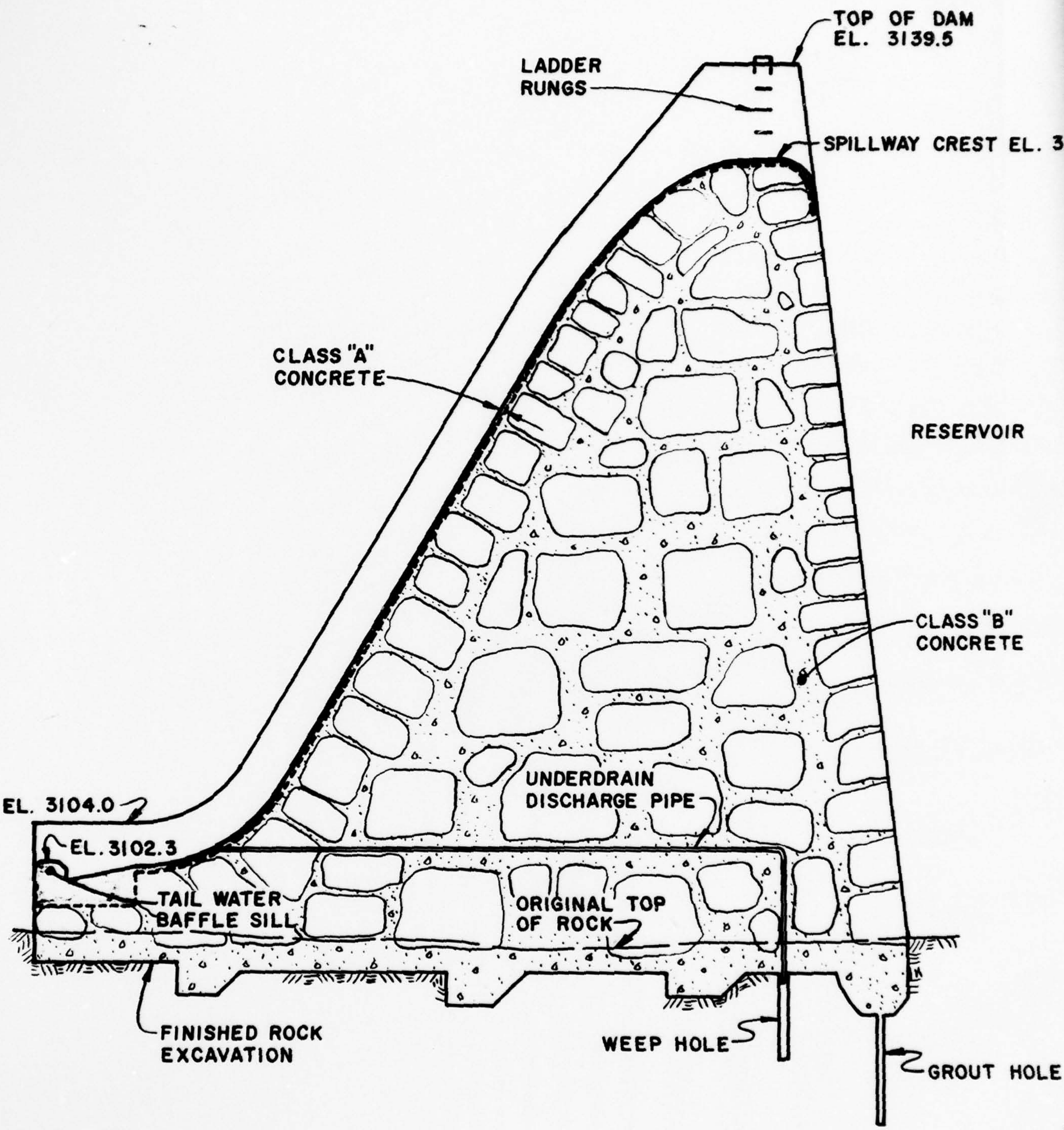


PROFILE OF DAM



SOURCE:
DRAWINGS PREPARED FOR WATER WORKS DAM AND IMPOUNDING RESERVOIR FOR THE TOWN OF BIG STONE GAP, VIRGINIA BY WILEY & WILSON - CONSULTING ENGINEERS COMM. NO. 3403, DWG. NO. 4, DATED JUNE 1934.

FIGURE 2
PLAN & PROFILE
BIG CHERRY DAM



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SECTION THRU SPILLWAY

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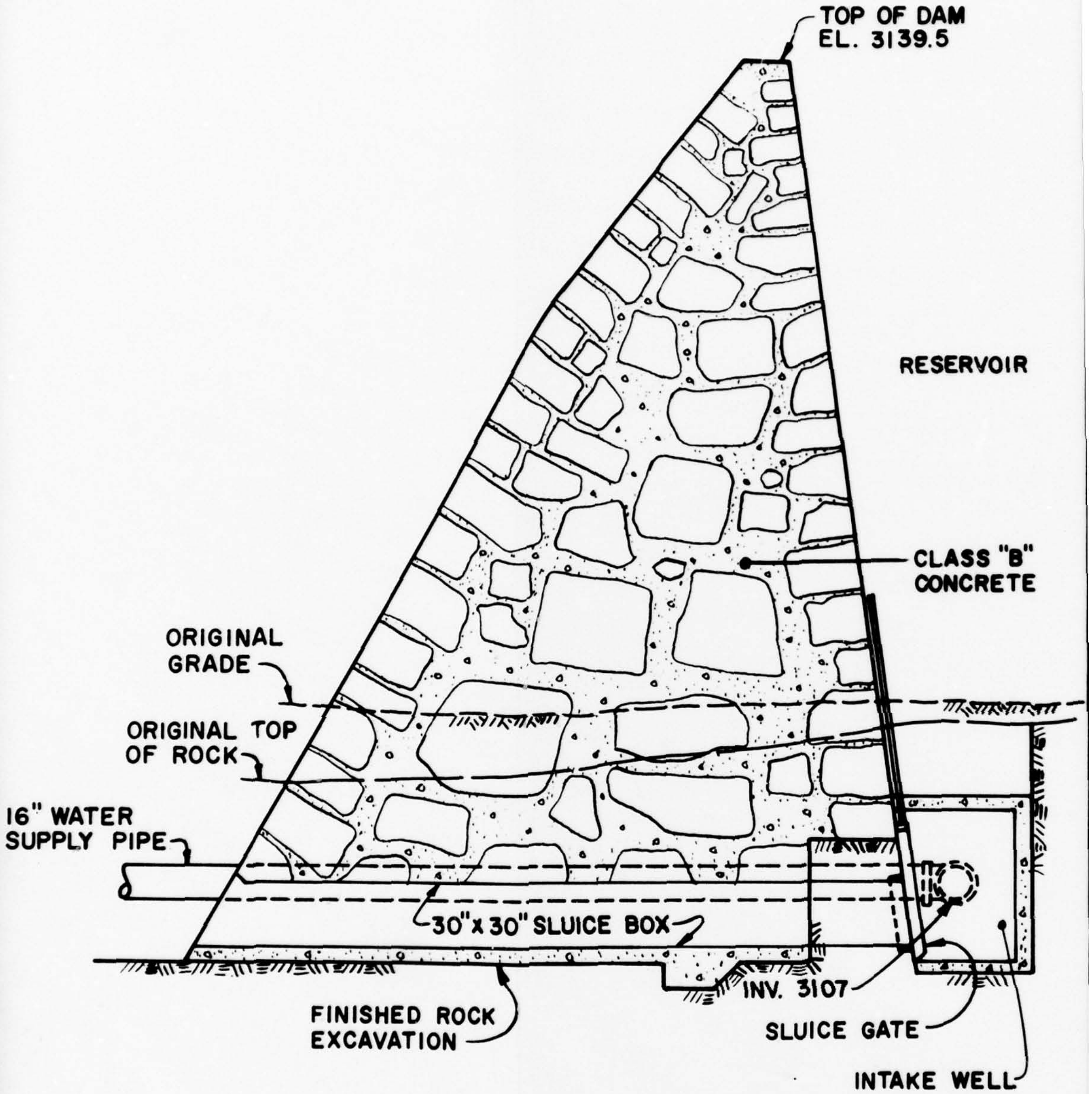
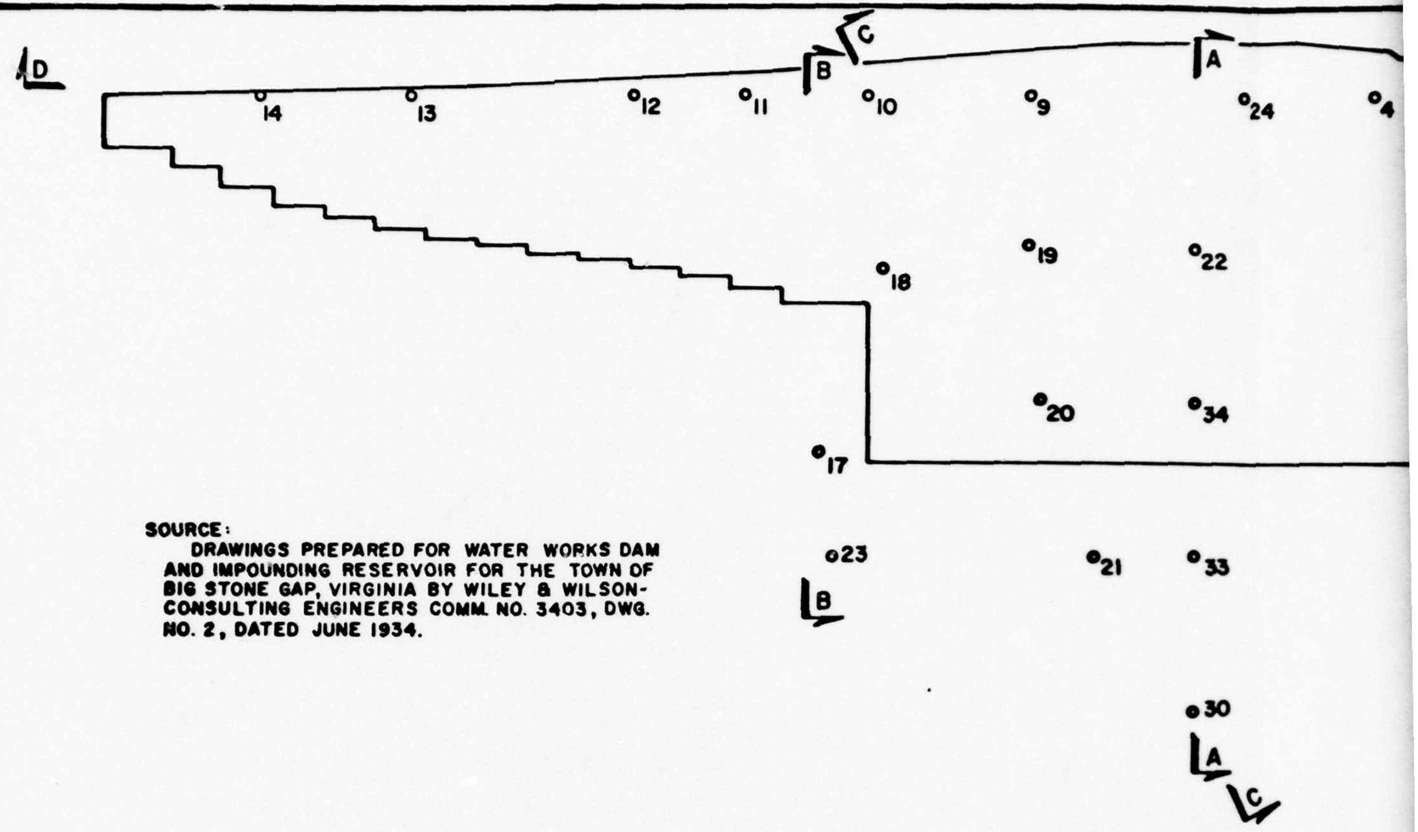


SECTION THRU SLUICE AND INTAKE

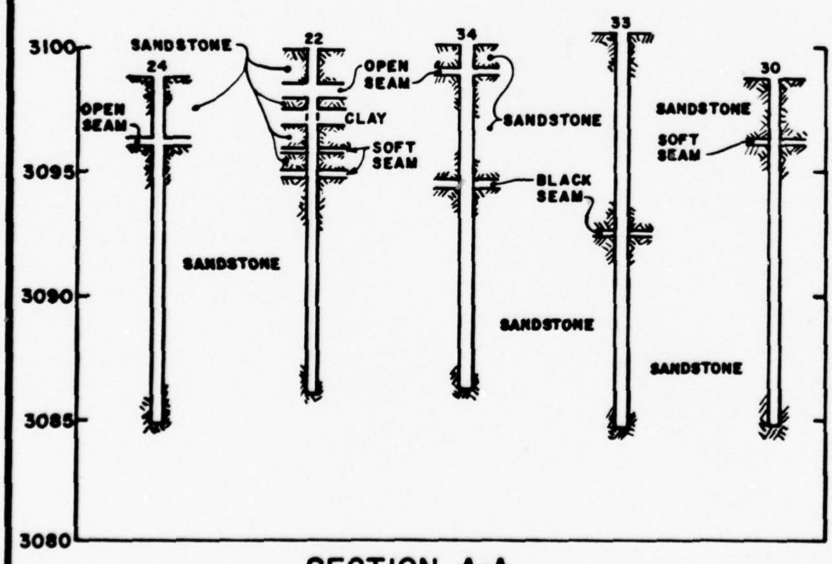
CE:
RAWINGS PREPARED FOR WATER WORKS DAM
IMPOUNDING RESERVOIR FOR THE TOWN OF
STONE GAP, VIRGINIA BY WILEY & WILSON-
SULTING ENGINEERS COMM. NO. 3403, DWG.
5, DATED JUNE 1934.

FIGURE 3
DAM SECTIONS
BIG CHERRY DAM

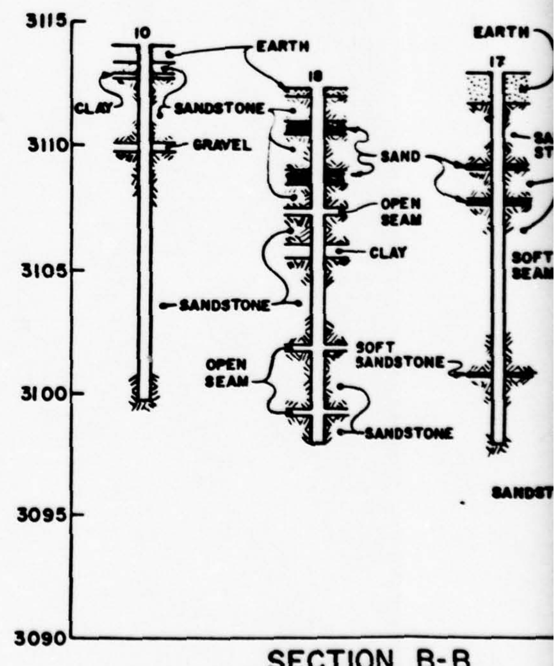


SOURCE:
DRAWINGS PREPARED FOR WATER WORKS DAM AND IMPOUNDING RESERVOIR FOR THE TOWN OF BIG STONE GAP, VIRGINIA BY WILEY & WILSON-CONSULTING ENGINEERS COMM. NO. 3403, DWG. NO. 2, DATED JUNE 1934.

LOCATION PLAN
FOUNDATION TEST DRILLINGS



SECTION A-A



SECTION B-B

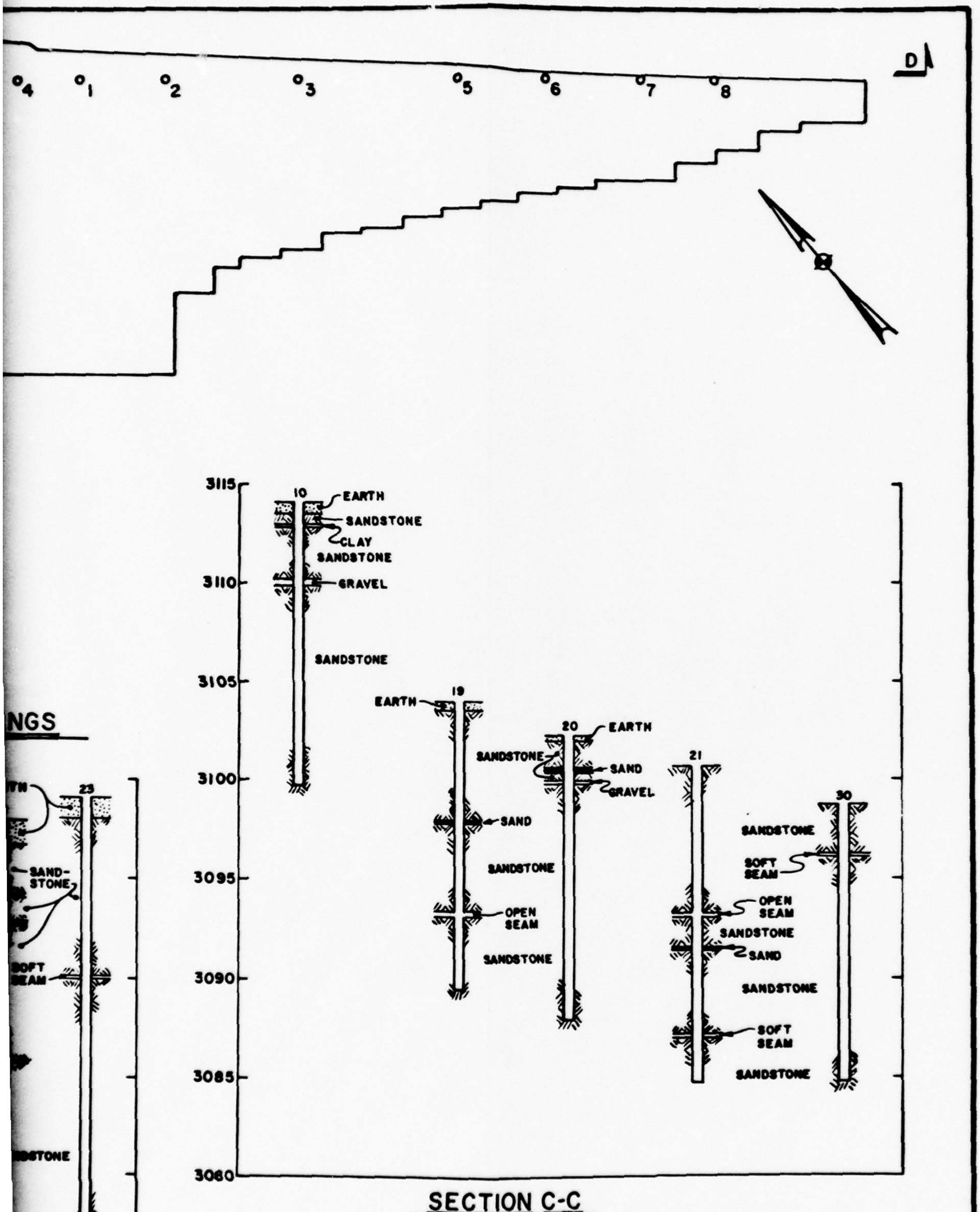
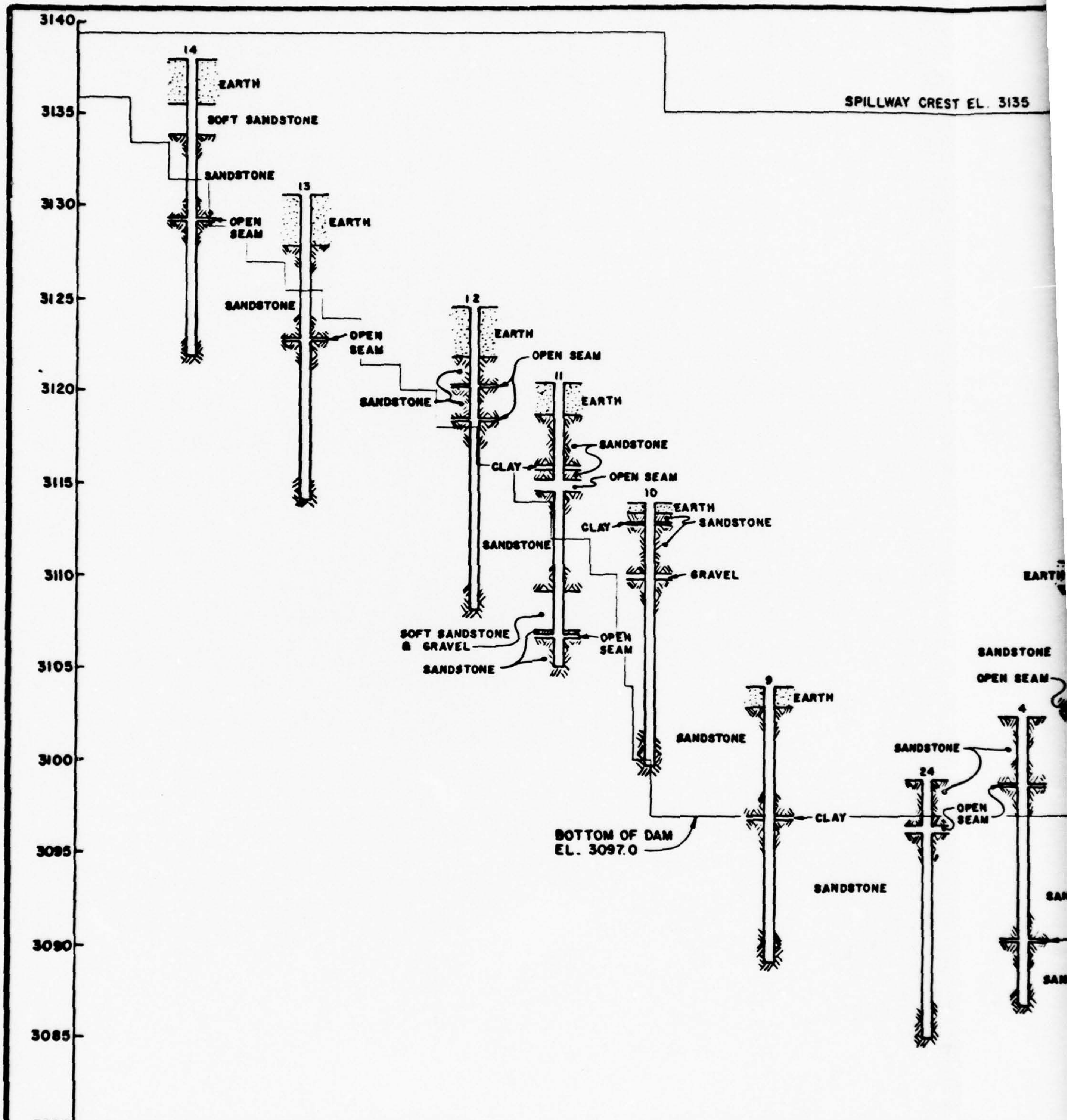
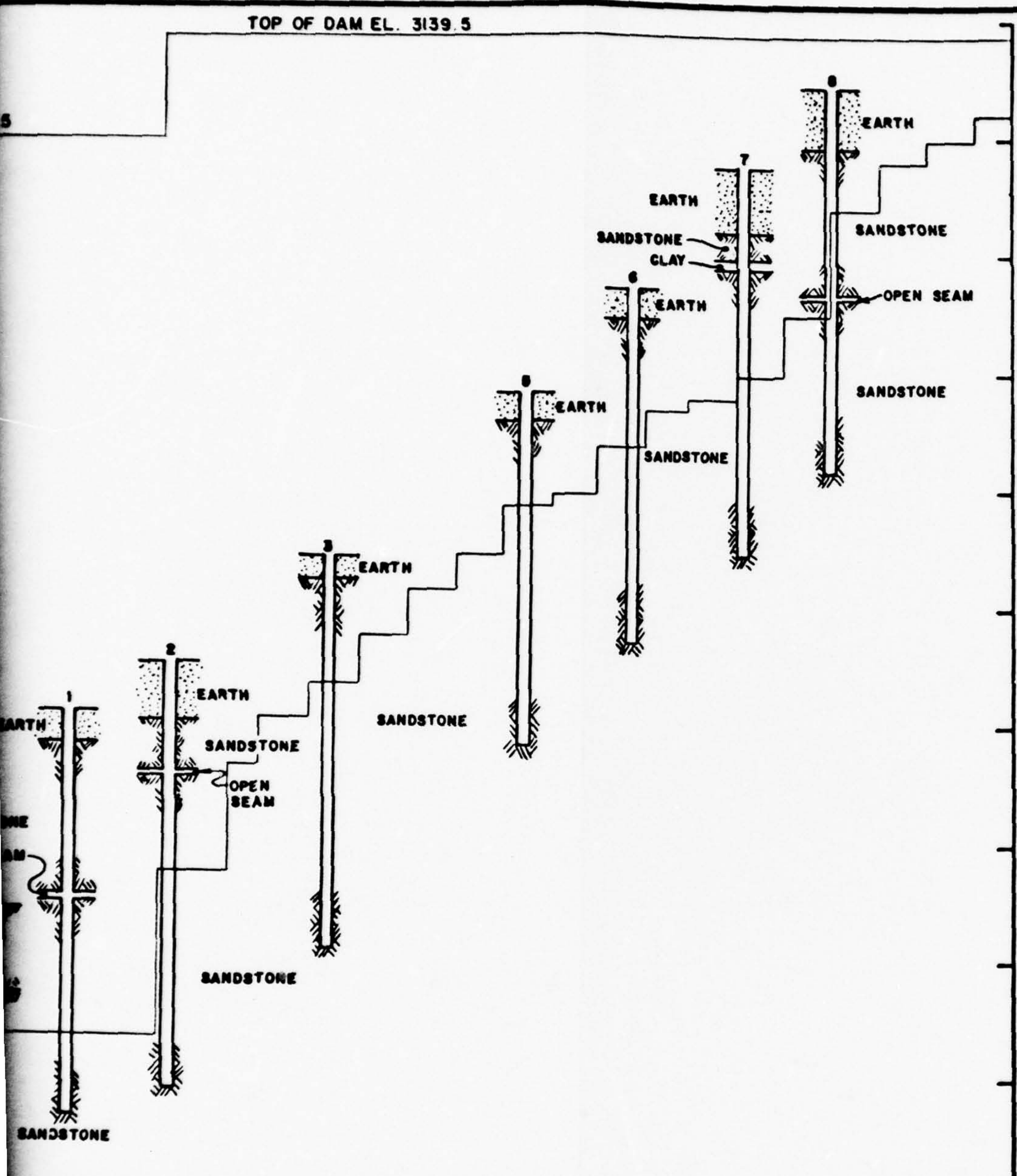


FIGURE 4
PLAN & SECTIONS
FOUNDATION TEST DRILLINGS


3140
3135
3130
3125
3120
3115
3110
3105
3100
3095
3090
3085
3080
SPILLWAY CREST EL. 3135
14
EARTH
SOFT SANDSTONE
SANDSTONE
OPEN SEAM
13
EARTH
SANDSTONE
OPEN SEAM
12
EARTH
OPEN SEAM
SANDSTONE
11
EARTH
SANDSTONE
CLAY
OPEN SEAM
10
EARTH
CLAY
SANDSTONE
SANDSTONE
GRAVEL
SOFT SANDSTONE & GRAVEL
OPEN SEAM
SANDSTONE
9
EARTH
SANDSTONE
BOTTOM OF DAM EL. 3097.0
CLAY
24
OPEN SEAM
SANDSTONE
SANDSTONE
4
SANDSTONE
OPEN SEAM

SECTION D-D



SOURCE:
DRAWINGS PREPARED FOR WATER WORKS DAM AND IMPOUNDING RESERVOIR FOR THE TOWN OF BIG STONE GAP, VIRGINIA BY WILEY & WILSON-CONSULTING ENGINEERS COMM. NO. 3403, DWG. NO. 2, DATED JUNE 1934.

FIGURE 5
SECTION
FOUNDATION TEST DRILLINGS

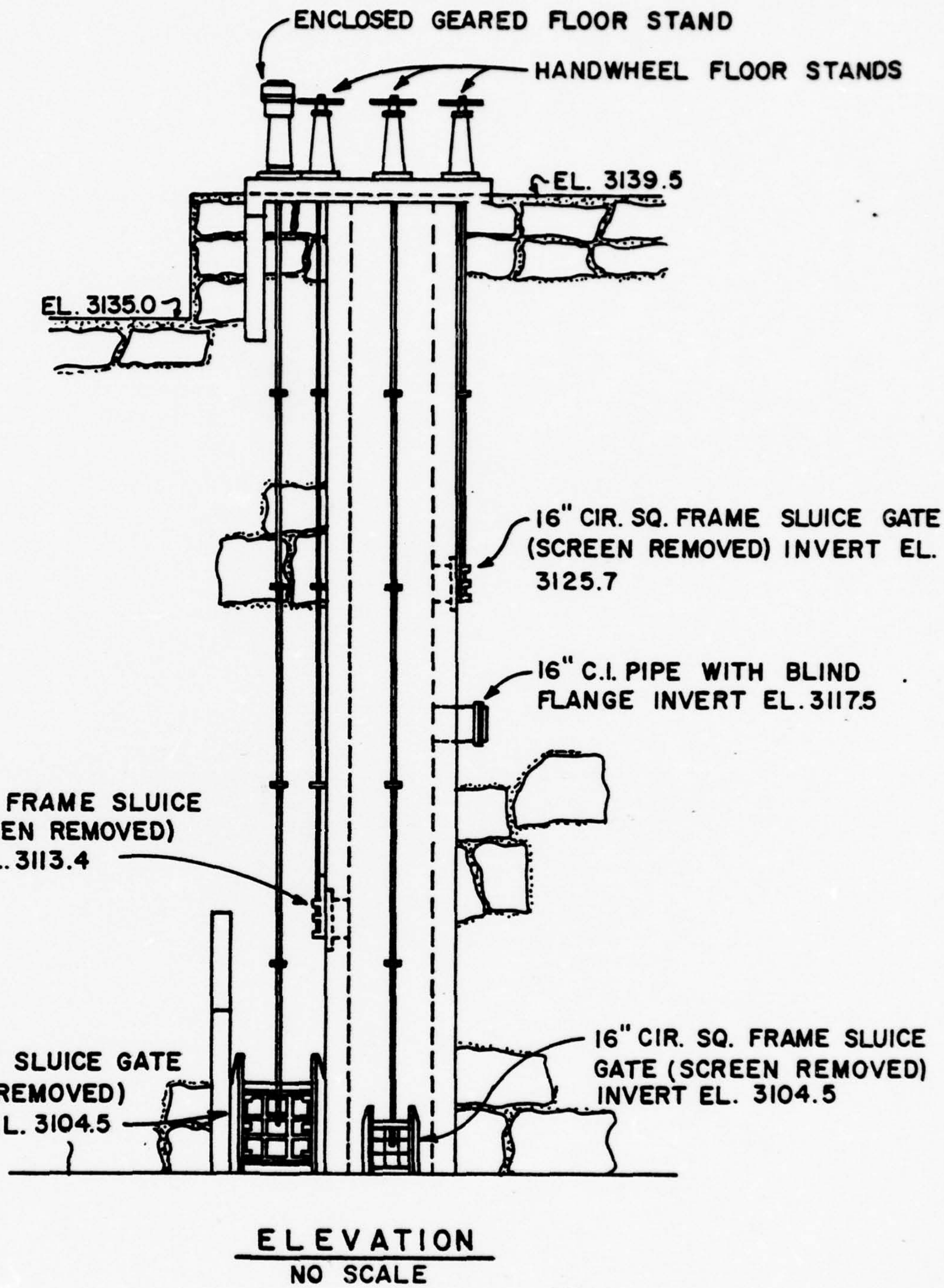
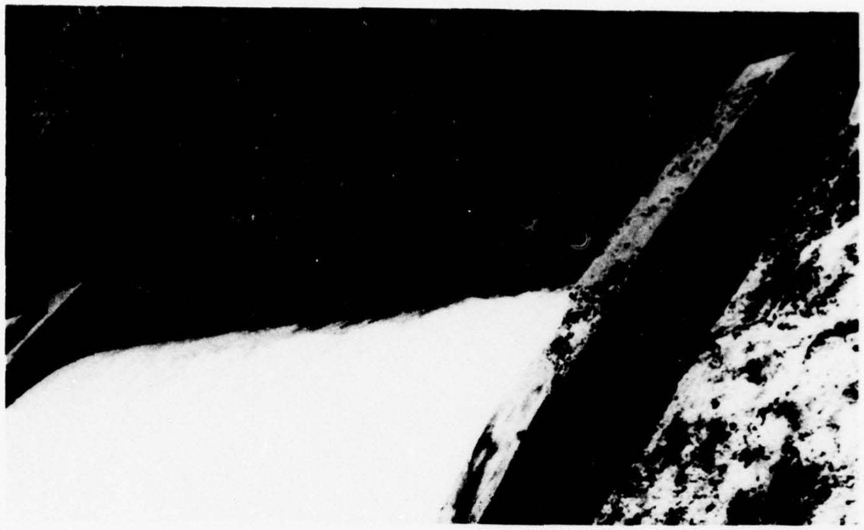


FIGURE 6
BIG CHERRY
INTAKE WELL

SOURCE:
WATER WORKS DAM (DESIGN DRAWINGS)
WILEY & WILSON, CONSULTING ENGINEERS
DRAWING No. 6.

APPENDIX II

PHOTOGRAPHS

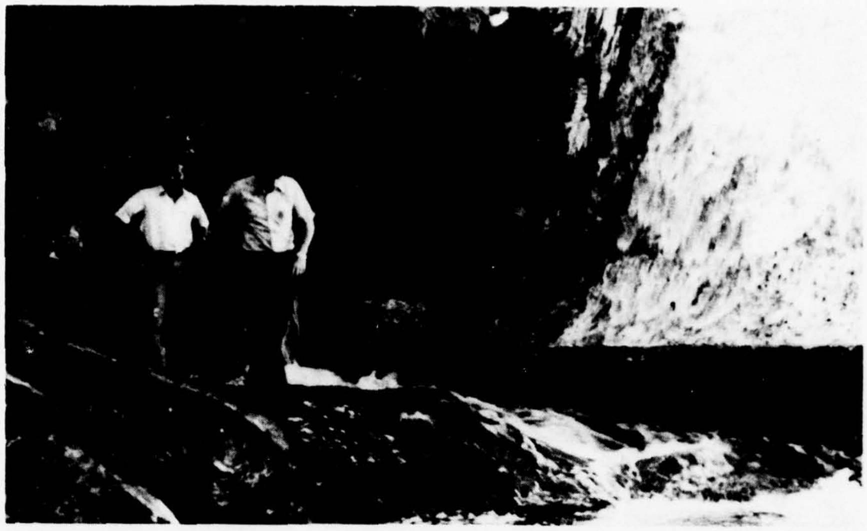


June 1978

TOP OF OVERFLOW WEIR
NOTE: A) WIRE WHICH IS USED TO CROSS THE WEIR, AND
B) SEVERE SCALING AND MOSS GROWTH AT RIGHT

June 1978

VIEW OF STILLING BASIN



June 1978

STILLING BASIN AND RIGHT ABUTMENT

June 1978

DOWNSTREAM CHANNEL

June 1978

UPSTREAM FACE OF DAM

June 1978

CLOSE-UP OF DOWNSTREAM LEFT-SIDE
FACE SHOWING SEEPAGE AREAS

APPENDIX III

FIELD OBSERVATIONS

Check List
Visual Inspection
Phase 1

Name Dam: Big Cherry County: Wise State: Virginia Coordinators: Corps of Engineers
Norfolk District

Date(s) Inspection: June 13, 1978 Weather: Fair Temperature: 80°F

Pool Elevation at Time of Inspection: ±3035.1 feet m.s.l. Tailwater at Time of Inspection: Not Available

Gilbert Associates, Inc.

Inspection Personnel:

Nazir A. Qureshi	Buck Arnold - Virginia State Water Control Board
James A. Hagen	Jim Garrison - Caretaker
Yogesh S. Shah	Alvin Collins - Water Superintendent
	James A. Hagen - Recorder

CONCRETE/MASONRY DAMS

Sheet 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SEEPAGE OR LEAKAGE	Three areas of slight leakage were observed on the left downstream non-overflow face. They were apparently located at the horizontal mortar joints approximately 8 feet and 11 feet below the top of the dam and within a distance from 6 feet to 25 feet from the left edge of the weir.	Leakage should be periodically monitored.
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	The left downstream side abutment-dam junction was covered with brush and fallen trees and was soggy. The junction at the right did not show any sign of distress except for normal weathering effects.	None
DRAINS	The 1-1/2-inch underdrain discharge pipe at right side, (approximately 3 feet above stilling basin pool level) appears to be partially clogged. The drawings also show a line of drain holes approximately 6 feet from the heel.	The 1-1/2-inch pipe is probably one of the underdrain discharge pipes shown on the design drawings. They should all be unclogged.

CONCRETE/MASONRY DAMS

Sheet 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
WATER PASSAGES	A 16-inch cast iron pipe and a 30-inch x 30-inch concrete tunnel run parallel through the dam, at the vicinity of the left edge of the overflow structure.	None
FOUNDATION	As observed from the toe of the overflow spillway, the foundation appears to be rocky and composed of sandstones. Large pieces of sandstones of harder variety were observed at the toe of the spillway. These stones showed good resistance to erosion. No significant surficial distress to the foundation strata was observed.	
SURFACE CRACKS CONCRETE SURFACES	Random surface cracking on the upstream face, above the water line. Some areas appeared to have been previously repaired.	
STRUCTURAL CRACKING	None observed.	
VERTICAL AND HORIZONTAL ALIGNMENT	Crest appeared to be straight both vertically and horizontally.	

CONCRETE/MASONRY DAMS

Sheet 3

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONOLITH JOINTS	None observed.	
CONSTRUCTION JOINTS	Horizontal construction joint located 8 to 10 feet below top of non-overflow face. Light vegetation growing from seam.	The seepage should be observed and monitored monthly.

OUTLET WORKS

Sheet 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Non-applicable.	
INTAKE STRUCTURE	None observed.	
OUTLET STRUCTURE	Observed to be a 16-inch cast iron pipe. Visible portion of the pipe appeared to be in good condition.	None
OUTLET CHANNEL	See downstream channel comments, sheet "Downstream Channel."	
EMERGENCY GATE	None observed.	Design drawings indicate a sluice gate for a 30-inch x 30-inch concrete tunnel.

UNGATED SPILLWAY

Sheet 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	No cracking or spalling of concrete mortar on the spillway chute.	
APPROACH CHANNEL	Reservoir itself not visible.	Dam is protected from wave buildup on reservoir by topography.
DISCHARGE CHANNEL	Rocks and trees; no signs of slope failure. Right bank is steep. Lenses of highly decomposed, friable, conglomeratic sandstone seen exposed a few feet downstream from the dam. Seepage along bedding planes was observed; quantity was approximately 5 g.p.m.	The source of seepage could not be ascertained.
BRIDGE AND PIERS	No railing or bridge. A wire tied from left abutment to right abutment. All the controls are on right abutment. Right abutment has railing. No access to right abutment except crossing the spillway.	Left abutment should have railing and bridge over the spillway, or access to right abutment must be provided.

INSTRUMENTATION

Sheet 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None observed.	
OBSERVATION WELLS	None observed.	
WEIRS	None observed.	
PIEZOMETERS	None observed.	
OTHER		

RESERVOIR

Sheet 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Slopes are thickly vegetated. Slopes are relatively flatter than the downstream channel. No slope failures seen.	
SEDIMENTATION	Not visible.	

DOWNSTREAM CHANNEL

Sheet 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Rocks and logs across channel.	Channel should be cleaned of debris.
SLOPES	Steep and heavily forested.	
APPROXIMATE NO. OF HOMES AND POPULATION	There are no homes shown on the latest (1957) USGS 7-1/2 minute quadrangle maps for 2 miles below the dam. However, this area is shown to be a narrow forested valley. Where the area widens there are about 50 buildings shown with an estimated population of 200 people.	

APPENDIX IV

REFERENCES

APPENDIX IV

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.

6. Engineering Technical Letter No. 1110-2-234, Reviews of Spillway Adequacy, (Washington, D.C., Department of the Army, Office of the Chief of Engineers).

APPENDIX V

STABILITY ANALYSIS

APPENDIX V

STABILITY ANALYSIS

Following is a summary of the assumptions and results of the various combinations of hydrostatic and other forces acting on the dam and affecting its stability.

General assumptions:

a. A weak plane (based on the soil borings in Appendix I) was assumed to exist at elevation 3093 feet, and to extend 32 feet past the toe of the dam; sliding stability was calculated along this plane.

b. The specific weight of rock was assumed to be 150 pounds per cubic feet (p.c.f.), and that of masonry also 150 p.c.f.

c. The internal angle of friction at the sliding plane in the rock, ϕ was assumed to be 32 degrees; the cohesive strength of the sliding plane was assumed to be zero.

d. From hydrological and hydraulic investigations, the following water elevations were determined:

PMF: 3145.1 feet m.s.l.
One-half PMF: 3142.1 feet m.s.l.
Normal water level, with ice: 3135.0 feet m.s.l.

e. Ice loading at the spillway crest elevation was assumed to be 1 foot thick and exerting a pressure of 5 kips per square foot.

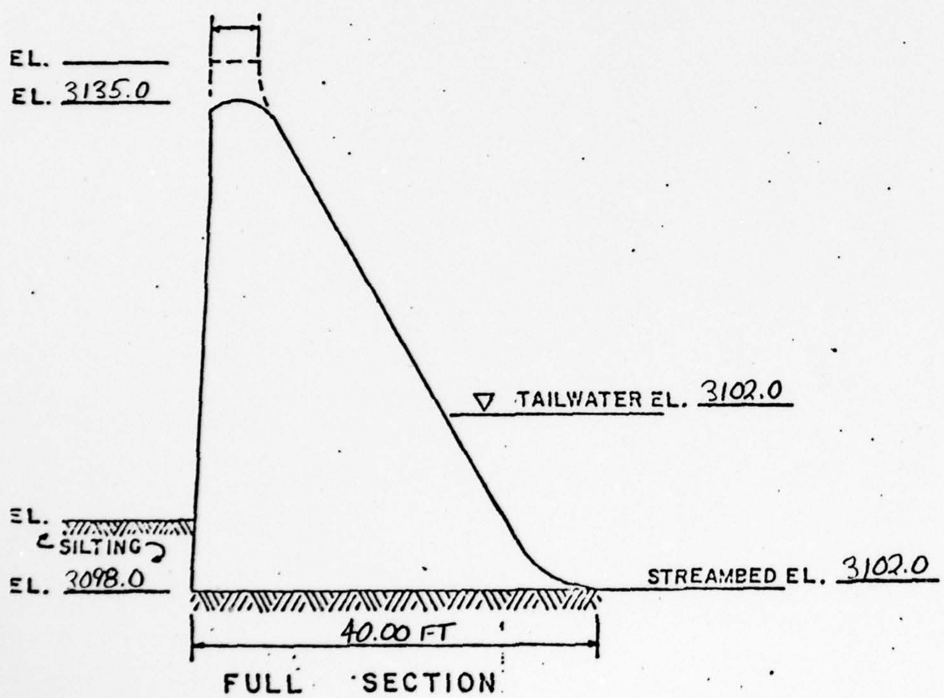
f. The underdrain discharge lines were assumed to be completely non-operational, which results in the development of full uplift pressures.

g. In calculating factors of safety for overturning and sliding, a 1-foot wide section in the middle of the spillway section was assumed. The results of the dam stability are therefore conservative, because side resistance forces were not taken into account.

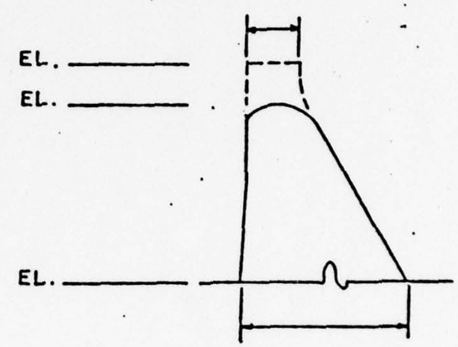
GRAVITY DAM DESIGN
STABILITY ANALYSIS

ANALYSIS DONE ON X FULL SECTION ___ PARTIAL SECTION
LOCATION OF SECTION Big Cherry Dam
ANALYSIS PREPARED BY DC Beechwood

LOADING CASE	ELEV. HEAD WATER	ELEV. TAIL WATER	ΣV	ΣH	$\frac{\Sigma H}{\Sigma V}$	LOCATION RESULTANT FROM TOE	% BASE IN COMPRESSION	FACTOR SAFETY SLIDING	FOUNDATION PRESSURE	
									TOE	HEEL
PMF	3145.1	3102.0	63.0 K/FT	66.1 K/FT	1.05	11.49 FT	86%	0.54	3.66 KSF	0.0 KSF
½ PMF	3142.1	3102.0	66.8	59.1	0.88	14.27	100%	0.67	3.11	0.23
Normal Water Level + Ice	3135.0	3102.0	75.6	47.7	0.63	17.31	100%	1.04	2.65	1.13



FULL SECTION



PARTIAL SECTION

NOTES: Analysis Performed on 1 FT. Thick Section with Full Uplift
For Sliding Along Potential Failure Plane,
$\phi = 32°$
$S = 0$

APPENDIX VI

CONDITIONS

APPENDIX VI

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.